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Post-COVID-19 Society and Profound Societal Shifts

Edited by Patricio Trujillo-Montalvo



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Contributors

Ankit Pandey, Bekir Cihan Uçkaç, Bilal Kargi, Dillo Justin Ramoshaba, Jan P. Grundling, Kandasamy Karthikeyan, Lizl Steynberg, Mapula Hildah Lefophane, Margaret Kaseje, Mario Coccia, Motsatsi Morwatshehla, Mukti Advani, Nelly Vuyokazi Sharples, Niraj Sharma, Singaram Sudha, Surajmani Shalini, Victor Mbulaheni Mmbengwa

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Aims and Scope of the Series

The social sciences, as a form of scientific knowledge anchored on epistemological foundations, theories, and specific methodologies, both in their fundamental and applied dimensions, are paramount for understanding and, consequently, developing instruments that contribute to improving social and environmental living conditions. This Social Sciences book series, based on the concept of the social sciences as key elements in the promotion of scientific knowledge and its inherent consequences, has as its primary goal to be a space for the dissemination of relevant information on various objects of study, aimed at specialists, students, policymakers, and others interested in the challenges facing humanity. Thus, the aim is to promote scientific progress through the sound and rigorous dissemination of studies that, from the perspective of the social sciences, either through a specialised disciplinary approach or through interdisciplinary perspectives, foster a deeper understanding of the objects under analysis, clarifying the issues addressed and their implications.

Meet the Series Editor



Dr. Sandro Serpa is an Associate Professor in the Department of Sociology at the University of the Azores (UAc), Portugal. His career in social sciences and education began at UAc in 2000. He earned his Ph.D. in Education, specializing in Sociology of Education, from UAc in 2013. He is also an integrated researcher at the Interdisciplinary Centre of Social Sciences of the Azores Centre (CICS. NOVA. UAçores). Dr. Serpa has demonstrated a strong commitment to higher education throughout his career. He has served in various positions at UAc, including Head of the Department of Sociology, Director of the Bachelor's in Social Work, Coordinator of the Scientific-Pedagogical Supervision Team for Social Work Internships, Member of the Pedagogical Council of the Faculty of Social and Human Sciences, and Member of the Quality Commission. Additionally, he held the position of Deputy Director of CICS. UAc. Currently, he serves as Senior Editor (Sociology Section) for Social Sciences & Humanities Open (Elsevier), among several other journals. He previously held the position of Senior Editor - Sociology Section for Cogent Social Sciences (Taylor & Francis) from 2020 to 2022. Dr. Serpa maintains a distinguished research profile, evidenced by over 400 publications in international journals, books, and other scientific outlets across a wide range of countries: Brazil, Canada, China, United Arab Emirates, Germany, India, Kazakhstan, the Netherlands, Pakistan, Poland, Portugal, Romania, Spain, Switzerland, Turkey, United Kingdom, United States of America. His research interests encompass Teaching Sociology, Sociology of Education, Sociology of Organisations, Organisational Culture, Scientific Communication, Digital Society, Digital Literacy, Society 5.0 and Sociology of Artificial Intelligence. Dr. Serpa emphasizes the importance of integrating academic knowledge with service to the university and society at large.

Meet the Volume Editor



Patricio Trujillo-Montalvo is a Professor at the Faculty of Health and Wellbeing and a researcher at the Institute of Public Health of the Pontificia Universidad Católica del Ecuador (PUCE). His work focuses on mental health, interculturality, and structural violence in Indigenous, Afro-descendant, and urban communities in Ecuador. He has led research on youth suicide, burnout among health students, and the revaluation of ancestral practices. During the COVID-19 pandemic, he studied cultural responses to confinement, illness, and death. He is part of international projects on the intercultural adaptation of the WHO's mhGAP. He conducts critical ethnographic research with Kichwa and Waorani peoples through participatory, decolonial, and collective health approaches.

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Preface

The global outbreak of COVID-19 at the end of 2019 marked a turning point in contemporary history. From its initial identification as a pneumonia of unknown cause in the city of Wuhan, China [1], to its subsequent declaration as a pandemic by the World Health Organization in March 2020, the SARS-CoV-2 virus had an unprecedented impact on all spheres of human life. The resulting health crisis quickly evolved into an economic, social, emotional, and cultural crisis, exposing multiple accumulated vulnerabilities in global systems of social and political organization.

Beyond its epidemiological dimension, the pandemic revealed deep structural inequalities that disproportionately affected already marginalized populations. The imposition of lockdowns, quarantines, and social distancing measures led to substantial changes in the everyday lives of millions of people, resulting — in addition to the physical effects of the virus — in lasting psychosocial consequences, such as increased anxiety, distress, isolation, and a widespread sense of uncertainty about the future.

The enforced lockdown, implemented as a key strategy to prevent the spread of the virus and reduce mortality, nonetheless had ambivalent consequences. While it undoubtedly saved countless lives, it also deepened economic disparities, led to massive job losses, and radically altered family, emotional, and community life. Isolation measures forced a rethinking of notions such as space, proximity, and connection, deeply reshaping social fabrics across multiple scales — from the intimate to the institutional, from the local to the global.

From a range of disciplinary perspectives, approaches, and concerns, the contributions gathered in this collective volume explore the multiple transformations brought about by the pandemic. Among other topics, they examine the reconfigurations of public and private space, the impact on individual and collective mental health, emerging forms of exclusion and resistance, as well as the tensions between scientific knowledge, digital communication, and governance. These reflections not only help us understand the immediate effects of the crisis, but also raise important questions about the kind of society we are building in its aftermath.

A transversal theme in the perspectives presented here is the understanding of COVID-19 not merely as a viral phenomenon, but as a syndemic—that is, an event arising from the interaction between biological factors and social, economic, and cultural determinants that exacerbate its consequences [2]. This approach, initially proposed within the field of medical anthropology, enables a more comprehensive reading of both the pandemic and post-pandemic processes, moving beyond strictly biomedical or technocratic interpretations.

In particular, this volume offers a situated interpretation of the syndemic from the Global South, bringing together studies and research conducted in historically peripheral contexts, such as various regions of Africa and India. It emphasizes the need to

shed light on the impacts of COVID-19 in rural areas, within community-based health systems, and in the development of local public policies—areas where responses to the crisis have often received neither the same level of attention nor the same resources as urban centers. This approach provides a critical and plural reading of how the syndemic has affected bodies, territories, and ways of life in contexts marked by deep structural inequalities.

The analyses compiled in this book aim to challenge the dominant narratives of a “return to normality”, recognizing that such normality was precisely the breeding ground for many of today’s crises. Instead, the volume calls for an open debate on the possibilities for deep transformation, social justice, and the construction of new forms of care, solidarity, and communal life.

The studies included in this work critically address key issues such as education, child nutrition, access to vaccines, health and community infrastructure, and the effects on mental health, particularly in rural or peripheral areas. These thematic axes make it possible to understand how local public policies, often centralized and disconnected from context, were insufficient to address the multiple layers of social harm produced. At the same time, the contributions presented here offer interpretive frameworks that shed light on local responses, forms of community resilience, and the possibilities for structural transformation in the post-pandemic landscape.

This volume does not seek to close the debate, but rather to open new pathways for critical and situated analysis of the post-COVID-19 world, while highlighting the importance of understanding social responses from the ground up, through the interweaving of local knowledge, public policy, and memories of past crises.

We extend our sincere appreciation to all those who contributed to the production of this volume, whose intellectual and human commitment made this publication possible.

Patricio Trujillo-Montalvo
Public Health Institute,
Pontificia Universidad Católica del Ecuador,
Quito, Ecuador

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Examining Food Purchasing Behavior of Rural Households in South Africa Post-COVID-19 Lockdown Restrictions

*Mapula Hildah Lefophane, Motsatsi Morwatshehla
and Victor Mbulaheni Mmbengwa*

Abstract

This study examines food purchasing behavior among rural households in South Africa post-lockdown restrictions and the socio-demographic factors influencing these behaviors. Primary data were collected from 327 households in Mokgolobotho village through face-to-face interviews, using simple random sampling. A Likert scale, Chi-square analysis, and an Ordered Probit model were employed for the analysis. The findings indicate that most households purchased food more frequently post-lockdown, with fresh produce, dairy, snacks, fast food, prepared food, and alcoholic beverages purchased more often. Household size, employment sector, brand loyalty, and market preference reduced the likelihood of monthly purchases while increasing the probability of frequent shopping. Conversely, gender, education level, employment status, SRD grant, savings behavior, advertisement, and market distance increased the likelihood of monthly purchases while reducing frequent shopping. These findings highlight the need for retailers to ensure affordability, accessibility, and consumer trust, while policies improving financial security, employment stability, market access, and consumer education can enhance food access and promote sustainable purchasing behavior.

Keywords: food purchasing behavior, rural households, Post-COVID-19, lockdown restriction, South Africa

1. Introduction

The lockdown restrictions, which were imposed in various forms around the world to curb the spread of COVID-19, resulted in changes in consumers' food shopping and consumption behaviors [1–3]. The key notable restrictions that were imposed in the food retail sector include social distancing, and a restriction on the number of customers inside stores and at checkout points [4, 5]. In the South African context, the restrictions also encompassed the prohibition of the sale of certain food items during

the early stages of the lockdown restrictions. These restrictions, as well as consumers' concerns about their health, prompted consumers to change their frequency of shopping, purchase certain food items more or less than usual, and change their behavioral consumption of food [1–3].

Several studies investigated food purchasing behavior during the COVID-19 pandemic. Four main findings can be deduced from those studies as follows. First, there were changes in the modes of acquiring food, with consumers opting for the mode of transport that enabled them to deal with or avoid the risk of infection [3, 6, 7]. Second, there was a decline in grocery shopping frequency due to lockdown restrictions [6, 7]. Third, consumers bought food more than usual to minimize visiting stores frequently [6, 8]. Lastly, there were changes in eating behavior with consumers shifting toward healthier foods [6, 9].

The aforementioned investigations were conducted during COVID-19, when lockdown restrictions were tighter, and the virus spread rapidly. As a result, consumers' food purchasing behavior could have shifted due to the decline in COVID-19 cases, vaccination rollout, and the termination of lockdown restrictions. Consequently, there exists a gap in the literature regarding consumers' food purchasing behavior and associated factors post-lockdown restrictions. This study addresses this gap by examining food purchasing behavior among rural households post-lockdown restrictions in South Africa and the contributing factors. This is achieved through two objectives. The first objective is to determine changes in the frequency of grocery shopping by rural households post-lockdown restrictions. This includes examining whether consumers purchased certain food items the same, more, or less frequently post-lockdown compared to during lockdown restrictions.

The second objective is to explore the relationship between the socio-demographic characteristics of rural households and their food purchasing behavior post-lockdown. This includes assessing how socio-demographic characteristics influenced food purchasing behavior, particularly in relation to changes in shopping frequency. The findings provide valuable insights into rural households' most preferred shopping frequency and their most preferred food items post-lockdown restrictions. By doing so, this study offers retailers critical knowledge about consumers' preferences, which would assist them in developing effective marketing and advertising strategies tailored to meet the needs of rural households.

The remainder of the sections in this study are arranged as follows. Section 2 presents literature review, highlighting areas of commonality among previous studies and identifying gaps in the literature. Section 3 focuses on the case study, including a description of the study area, data collection and sampling procedures, and data analysis techniques. Section 4 presents the results, including findings from both descriptive analyses and correlation analyses, as well as the Ordered Probit model analysis. Section 5 concludes the study by summarizing key findings, discussing their implications, and offering recommendations for future research.

2. Literature review

2.1 Areas of commonalities

In reviewing the studies on consumer behavior during the COVID-19 pandemic, several key areas of commonality emerge. These include health and safety concerns, an increased focus on food security and stockpiling, a shift to online shopping and

delivery services, and the influence of socio-demographic factors on consumer behavior. Additional aspects include psychological impacts and consumer anxiety, adaptation of eating habits, and the impact of external stressors on consumer behavior. These aspects are comprehensively discussed below.

Regarding health and safety concerns, many studies highlighted that health concerns significantly influenced food purchasing and eating behaviors during the pandemic. This was evident in studies across different countries, such as Bolek [9] and Marinković Lazarević [10], where consumers prioritized healthier food choices and increased their focus on immune-boosting foods. The perceived risk of the virus also prompted consumers to adopt behaviors aimed at reducing contact with others, such as shopping online or increasing food preservation practices (e.g., freezing food), as seen in studies like Jeżewska-Zychowicz et al. [11] and AlTarrah et al. [12]. This common theme suggests a widespread shift toward health-conscious behaviors driven by fear of the virus.

A noticeable trend across several studies was the shift toward stockpiling and purchasing larger quantities of food. This was observed in Ben Hassen et al. [6], Rabbi et al. [7], and Pappalardo et al. [8], where participants increased the volume of food bought per trip, often focusing on non-perishable items, to ensure food security during uncertain times. This behavior can be attributed to both economic stress (increased food prices, income reductions) and the fear of food shortages, reflecting how external stressors, such as supply chain disruptions, amplified the desire to secure food resources.

Online shopping and the use of delivery services emerged as a dominant theme across multiple studies, including AlTarrah et al. [12], Khayru [13], and Ogundijo et al. [14]. The need to minimize physical contact due to health concerns led to a rise in digital shopping behaviors. This shift to online food purchasing and delivery became a key coping mechanism during the lockdowns, particularly in countries like the U.S.A. [3], where health and financial fears significantly influenced consumer behavior.

Several studies, such as Poelman et al. [2], Truong and Truong [3], and Ogundijo et al. [14], found that socio-demographic factors played an essential role in shaping food purchasing behaviors. Factors such as age, gender, income, and education level influenced whether individuals adopted healthier eating habits, increased their food purchases, or shifted to online shopping.

Other studies discussed the psychological effects of the pandemic, particularly anxiety and stress, as major drivers of purchasing behavior. For instance, Jeżewska-Zychowicz et al. [11] and Khayru [13] emphasized how consumer fears about food availability and health risks led to panic buying and increased demand for food, especially in times of uncertainty. These studies suggest that perceived stress and trust in media influenced purchasing behavior, highlighting the psychological dimension of consumer decisions.

A significant number of studies, including Ben Hassen et al. [6] and Marinković and Lazarević [10], noted that the pandemic led to a shift toward healthier eating habits. This change was often associated with greater home cooking and an increased interest in healthy food choices. Consumers in these studies tended to reduce reliance on ready-made meals and fast food, opting for fresh produce and home-cooked meals, reflecting a broader societal shift in food consumption due to health-related concerns.

External stressors, such as the fear of the pandemic, economic disruptions, and uncertainty, were found to shape consumer behavior in several studies. Truong and Truong [3] and Rabbi et al. [7] demonstrated that consumers facing economic

hardships or financial fears adjusted their food purchasing patterns by buying in bulk, switching to more affordable food options, or reducing shopping frequency. These studies underline the significant role that stress and uncertainty play in influencing consumer decision-making during crises.

The commonalities across these studies illustrate that the COVID-19 pandemic significantly disrupted food purchasing behaviors worldwide, driven by health concerns, economic stressors, and the need for food security. Consumers exhibited a shift toward healthier eating, increased stockpiling, reliance on online shopping, and psychological adjustments due to the crisis. These studies underscore the complex interplay between socio-demographic factors, external stressors, and shifting consumer preferences during periods of uncertainty. This collective insight provides a comprehensive understanding of how consumer behavior was reshaped by the pandemic.

2.2 Discussion of the literature gap

The literature on food purchasing behavior during the COVID-19 pandemic provides important insights into how the crisis influenced consumer habits across various regions. However, there are three significant gaps, particularly regarding food purchasing behavior post-lockdown, contributing factors, and rural populations in South Africa. First, while several studies, such as those by Truong and Truong [3] and Ben Hassen et al. [6]), explored the immediate impact of the pandemic, there is a lack of studies examining the long-term changes in consumer behavior once lockdown restrictions were relaxed or lifted. For instance, while Ben Hassen et al. [6] highlighted changes in food purchasing behaviors during the pandemic, it remains unclear whether these changes persisted after restrictions were eased. Therefore, a gap exists in understanding whether these changes in food purchasing patterns, such as frequency of shopping, preference for healthier foods, and purchase of non-perishable goods, have been sustained post-lockdown.

Second, much of the existing research, such as studies by Rabbi et al. [7] and Pappalardo et al. [8] focused on urban or general populations. As a result, there is limited research examining how rural households, with potentially different access to resources, markets, and infrastructure, adapted to the changing circumstances during and after the pandemic. For instance, Pappalardo et al. [8] briefly touched on rural areas in Sicily, showing that rural consumers were not immune to changes in food purchasing. However, similar studies specifically focusing on rural households in South Africa remain scarce. Rural areas may exhibit distinct behaviors and challenges that urban areas do not face, making this an essential gap in the literature.

Lastly, several studies, such as those by Truong and Truong [3] and Ogundijo et al. [14], identified socio-demographic factors, like age, income, and employment status, influencing food purchasing behavior during the pandemic. However, there is limited research on how these factors continued to influence purchasing behavior post-lockdown. For instance, are the socio-demographic impacts of the pandemic still felt in food purchasing behavior, particularly in rural communities?

This study aims to fill these gaps by focusing on the food purchasing behaviors of rural households in South Africa post-lockdown restrictions. Specifically, it addresses how rural consumers' frequency of grocery shopping has evolved, the types of food they purchased more, less or the same during the pandemic, and whether these behaviors have persisted after the end of lockdown restrictions. Additionally, the study provides insights into the association between socio-demographic factors and

the frequency of food purchases post-pandemic. By examining these aspects, the study contributes to an understanding of food purchasing behaviors, specifically in the context of post-lockdown South Africa, and helps bridge the gap in existing literature regarding rural food consumption patterns.

3. Methodology

3.1 Description of the study area

The study on examining households' food purchasing behavior post-lockdown restrictions was conducted at Mokgolobotho village, which is located in Greater Tzaneen Municipality within Mopani District, Limpopo Province of South Africa. As with any typical rural area in most developing countries, several characteristics of rural areas make rural consumers in the study case more vulnerable to the economic hardships of COVID-19 than urban consumers. These include economic activities, which are dominated by primary agricultural activities with lower wages, lack of job opportunities, longer distances to grocery shopping centers, and households living in extreme poverty. However, previous studies on food purchasing behavior focused on urban consumers in developed countries rather than rural consumers in developing countries [6–8]. As such, the findings from previous studies cannot provide empirical evidence on changes in food purchasing frequency by rural households and contributing factors; hence, Mokgolobotho village was chosen as the study case.

3.2 Data collection and sampling

The study used primary data, which were collected through face-to-face interviews in 2022, that is, post-lockdown restrictions in South Africa. A simple random sampling procedure was used to select a sample size of 327 households from the overall population of 1790 households, using a sample size equation developed by Kothari [15]. Household numbers were written on slips of paper that were placed inside a box, from which 327 households were randomly selected and surveyed. The respondents were individuals responsible for grocery-purchasing decisions, as well as the cooking, preparing and serving of food. Face-to-face interviews were conducted using a structured questionnaire, pre-tested with 12 respondents to identify errors and ensure clarity, following Government Accountability Office [16] and Sheatsley [17] guidelines. Based on feedback, necessary adjustments were made to improve the questionnaire's reliability and validity. The final version captured data on food consumption behavior and influencing factors in the study area. Potential biases were minimized by refining the questionnaire to enhance clarity and relevance, ensuring accurate data collection.

3.3 Data analysis

Likert scale was used to achieve the first objective, which determines the changes in the frequency of grocery shopping by rural households post-lockdown restrictions. The use of a Likert scale in this study is grounded in its ability to quantify attitudes or behaviors on an ordinal scale [18], providing a clear and structured way to capture variations in food purchasing frequency. In this study, food purchasing behavior is defined, in line with previous studies, as changes in the frequency of grocery shopping by a household [6, 7], enabling a focused analysis of shifts in purchasing patterns

during and after lockdown restrictions. Consequently, changes in the frequency of grocery shopping were measured on a four-point Likert scale in terms of whether a household purchased groceries (1) three or more times a month, (2) weekly, (3) biweekly, or (4) monthly.

In addition, the respondents were asked to rate their frequency of grocery shopping during and post-lockdown restrictions for 12 major food and beverage categories: Fresh produce, Dairy, Meat, Grains, Snacks, Fast food, Frozen food, Canned food, Prepared food, Bottled water, Beverages (non-alcoholic) and Beverages (alcoholic). Using these categories, the respondents were further asked to rate changes in their grocery purchases on a three-point scale, ranging from “more than usual”, “same as usual” to “less than usual”, post-lockdown restrictions, in line with Poelman et al. [2].

To achieve the second objective, Chi-square test analysis was conducted to explore the relationship between the socio-demographic characteristics of rural households and their food purchasing behavior post-lockdown. This analysis helps identify how socio-demographic factors influenced purchasing decisions after the lockdown restrictions were lifted, as households were no longer facing constraints such as limited movement or access to markets.

The Chi-square test is a statistical test used to determine whether there is a significant association between two categorical variables. It compares the observed frequency of events in each category to the expected frequency under the assumption that there is no association. The test is commonly used in categorical data analysis to assess whether distributions of categorical variables differ from each other [19]. Alternative tests, such as ANOVA, ANCOVA, and Pearson's correlation, were considered but were not suitable for this study, as follows.

ANOVA (Analysis of Variance) is typically used to compare the means of continuous variables across different groups [20, 21]. However, the outcome variable in this study (food purchasing behavior) is categorical (monthly, weekly, biweekly, and three or more times a month). Therefore, ANOVA would not be appropriate for examining the differences in purchasing behavior across socio-demographic groups, as it requires a continuous dependent variable.

ANCOVA (Analysis of Covariance) was also considered, as it allows for examining the impact of categorical independent variables on a continuous dependent variable, while controlling for continuous covariates [20, 22]. However, this study's dependent variable (food purchasing behavior) is categorical, which makes ANCOVA unsuitable. Thus, ANCOVA requires the dependent variable to be continuous, and food purchasing frequency does not meet this criterion.

Pearson's correlation test was considered as another alternative, but it is used to measure the strength and direction of a linear relationship between two continuous variables [20, 23]. Since many of the explanatory variables are categorical, Pearson's correlation would not be suitable for exploring the relationships between these variables and food purchasing behavior. Due to this, household size and market distance were excluded from the Chi-square analysis since they are continuous explanatory variables; thus, they fail to meet the requirements for this test, which assumes that both variables are categorical [19, 24]. The expected outcome is to assess whether the socio-demographic characteristics of rural households influenced the increase in their frequency of food purchases after lockdown restrictions were lifted. This could reflect changes in disposable income, access to food, or other socio-economic factors. A significant relationship would suggest that these socio-demographic characteristics play a key role in shaping food purchasing behavior post-lockdown. On the other hand, if no significant relationship is found, it would imply that socio-demographic

characteristics do not significantly impact food purchasing behavior in the post-lockdown period.

In addition to correlation analysis, an Ordered Probit model was used to provide a more comprehensive and robust statistical analysis of the relationship between the socio-demographic characteristics of rural households and their food purchasing behavior. Unlike ANCOVA, the Ordered Probit model allows for the inclusion of both categorical and continuous socio-economic variables, such as household size and market distance, which influence food purchasing decisions [20, 23]. The study categorizes food purchasing frequency into four distinct groups: (1) three or more times a month, (2) weekly, (3) biweekly, and (4) monthly. Given the ordinal nature of these categories, the Ordered Probit model was selected to examine the factors influencing food purchasing behavior among rural households following the lifting of COVID-19 lockdown restrictions.

Johnston et al. [25] asserted that ordered choices are typically modeled using the Ordered Probit model, which accounts for the ordinal nature of responses while assuming normally distributed error terms. The model has been widely applied in studies evaluating factors influencing ordinal-dependent variables, as documented in earlier research by Boccaletti and Moro [26], Cranfield and Magnusson [27], Senyolo et al. [28], and Lefophane [29]. The unobserved preference of households to maintain their food purchasing frequency post-COVID-19 is represented as follows [1]:

$$Y_i = \beta x_i + \varepsilon_i \quad (1)$$

where x_i represents explanatory variables, including household socio-economic characteristics that influence food purchasing behavior, β denotes the corresponding coefficients, and ε_i is the error term, assumed to follow a standard normal distribution. Factor Y_i is the observed ordinal variable, representing the food purchasing frequency of households, which is specified as follows [1]:

$$y_i = j \Leftrightarrow u_{j-1} < y_i < u_j \quad (2)$$

where $j = 0, \dots, M$ represent the possible food purchasing frequency categories, with $M = 4$ in this study. The cut-off values, u_j s, remain unknown and are estimated within the model. In this study, M is equal to four. Assuming that the error term follows a standard normal distribution, the probability of each food purchasing category is given by [1]:

$$\begin{aligned} \Pr(y_i = 0) &= \int_{-\infty}^{-\beta x_i} \phi(\varepsilon_i) d\varepsilon_i = \Phi(-\beta x_i), \\ \Pr(y_i = 1) &= \int_{-\beta x_i}^{u_1 - \beta x_i} \phi(\varepsilon_i) d\varepsilon_i = \Phi(u_1 - \beta x_i) - \Phi(-\beta x_i), \\ \Pr(y_i = M-1) &= \int_{u_{M-2} - \beta x_i}^{u_{M-1} - \beta x_i} \phi(\varepsilon_i) d\varepsilon_i = \Phi(u_{M-1} - \beta x_i) - \Phi(u_{M-2} - \beta x_i), \\ \Pr(y_i = M) &= \int_{u_{M-1} - \beta x_i}^{\infty} \phi(\varepsilon_i) d\varepsilon_i = \Phi(u_{M-1} - \beta x_i) - \Phi(u_{M-1} - \beta x_i) = 1 - \Phi(u_{M-1} - \beta x_i) \end{aligned} \quad (3)$$

where ϕ represents the standard normal probability density, while Φ represents the cumulative distribution function [1, 30].

The categorization of food purchasing frequencies allowed for a more structured analysis of how various socio-demographic factors influenced household food purchasing behaviors post-COVID-19, specifically by assessing how likely households were to move into higher purchasing frequencies compared to all lower frequencies.

4. Results

4.1 Socio-demographic characteristics

This section presents the descriptive statistics for the socio-demographic characteristics of rural households in the study case. The socio-demographic characteristics in this study are examined in terms of their association with food purchasing behavior, as assessed using Chi-square analysis. The results are presented in **Table 1**.

The results indicate that 60.3% of respondents were female, while 39.7% were male, with most women serving as the primary grocery shoppers in rural households within the study area. The majority (62.1%) were aged 35–60 years, followed by 16.2% aged 18–35, and 21.7% over 60, indicating that grocery shoppers were predominantly middle-aged. No respondents were below 18 years. For marital status, the majority (64.4%) were single, while 21.4% were married, 3.6% were widowed, and 8.6% were divorced, indicating that most respondents were unmarried. In terms of education, most respondents (32.7%) had completed tertiary education, followed by 29.1% with secondary education, 21.7% with primary education, and 16.5% had no formal education, showing that tertiary education was the most common level attained. Employment-wise, the majority (65.1%) were unemployed, while 27.8% were employed full-time and 7.0% were employed part-time, highlighting that unemployment was prevalent among respondents. Among those employed, most (78.1%) worked in the formal sector, while 21.9% were in the informal sector, indicating that formal employment was more dominant.

In terms of grants, most respondents (39.1%) received a child support grant, while 22.0% did not receive any grant. Additionally, 11.3% received an old age grant, 16.8% received a care dependency grant, 6.7% received a foster child grant, and 4.0% received a disability grant. No respondents received a war veteran's grant or grant in aid. Additionally, most respondents (52.6%) did not receive the Social Relief of Distress (SRD) grant, while 47.4% benefited from it. For household income, the majority (50.1%) earned less than \$263 (R5,000) per month, while 8.6% earned above \$789 (R15,000), indicating that lower-income households were more prevalent. Regarding saving habits, most respondents (40%) did not save money, while 60% did. Among savers, 9.9% saved more, 20.6% saved less, and 9.9% saved the same, totaling approximately 40% of those who saved. Market preference showed that most households (79.2%) preferred formal markets, while 20.8% opted for informal ones. Additionally, the majority (73.4%) visited markets specifically for grocery shopping, while 26.6% visited for other purposes. Advertisements played a significant role in influencing food purchases, with most households (64.5%) being influenced by ads, while 35.5% were not. Brand loyalty was low, as the majority (60%) chose promotional offers over preferred brands, while 40% remained loyal to their chosen brands. The average household size was approximately five members, ranging from one to ten. Travel time to preferred grocery store (market distance) averaged around 12 minutes, with the shortest time being 2 minutes and the longest 20 minutes.

Categorical variables			
Variable	Category	Frequency	Percentage
Gender	Female	198	60.3%
	Male	129	39.7%
Age	Less than 18	0	0%
	18–35	53	16.2%
	35–60	203	62.1%
	Above 60	71	21.7%
Marital status	Single	217	66.4%
	Married	70	21.4%
	Divorced	28	8.6%
	Widowed	12	3.6%
Educational level	No formal education	54	16.5%
	Primary education	71	21.7%
	Secondary education	95	29.1%
	Tertiary education	107	32.7%
Employment status	Employed full time	91	27.8%
	Employed part-time	23	7.0%
	Unemployed	213	65.1%
Type of employment sector	Formal sector	89	78.1%
	Informal sector	25	21.9%
Type of grant	Old age	37	11.3%
	Child support	128	39.1%
	Care dependency	55	16.8%
	Grant in aid	0	0%
	War veteran	0	0%
	Foster child	22	6.7%
	Disability	13	4.0%
	Not receiving grant	72	22.0%
Social Relief of Distress grant	Yes	155	47.4%
	No	172	52.6%
Monthly income of the household head	Less than R5000	164	50.1%
	R5000-R10000	81	24.8%
	R10000-R15000	54	16.5%
	Above R15000	28	8.6%
Savings	Yes	131	40%
	No	196	60%
Change in savings	Saved more	13	9.9%
	Saved the same	13	9.9%
	Saved less	27	20.6%
Market preference	Formal market	259	79.2%
	Informal market	68	20.8%
Food purchasing intention	Yes	240	73.4%
	No	87	26.6%
Advertisement influence	Yes	211	64.5%
	No	116	35.5%
Brand loyalty	Yes	131	40%
	No	196	60%

Categorical variables					
Variable	Category			Frequency	Percentage
Variable	Range	Minimum	Maximum	Mean	Standard deviation
Household size	9	1	10	5.21	2.87
Market distance	18	2	20	12.29	5.48

Table 1.
Descriptive results (N = 327).

4.2 Changes in the frequency of grocery shopping

This section presents the descriptive statistics on food purchasing behavior, which is explained with respect to changes in the frequency of grocery shopping in terms of whether a household purchased groceries (1) three or more times a month, (2) weekly, (3) biweekly, or (4) monthly. This is followed by the descriptive results on changes in the frequency of grocery shopping per food and beverage categories. The results for changes in food purchasing behavior during and post-lockdown restrictions are presented in **Figure 1**.

To measure the changes in food purchasing behavior, respondents were asked about their frequency of grocery purchases when the lockdown restrictions were tight and when the lockdown restrictions were eased. As illustrated in **Figure 1**, before the lockdown restrictions were relaxed, 58.4% of the households purchased groceries monthly, 9.5% weekly, 24.5% biweekly, and 7.6% purchased groceries three or more times a month. After the lockdown restrictions were relaxed, 42.2% of the households purchased groceries monthly, 16.2% weekly, 27.5% biweekly, and 14.1% purchased groceries three or more times a month. Overall, the results indicate that there were

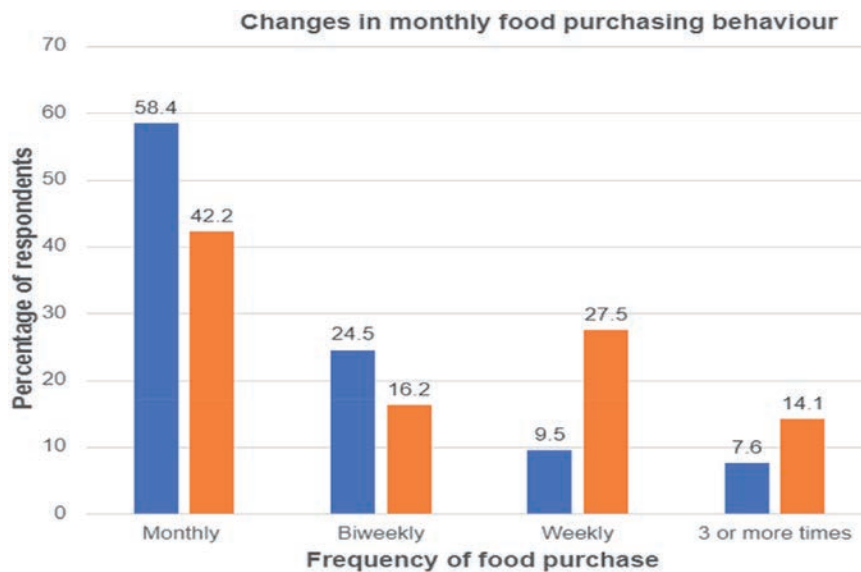


Figure 1.
Changes in food purchasing behavior during and post-lockdown restrictions. Note: During lockdown restrictions = blue; post-lockdown restrictions = Orange.

changes in rural households' grocery shopping frequency. In particular, most of the respondents reported that they purchased groceries less frequently during lockdown restrictions. This finding is in line with that of Ben Hassen et al. [6] who found that consumers in Russia reduced the number of shopping trips during COVID-19. This is attributed to fear of contracting the COVID-19 disease [3, 25], and to avoid having to wait long hours in a queue to enter the grocery stores and complete their shopping [26].

However, after the lockdown restrictions were relaxed, vaccines were administered, and COVID-19 cases had subsided, many households visited the grocery store more frequently. In addition, some of the households shifted from purchasing groceries once a month to either biweekly, every week, or three or more times a month. Overall, this shows that there were changes in the monthly grocery purchasing frequency by rural households, which is in line with the observation discovered in other countries and for urban households [6–8].

4.3 Changes in food purchasing behavior by category

In determining food purchasing behavior, the respondents were further asked to rate their frequency of grocery shopping during and post-lockdown restrictions for 12 major food and beverage categories: Fresh produce, Dairy, Meat, Grains, Snacks, Fast food, Frozen food, Canned food, Prepared food, Bottled water, Beverages (non-alcoholic) and Beverages (alcoholic). This aim is to underline the category of food and beverage that rural households purchased “more than usual”, “same as usual,” and “less than usual” post-lockdown restrictions, relative to during lockdown restrictions. In other words, “more than usual” implies that a household purchased a particular food item more frequently post-lockdown restrictions, relative to during lockdown restrictions. “Same than usual” implies that a household purchased a particular food item with the same frequency during and post-lockdown restrictions. Lastly, “less than usual” implies that a household purchased a particular food item less frequently post-lockdown restrictions, relative to during lockdown restrictions. The results for monthly food purchasing behavior per category post-lockdown restrictions are presented in **Table 2**.

Table 2 shows the frequency of grocery purchases per food and beverage category during and post-lockdown restrictions. The key finding is that most of the respondents reported having purchased most of the food and beverage categories more post-lockdown restrictions than during lockdown restrictions. These categories are, namely, fresh produce, dairy, snacks, fast food, prepared food, and alcoholic beverages. For fresh produce, Mkasi and Lefophane [31] found that rural households in South Africa decreased their consumption of fresh produce during the COVID-19 pandemic due to the prohibition of informal fresh produce trading during the initial stages of the lockdown. The observed increase in the frequency of purchase for fresh produce post-lockdown is attributed to the relaxation of restrictions, particularly the lifting of the ban on informal street vendors who were unable to operate during the strictest lockdown phases.

The increase in the frequency of purchase for snacks, fast food, prepared foods, and alcoholic beverages is also explained by the easing of lockdown restrictions. These items were prohibited during the stringent phases of the lockdown, leading to a noticeable increase in purchases once the restrictions were relaxed. This aligns with the findings of Mkasi and Lefophane [31], which highlighted that rural households consumed fewer snacks, fast foods, and fresh produce during stricter lockdown phases in South Africa.

Category	Outcome	Frequency	Percentage
Fresh produce	More than usual	185	56.6%
	Same as usual	90	27.5%
	Less than usual	52	15.9%
Dairy	More than usual	160	48.9%
	Same as usual	122	37.3%
	Less than usual	45	13.8%
Meat	More than usual	75	22.9%
	Same as usual	68	20.8%
	Less than usual	184	56.3%
Grains	More than usual	143	43.7%
	Same as usual	61	18.7%
	Less than usual	123	37.6%
Snacks	More than usual	129	39.4%
	Same as usual	83	25.4%
	Less than usual	115	35.2%
Fast food	More than usual	199	60.9%
	Same as usual	71	21.7%
	Less than usual	57	17.4%
Frozen food	More than usual	103	31.5%
	Same as usual	168	51.4%
	Less than usual	56	17.1%
Canned food	More than usual	85	26.0%
	Same as usual	49	15.0%
	Less than usual	193	59.0%
Prepared food	More than usual	252	77.1%
	Same as usual	20	6.1%
	Less than usual	55	16.8%
Bottled water	More than usual	81	24.8%
	Same as usual	93	28.4
	Less than usual	153	46.8%
Beverages (non-alcoholic)	More than usual	121	37.0%
	Same as usual	77	23.5%
	Less than usual	129	39.4%
Beverages (alcoholic)	More than usual	183	56.0%
	Same as usual	59	18.0%
	Less than usual	45	13.8%
	No response	40	12.2%

Table 2.
Changes in food purchasing behavior per category (N = 327).

4.3.1 Dairy

The observed increase in dairy purchases post-lockdown could be attributed to the return of consumer confidence and easing of mobility restrictions, which allowed rural households to access dairy products more frequently. Dairy is considered a staple food item, and with reduced mobility and limited access to grocery stores during the lockdown, many households may have consumed dairy less frequently during stricter lockdown periods. Post-lockdown, households likely resumed purchasing dairy more frequently as dairy availability became more

consistent, aligning with findings from similar studies in other regions [8], where dairy purchases also rose as restrictions eased.

4.3.2 Meat

For meat, the data shows that a significant proportion of households reported purchasing less frequently during lockdown restrictions (56.3%), with only 22.9% purchasing more than usual post-lockdown. This could be due to supply chain disruptions, limited access to markets, or financial constraints during the lockdown. Meat is often a higher-cost food item, and economic uncertainty during the lockdown likely led to reduced consumption. Post-lockdown, as restrictions eased and households regained financial stability and access to a wider range of products, there was a gradual recovery in meat purchases. This aligns with similar findings in other studies, such as those by Ben Hassen et al. [6], which noted that meat consumption dropped due to both supply chain issues and budgetary constraints during lockdown.

4.3.3 Grains

Grain products, such as rice, maize meal, and bread, are often essential staples in rural households. The increase in grain purchases post-lockdown (43.7% of households purchasing more than usual) may reflect a return to normalcy, with households stocking up on these affordable, long-lasting food products after a period of scarcity or limited availability during the lockdown. During the lockdown, some households may have experienced economic pressures that affected their purchasing behavior, focusing on less expensive staples. As the economy began to recover post-lockdown, grain consumption increased due to the need for basic, everyday food items. Studies have indicated that, during economic downturns, rural populations tend to prioritize affordable staple foods like grains [8].

4.3.4 Frozen food

Frozen food purchases, while increasing for 31.5% of the respondents post-lockdown, showed a higher proportion of households purchasing the same amount during both periods (51.4%). This category likely experienced relatively stable demand during the lockdown due to its longer shelf life and convenience, making it a popular choice for households with limited access to fresh food items. However, once restrictions were relaxed, households may have shifted toward fresher products, such as dairy or fresh produce, which are perceived as healthier alternatives. This aligns with findings from other studies on frozen food consumption during the pandemic, where increased shelf life and ease of storage were critical factors influencing purchases [7].

4.3.5 Canned food

The data indicates that many households purchased fewer canned foods post-lockdown (59%), possibly due to the relaxation of food storage practices as fresh foods became more readily available. During lockdown restrictions, canned food often became a necessity as it has a longer shelf life and can be stored for extended periods. As restrictions eased, and markets reopened, households likely shifted back to purchasing more perishable foods like fresh produce or meats, leading to a decline in canned

food purchases. This trend is supported by similar studies, where reliance on canned goods increased during lockdowns due to their long shelf life and convenience [6].

4.3.6 Prepared food

Prepared food purchases showed a significant increase post-lockdown (77.1% of respondents purchasing more than usual). During the lockdown, the closure of restaurants, takeaways, and limited social gatherings significantly reduced the availability and consumption of prepared foods. As restrictions eased and businesses reopened, there was a marked increase in prepared food consumption as households returned to dining out or ordering takeaways. This finding is consistent with global trends observed in urban settings, where demand for convenience foods, including prepared meals, surged after lockdown restrictions were lifted [8].

4.3.7 Bottled water

Bottled water purchases decreased post-lockdown for many respondents, with 46.8% purchasing less than usual. The initial spike in bottled water consumption during the early stages of the pandemic was likely driven by panic buying and concerns about water access and hygiene [32]. Once the pandemic's immediate effects subsided and the supply chain was stabilized, bottled water consumption normalized. This observation aligns with global trends where bottled water sales surged during the early stages of COVID-19 but later decreased as households resumed relying on regular tap water and other hydration sources [31].

4.3.8 Beverages (non-alcoholic)

Non-alcoholic beverages (such as juices and soft drinks) saw increased purchases post-lockdown (37.0%). During the lockdown, the closure of restaurants and limited social events likely led to a decline in the consumption of such beverages. However, once restrictions eased and gatherings resumed, the consumption of non-alcoholic beverages rose. This trend reflects a broader global pattern of increased beverage consumption once social activities resumed post-lockdown [7].

4.3.9 Beverages (alcoholic)

Alcoholic beverage purchases increased for 56.0% of respondents post-lockdown. During the stricter lockdown phases, alcoholic beverages were either prohibited or heavily restricted in many countries, including South Africa, due to concerns about alcohol's impact on public health, particularly its potential to exacerbate COVID-19-related health risks and overwhelm healthcare systems [6, 8, 31]. As these restrictions were lifted, there was a marked increase in alcohol consumption, especially in rural areas where informal alcohol sales may have been prevalent. This increase in purchases post-lockdown mirrors global trends, where the easing of alcohol bans led to a spike in consumption [6].

4.4 Correlation analysis results

This section presents the results of the Chi-square test, which was used to achieve the second objective of this study: to explore the relationship between

socio-demographic characteristics of rural households and their food purchasing behavior post-lockdown. The Chi-square test was deemed suitable for this analysis since both the dependent variable, food purchasing behavior (categorized as: (1) three or more times a month, (2) weekly, (3) biweekly, or (4) monthly), and the explanatory variables, socio-demographic factors, are categorical. The interpretation of the results, including the p-values, helps determine whether there are significant relationships between the variables under consideration. The Chi-square test results are presented in **Table 3**.

The Chi-square test reveals that there is no significant relationship between gender and food purchasing behavior in this study, which suggests that, in rural South Africa, gender may not play a significant role in shaping food purchasing patterns. This finding contrasts with studies like Ogundijo et al. [14], which found that gender influenced purchasing decisions in England. The discrepancy may be attributed to the different socio-demographic factors of rural South Africa. Similarly, age does not show a significant association with food purchasing behavior. This contrasts with studies by Poelman et al. [2] and Truong and Truong [3], which found a relationship between younger consumers and healthier food purchases in the Netherlands and the United States. The lack of a significant association may be due to the rural setting, where both younger and older consumers have similar access to food markets, reducing age's role in purchasing decisions.

However, marital status shows a highly significant relationship with purchasing behavior of rural households. This aligns with the findings of Truong and Truong [3], who noted that household composition (married vs. single) influenced shopping

Variable	Chi-square value	Df	Asymptotic significance (2-sided)
Gender	1.626	3	0.653
Age	6.256	6	0.395
Marital status	52.656	9	0.001***
Educational level	9.799	9	0.367
Employment status	4.173	3	0.243
Type of employment	4.655	6	0.589
Type of employment sector	15.387	6	0.017**
Type of grant	34.02	12	0.001***
SRD grant	4.899	3	0.179
Household head income	11.937	9	0.217
Savings	5.827	3	0.120
Change in savings	12.042	6	0.061*
Food purchasing intention	0.140	3	0.987
Advertisement influence	5.651	3	0.13
Brand loyalty	8.513	3	0.037**
Market preference	1.357	3	0.716

Note: * $p < 0.01$ (1% significance level), $p < 0.05$ (5% significance level), and $p < 0.10$ (10% significance level).

Table 3.
Chi-square test results.

choices in the United States. This means that married individuals may prioritize bulk purchases or home-cooked meals to manage larger family needs and budgets more efficiently, as family structure influences food purchasing habits. This aligns with Ben Hassen et al. [6] for Qatari consumers, suggesting that marriage leads to more strategic food choices focused on long-term savings and family well-being.

In contrast, education level is not significantly associated with food purchasing behavior of rural households. This contrasts with Poelman et al. [2], who found that higher education levels were associated with healthier eating among adults in the Netherlands. This divergence may be explained by the fact that, in rural areas, food choices are more influenced by food availability than education, as limited access to food markets makes practical considerations more important. Similarly, employment status does not significantly affect food purchasing behavior in rural households. While Rabbi et al. [7] linked job losses and income reductions to food stress for Bangladeshi consumers, this study suggests that, in rural areas, employment status may not dictate purchasing behavior, possibly due to reliance on informal markets where food is more affordable and accessible.

However, there is a significant relationship between the type of employment sector and food purchasing behavior, suggesting that whether individuals are employed in the formal or informal sector influences their purchasing decisions. Informal sector workers may face financial instability, leading to more cost-conscious behavior, while formal sector employees may have more stable incomes, allowing for greater flexibility in food choices. These findings align with the broader understanding that income stability influences purchasing power and priorities [33–36].

Similarly, there is a highly significant relationship between the type of grant received and food purchasing behavior among rural households, likely due to the increased disposable income grants provide. As Aguilar-Lopez and Kuhar [37] suggest, grants expand households' consumption possibilities, influencing their food purchasing decisions. While previous studies found grants led to greater participation in food away from home (FAFH), this study focused on food for home consumption (FAH). The increased disposable income from grants likely influences the frequency of grocery shopping, enabling recipients to purchase more groceries or make more frequent trips for home-cooked meals. Despite this, there is no significant association between the SRD grant and the food purchasing behavior of rural households. This can be attributed to the relatively small amount provided by the SRD grant (R350), which was primarily designed to offer temporary financial relief during the COVID-19 pandemic, rather than to stimulate long-term changes in consumption behavior [38]. This finding aligns with Mkasi and Lefophane [31], who concluded that the SRD grant stabilizes food consumption, rather than increasing it.

There is no significant association between household income and food purchasing behavior in rural households. While studies like Rabbi et al. [7] linked income reductions to food stress, this study suggests that rural households may still meet their food needs through alternative sources, such as informal vendors, where food costs are lower or more flexible. Similarly, there is no significant association between market preference (formal vs. informal) and food purchasing behavior, indicating that rural households may rely more on informal vendors despite the availability of formal markets.

There is no significant association between savings and food purchasing behavior in rural households, suggesting that savings may not influence purchasing patterns. This could be due to the immediate need for food taking precedence over long-term savings, or limited financial resources making it difficult to save [39–43]. However,

changes in savings show a marginally significant relationship with food purchasing behavior, indicating that households with more savings may have more flexibility in their food choices, while those with less may prioritize cheaper options [44]. The impact of savings changes is likely secondary to factors such as income stability or household composition [45].

There is no significant relationship between food purchasing intention and actual purchasing behavior, suggesting that intention does not always translate into action in rural South Africa [46], as per the Theory of Planned Behavior [47]. External factors like availability, affordability, infrastructure, and market access may prevent individuals from following through on their intentions [48, 49]. This emphasizes the need to consider not only intentions but also barriers to purchasing when assessing food behavior.

The relationship between advertisement and food purchasing behavior is not statistically significant, suggesting that advertisements do not heavily influence the purchasing decisions of rural households. Instead, factors like local availability, cost, and need may have a greater impact [50]. Additionally, rural households may be less exposed to advertisements or more skeptical of them [51]. In contrast, brand loyalty shows a significant relationship with food purchasing behavior, with rural households more likely to purchase food frequently from preferred brands. This aligns with findings by Liu and Wang [52] and Sun and Chen [53], as brand loyalty often stems from positive past experiences, trust in product quality, or familiarity with the brand [54–57].

4.5 Ordered Probit model results

The Ordered Probit model was used to derive predicted probabilities and marginal effects for each frequency of food purchase by rural households. The estimated coefficients are presented in **Table 4**, while the predicted probabilities and marginal effects are shown in **Table 5**. Both results are discussed together. By default, the predicted probabilities for the levels of food purchasing frequency sum to 1, while the marginal effects for the four levels of food purchasing frequency equal 0. In **Table 5**, FB1 represents monthly, FB2 represents biweekly, FB3 represents weekly, and FB4 represents purchases three or more times a week.

The model's (-2) log-likelihood value is 87.241, indicating a reasonable fit. According to Zack (2021), a higher log-likelihood value suggests better model performance in terms of fitting the data. The Nagelkerke R-square of 0.797 shows that the model explains 79.7% of the variation in the dependent variable, indicating a substantial influence of socio-demographic variables on food purchasing behavior among rural households.

Out of the 16 explanatory variables included in the model, 11 significantly influence the food purchasing behavior of rural households. Notably, marital status, type of grant, and change in savings, previously found to be significant in the Chi-square analysis, are now insignificant. However, two continuous variables (household size and market distance), which were excluded from the Chi-square analysis due to its categorical data requirements, are found to be significant. Additionally, six variables (gender, education, SRD grant, savings, advertisement influence, and market preference), which were not significant in the Chi-square analysis, now show a significant influence. This shift highlights the Ordered Probit model's ability to account for the ordinal nature of food purchasing behavior, control for multiple variables, and capture variations missed by correlation analysis. The 11 significant variables are discussed below in detail.

Variables	B Coefficient	Standard error	Wald statistics
Gender	−0.347	0.204	2.897**
Age	−1.657	1.061	1.061
Marital status	3.216	2.560	1.578
Household size	3.182	1.176	7.324***
Educational level	−3.864	1.614	5.731**
Employment status	−5.818	3.213	3.279**
Type of employment sector	1.891	1.099	2.960*
Type of grant	−3.034	2.496	1.477
Social relief grant	−2.355	0.937	6.320***
Monthly income of the household head	−26.960	21.094	1.634
Savings	−3.746	2.151	3.031*
Change in savings	−3.246	3.026	1.150
Food purchasing intention	−0.921	0.684	1.815
Advertisement influence	−4.036	2.409	2.409*
Brand loyalty	1.315	0.621	4.494**
Market preference	1.603	0.950	2.850*
Market distance	−1.744	0.760	5.271***
Model summary			
(−2) Log-likelihood			87.241
Pseudo R-Square			
Cox and Snell R-Square			0.734
Nagelkerke R-Square			0.797

Table 4.
Results for Ordered Probit model.

Unlike the correlation results, the Ordered Probit model shows that gender has a negative and significant (5%) effect on food purchasing behavior, indicating that males are less likely to engage in high-frequency food purchases than females. The marginal effects reveal a negative association with monthly purchases but a positive association with biweekly, weekly, and more frequent purchases. This suggests that women are more likely to make frequent food purchases than men, consistent with Ogundijo et al. [14], who found that gender influenced food purchasing decisions in England.

Household size has a positive and highly significant (1%) effect on food purchasing behavior, indicating that larger households purchase food more frequently. The marginal effects show a decreased likelihood of monthly purchases but an increased likelihood of biweekly, weekly, and more frequent purchases. This contrasts with Mkasi and Lefophane [31], who found a negative effect on food consumption, suggesting larger households consume stable or lower amounts of food. The discrepancy may stem from differences in study focus; specifically, consumption levels versus purchasing frequency.

Contrary to correlation results, education level has a negative and significant (5%) effect on food purchasing behavior, indicating that rural households with

Variable	FPB = 1	FPB = 2	FPB = 3	FPB = 4
Predicted Probability	0.5699	0.1671	0.1106	0.1524
Marginal effects				
Gender	−0.2975	0.0553	0.0817	0.1605
Age	−0.0178	0.0037	0.0048	0.0093
Marital Status	−0.2188	0.0453	0.0589	0.1146
Household Size	−0.0524	0.0097	0.0144	0.0283
Educational Level	0.0412	−0.0158	−0.0118	−0.0136
Employment status	0.017	−0.0032	−0.0047	−0.0091
Type of employment	0.112	−0.0232	−0.0303	−0.0585
Type of sector	−0.0142	0.0026	0.0039	0.0077
Type of grant	−0.0224	0.0086	0.0064	0.0074
Social relief grant	0.5823	−0.1083	−0.16	−0.314
Income	0.0468	−0.0097	−0.0126	−0.0245
Savings	1.2146	−0.2259	−0.3337	−0.655
Change in saving	0.2151	−0.0446	−0.058	−0.1125
Advertisement influence	0.2386	−0.0444	−0.0656	−0.1286
Brand loyalty	−0.2098	0.039	0.0577	0.1131
Market preference	−0.0629	0.0117	0.0173	0.0339
Market distance	0.005	−0.0009	−0.0014	−0.0027

Table 5.
Predicted probabilities and marginal effects.

higher education levels are less likely to purchase food frequently. This contrasts with Mkasi and Lefophane [31], who found no effect on food consumption behavior. The difference may be due to their study focusing on overall consumption, while this study examines purchasing frequency, emphasizing the context-dependent nature of education's impact on food behavior.

Employment status has a negative and significant (5%) effect on food purchasing behavior, indicating that employed individuals are less likely to purchase food frequently than the unemployed or those employed part-time. The marginal effects suggest that employment decreases the likelihood of biweekly, weekly, and more frequent purchases while increasing the likelihood of monthly purchases. This contrasts with Rabbi et al. [7], who linked employment and income reductions to food stress, suggesting that job losses or lower earnings led to difficulties in accessing sufficient food. In this study, employed individuals may prioritize monthly purchases over more frequent ones due to time constraints or financial management.

Consistent with the correlation results, the type of employment sector has a positive and significant (10%) effect on food purchasing behavior, indicating that formal sector employees purchase food more frequently than informal sector workers. The marginal effects suggest that formal sector employment increases the likelihood of biweekly, weekly, and more frequent purchases while reducing the likelihood of monthly purchases. This aligns with the correlation results, suggesting that formal sector employees, with more stable incomes, can make more frequent purchases,

reflecting the broader understanding that income stability influences purchasing power and priorities [33–36].

Unlike the correlation results, the SRD grant has a negative and highly significant (1%) effect on food purchasing behavior, indicating that recipients are less likely to purchase food frequently. This is likely due to the small amount provided (R350), intended for temporary relief during the COVID-19 pandemic rather than long-term consumption changes [38]. The marginal effects show that SRD recipients are less likely to purchase food biweekly, weekly, or more frequently, contradicting the correlation results. This aligns with Mkasi and Lefophane [31], who found that the SRD grant stabilizes food consumption rather than increasing it, highlighting its role in maintaining steady food intake.

Contrary to the correlation results, savings behavior has a negative and significant (10%) effect on food purchasing behavior, indicating that savers are less likely to purchase food frequently than non-savers. The marginal effects show that saving increases the likelihood of monthly purchases but decreases the likelihood of more frequent ones. In rural areas, the immediate need for food often takes precedence over saving, with households prioritizing consumption. Additionally, savers may reserve funds for other needs or emergencies [35, 36]. Limited financial resources further complicate saving, as much of the income is directed toward basic needs like food.

Contrary to the correlation results, advertisement has a negative and significant (10%) effect on food purchasing behavior, indicating that those influenced by advertisements are less likely to purchase food frequently than those not influenced. The marginal effects show that exposure to advertisements increases the likelihood of monthly purchases but reduces more frequent ones. This suggests that advertisements have a limited impact on the food purchasing decisions of rural households. In rural areas, purchasing decisions may be driven more by local availability, cost, and need, rather than marketing efforts [50]. Additionally, rural households may have less exposure to advertisements or be more skeptical of them, reducing their influence on purchasing behavior [51].

Brand loyalty, however, has a positive and significant (5%) effect on food purchasing behavior, indicating that households loyal to specific brands are more likely to purchase food frequently. The marginal effects show that brand loyalty reduces the likelihood of monthly purchases while increasing the likelihood of biweekly, weekly, and more frequent purchases. This aligns with the findings of Liu and Wang [52] and Sun and Chen [53], as brand loyalty may stem from positive past experiences, trust in product quality, or brand familiarity [54–57]. Therefore, despite limited advertisement influence, rural consumers may purchase food more frequently due to established trust in reliable, quality brands.

Contrary to the correlation results, market preference has a positive and significant (10%) effect on food purchasing behavior, indicating that those who prefer formal markets purchase food more frequently than those who prefer informal markets. The marginal effects show that a preference for formal markets increases the likelihood of biweekly, weekly, and more frequent purchases while decreasing monthly purchases. This suggests that consumers who prefer formal markets may have access to a more reliable or convenient food supply, influencing them to make more regular purchases [33–36].

Market distance has a negative and highly significant (1%) effect on food purchasing behavior, indicating that those who travel longer distances to purchase groceries are less likely to shop frequently. The marginal effects show that increased market distance increases the likelihood of monthly purchases while decreasing the likelihood

of biweekly, weekly, and more frequent purchases. This suggests that longer travel distances not only reduce shopping frequency but also influence purchasing patterns, with consumers adjusting their behavior based on travel logistics and other store attributes, consistent with previous studies [56, 57].

5. Conclusion

5.1 Summary and implications

This study examined food purchasing behavior among rural households in South Africa post-lockdown restrictions, focusing on the socio-demographic factors influencing these behaviors. Primary data were collected from 327 households in Mokgolobotho village, Greater Tzaneen Municipality, using simple random sampling and face-to-face interviews. The study aimed to determine changes in grocery shopping frequency and explore the relationship between socio-demographic characteristics and food purchasing behavior. A Likert scale measured changes in shopping frequency, while Chi-square analysis assessed the associations between socio-demographic factors and purchasing behavior. In addition to correlation analysis, an Ordered Probit model was used to provide a more robust analysis, allowing the inclusion of continuous variables excluded from the Chi-square analysis due to its categorical data requirements.

The findings revealed that rural households increased their grocery shopping frequency after the lockdown restrictions were relaxed, with purchases of fresh produce, dairy, snacks, fast food, prepared food, and alcoholic beverages notably rising post-lockdown. These findings have several important implications for both retailers and policymakers. The increased frequency of grocery shopping observed post-lockdown suggests a significant shift back toward pre-pandemic shopping behaviors, possibly driven by factors such as improved mobility, economic recovery, and greater access to food markets. As lockdown restrictions eased and COVID-19 cases subsided, rural households were able to resume more regular shopping routines. This shift is crucial for understanding consumer patterns and the factors influencing food access and consumption in post-pandemic settings.

The Ordered Probit model revealed that household size, employment sector, brand loyalty, and market preference reduced the likelihood of monthly purchases while increasing the probability of biweekly, weekly, and more frequent purchases. These findings highlight the crucial role of income stability and logistical factors in shaping food purchasing frequency. Financial constraints, such as low grant amounts and savings prioritization, limit frequent purchases, whereas economic security, through formal employment and larger household sizes, encourages regular shopping. Furthermore, market accessibility and brand trust significantly influence rural purchasing behavior, outweighing the impact of advertising. These insights suggest that policy interventions should prioritize improving rural market access, stabilizing incomes, and fostering consumer trust in local food sources.

Contrarily, gender, education level, employment status, SRD grant, savings behavior, advertisement, and market distance increased the likelihood of monthly purchases while reducing the probability of biweekly, weekly, and more frequent purchases. These findings suggest that financial constraints and logistical challenges limit frequent food purchases in rural households. Males and higher-educated individuals favor bulk shopping, while SRD recipients and savers prioritize financial management

over frequent purchases. Limited advertising influence highlights reliance on necessity and affordability, while market distance discourages regular shopping. Therefore, policy efforts should enhance market access, strengthen financial support, and promote consumer education for sustainable food purchasing behavior.

Interestingly, while this study was conducted in a rural South African setting, the findings were comparable to studies conducted in other countries, including the United States, Qatar, Bangladesh, England, and Russia. For instance, studies in the United States and Qatar found that marital status played a significant role in food purchasing decisions, particularly in relation to bulk purchases and home-cooked meals, aligning with the correlation results of this study. Similarly, the findings regarding brand loyalty in this study are consistent with consumer behavior research conducted in developed countries, where brand trust significantly influences purchasing habits. This suggests that, despite the different geographical and socio-economic contexts, certain socio-demographic factors, such as marital status, education, employment status, and brand loyalty, are universally important in shaping food purchasing behaviors across diverse cultural and economic settings. Additionally, the impact of financial support mechanisms, such as social grants, on food purchasing behavior in this study mirrors findings from other countries, where income stability and financial assistance are critical in influencing consumer decisions. These comparisons highlight the broader relevance of the findings and suggest that similar socio-demographic and economic factors may influence food purchasing behavior in rural and urban areas globally.

5.2 Limitations and areas for future exploration

The study aimed to analyze food purchasing behavior in rural households, but several limitations exist, presenting opportunities for future exploration as follows. The study relied on self-reported data, which may be subject to recall bias, particularly regarding food purchasing behavior during the lockdown. Longitudinal data collection methods are therefore required to capture more accurate and real-time information on food purchasing behavior during and after significant events such as lockdowns. Despite efforts to minimize biases through random sampling and pre-testing of the questionnaire, interviewer biases or respondent misinterpretation could still affect the accuracy of responses. Using mixed-methods approaches, including qualitative interviews, could supplement quantitative data and provide deeper insights into purchasing behavior. The study was conducted in a single rural village in Greater Tzaneen Local Municipality, which limits the generalizability of the findings to other regions or urban contexts. Expanding the geographical scope to include multiple rural areas and urban settings would allow for a comparison of food purchasing behavior across different socio-economic contexts. While the Ordered Probit model could account for factors such as psychological or cultural influences, market access infrastructure, and varying forms of financial assistance, these factors were not considered in the study. In the future, incorporating these additional variables into the Ordered Probit model to explore their impact on food purchasing behavior in rural households is necessary.

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Author details

Mapula Hildah Lefophane*, Motsatsi Morwatshehla
and Victor Mbulaheni Mmbengwa
Faculty of Science and Agriculture, Department of Agricultural Economics and
Animal Production, School of Agriculture and Environmental Sciences, University of
Limpopo, Polokwane, South Africa

*Address all correspondence to: hildajie@gmail.com

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Family Matters and Health Promotion: A Retrospective on COVID-19 and Vaccination in Rural South Africa

Nelly Vuyokazi Sharpley

Abstract

At the onset of the COVID-19 pandemic, the South African government, led by the Department of Health and a disaster advisory committee of biomedical specialists, enforced strict regulations to manage the crisis. These top-down measures, heavily reliant on policing, military enforcement, and a command council approach, positioned communities and families as potential offenders, emphasising compliance over collaboration. Public health interventions focused on controlling daily life and, later, mandatory vaccination. However, evidence from 1800 rural households in the Eastern Cape, gathered through a robust mixed-methods design, reveals a stark disconnect between government strategies and the realities of rural communities. Residents faced significant barriers in accessing information and healthcare, feeling alienated by a strategy that overlooked local context and agency. Despite limited support, rural families demonstrated resilience and innovation, developing self-reliant strategies to cope with the pandemic. These findings underscore that government and Department of Health responses failed to harness community strengths and neglected meaningful engagement with local realities. The chapter asserts the urgent need to shift away from a solely Western biomedical model towards health promotion that is people-centred, participatory, and grounded in local knowledge and practice. Policy approaches must be reoriented to include community voices and prioritise inclusive, contextually relevant public health strategies, particularly in rural African settings.

Keywords: COVID pandemic, vaccination, health promotion, family, health facilities

1. Introduction

The COVID-19 pandemic was an unusual and unfamiliar illness that required a multi-stakeholder response due to its complex effects. South Africa, as many scholars observed, adopted a singular, biomedical approach to manage and control the spread of the virus. This approach overlooked the diverse impacts of the virus and focused

more on the medicalisation of the population, with rules such as do this or that, or face the rule of law if you do not adhere to the set regulations. The actions taken by the provincial government in the Eastern Cape, South Africa, suggested that people, especially in rural areas, would act without sufficient knowledge and consideration of COVID-19 regulations. Therefore, the government, through the Department of Health, was decisive in controlling the spread of the virus by establishing a regulatory framework and implementing mandatory vaccination for the population. The fact that rural populations were seen as lacking knowledge, and possibly being careless about the threatening surge of the pandemic, led to these populations being subjected to mandatory vaccination and government-enforced COVID-19 regulations. The COVID-19 pandemic presented a global crisis characterised by uncertainty, complexity, and widespread disruption. In South Africa, the response to the pandemic was predominantly biomedical, with an emphasis on medical interventions, regulatory enforcement, and public health mandates. This chapter aligns with what most scholars have noted—that this approach was rooted in the medicalisation of the pandemic, where the focus was on controlling viral transmission through scientific and clinical measures such as lockdowns, mask mandates, and vaccination campaigns. While effective in slowing the spread, this strategy often sidelined the social, economic, and psychological dimensions of the crisis, resulting in a narrow public health response [1–3]. Furthermore, the chapter offers reflective findings on how the rural populations from the Eastern Cape Province of South Africa, subjected to the enforced COVID-19 regulations and mandatory vaccination, perceived the exclusive biomedical health promotion approach of the Department of Health and the South African government.

2. Literature

Carlitz and Makhura [4] noted that people in some South African communities were most affected by the pandemic in its early stages and were willing and able to act, while ensuring compliance with lockdown orders for rural populations. However, the main challenge was precarious living conditions in South Africa. The first strict COVID-19 lockdown in South Africa led to unemployment, poverty, and isolation from protective social networks, depriving families of the resources they needed. The main narrative in South Africa was that the COVID-19 pandemic deprived families and communities of the resources they require to care for children [1]. Key points that summarise the scholarly analysis of the SA government's pandemic response indicate that it was primarily regulatory, with the implementation of strict rules such as curfews and mandatory mask-wearing, supported by the threat of legal consequences. Decision-making was centralised, with health authorities leading the response with minimal input from community stakeholders, and the population was medicalised, viewed mainly as subjects for medical intervention through vaccination, with less regard for social context [2, 3, 5].

Critics argue that South Africa's biomedical approach overlooked the pandemic's complex, multidimensional effects [6]. COVID-19 impacted not just health but also livelihoods, mental health, and social cohesion, especially in marginalised communities. The lack of a multi-stakeholder approach—one that involves community leaders, social scientists, and civil society—limited the response's effectiveness [7]. Rural residents were often depicted as uninformed or careless, leading to top-down interventions that occasionally ignored local realities and eroded trust [8]. While vaccine

coverage increased, mandatory policies raised ethical concerns about autonomy, consent, and the stigmatisation of those who did not comply [9]. Limited involvement of local leaders and failure to tailor interventions to cultural contexts sometimes caused resistance and reduced policy success [7]. The experience of the Eastern Cape illustrates the difficulties of a regulatory, biomedical response in rural settings. While strict enforcement achieved short-term compliance, it occasionally undermined long-term public trust and cooperation, particularly when communities felt marginalised [8]. The relationship between public health and policy, both locally and internationally, cannot be overlooked during the pandemic. The South African government's initial response to COVID-19 was internationally praised as decisive and courageous. However, neither the interventions nor the praise was based on local information, locally parameterised models, epidemiological expertise, or local knowledge. Some might perceive that the country's undemocratic history partly explains how easily it moved to a strict lockdown [10] and mandatory vaccination. According to Gittings et al. [11], distrust of government and scientists contributed to reluctance to use vaccines, along with low awareness of susceptibility to disease, conspiracy beliefs, fear of injections and side effects, and a preference for non-biomedical remedies such as traditional or natural cures. Factors influencing vaccine acceptance include receiving information from trusted sources, the desire for safety, perceptions of vaccine effectiveness, and observing safe uptake by trusted individuals like peers and family members. Cooper et al. [12] highlighted that family members often decide about vaccination, reflecting the close connection between trust and vaccine acceptance. They also noted that South African adults were motivated to take the COVID-19 vaccine to protect themselves and others, especially family members. This shows the vital role of family, friends, and peers in fostering vaccine acceptance. Since families typically share beliefs and practices and often access traditional health services together, family-based messaging and campaigns can offer practical support while encouraging collective decision-making [11]. Linking processes with families and households also helps strengthen family bonds [13]. The biomedical approach, which places absolute trust in experts and views local people merely as subjects to obey rules and receive vaccines, highlights the need for a people-centred health promotion and disease management strategy in South Africa. Marginalised and vulnerable populations—lacking socio-economic and political power—are the ones most affected by state harshness. Furthermore, addressing vaccine hesitancy, including towards COVID-19 vaccines, requires a clear understanding of the complex factors influencing perceptions and practices, and interventions should be accordingly tailored [14, 15]. Cooper et al. [12] argued that approaches that are individualistic, decontextualised, and uniform are unlikely to effectively tackle the pandemic. There is evidence of vaccine hesitancy both within South Africa and across other African countries. Africa reports some of the world's lowest COVID-19 vaccination rates, affected not only by vaccine supply issues but also by hesitancy among healthcare workers and the general population. Hesitancy rates among healthcare providers in countries such as Burkina Faso, Ethiopia, Nigeria, Tanzania, and Ghana vary widely, with concerns centred on vaccine efficacy, side effects, and fears about receiving experimental vaccines [16]. Moreover, young people in sub-Saharan Africa exhibit particularly low vaccine acceptance, with a 2024 study indicating an acceptance rate of just 38.7% among adolescents and young adults aged 10 to 35. Contributing factors include negative healthcare experiences, distrust of government, and misinformation spread *via* social media [17]. Experts suggest that strategies to address COVID-19 vaccine hesitancy and promote acceptance should go beyond mere information dissemination, recognising

that individuals often base their beliefs on personal experiences, culture, background, class, and religion—all of which influence their reactions [18]. Building trust in COVID-19 vaccines must be part of broader efforts to foster community connection, transparency, participation, and equity. Effective leadership and clear communication are essential for engaging communities and encouraging participation in vaccination programmes, including involvement from non-governmental and cultural leaders [19]. Dzinamarira et al. [20] emphasised that acceptance of the COVID-19 vaccine depends on communities' perception of the pandemic as a threat to their health, families, and livelihoods. The evidence and literature cited here support the argument that a solely biomedical response in South Africa, which relies on strict regulation and expert authority, neglects the necessity of an inclusive, people-centred health promotion approach for success.

3. Methodology

The study employed a mixed-methods approach, collecting data through situational observations, dialogues, and a semi-structured questionnaire processed using Epicollect5 software. The data were gathered from 1800 households across 10 rural local municipalities in the Eastern Cape's former Transkei region. Quantitative data was analysed through the use of SPSS, and the qualitative data was coded and thematically arranged, cross-tabularised and matched to/against the quantitative data. Unlike most COVID-related studies at the time, which concentrated on the metropolitan and urban areas, this study focused on the rural landscape of the province, following a similar study we conducted on rural livelihoods and lockdown at the onset of the pandemic [21]. The emphasis on rural livelihoods allowed for a better understanding of the socio-economic dynamics and disparities affecting vaccine uptake among marginalised populations. It also emphasised people's perceptions and decision-making processes about vaccination, along with how the precarious living conditions of the study populations affected their health-seeking behaviour, particularly regarding COVID-19 vaccination rates.

4. Findings and interpretation

The findings presented are from the Vaccine Hesitancy study I co-led with the Human Sciences Research Council and Walter Sisulu University in 2022. We focused on nine municipalities in rural Eastern Cape to assess vaccination awareness and hesitancy, supporting the provincial government and local health authorities. These areas were chosen due to their involvement in a previous study on COVID-19 and funeral protocols in 2020 [22]. The following data presentation, findings, and discussion profiles participants based on their socio-economic status. This analysis aims to determine whether these factors influenced their ability to make an informed choice regarding vaccine hesitancy and other factors affecting their decision to get vaccinated.

Figure 1 shows that secondary education is the most common level among participants. The educational background of these individuals suggests limited post-secondary formal training, which indicates a less active economic population that heavily relies on public healthcare facilities. This matches Statistics South Africa's 2022 census report [23], which states that the proportion of adults with secondary education as

EDUCATION LEVELS IN SAMPLE POPULATION

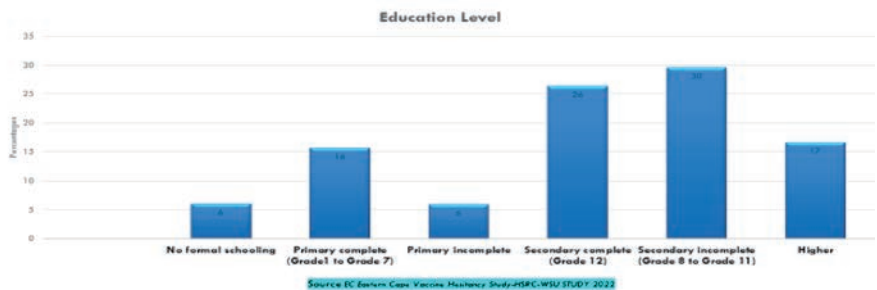


Figure 1.
Educational status. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

their highest achievement has steadily increased. For those aged 25 and older, the rate of at least completing secondary education rose from 21.5% in 1996 to 48.1% in 2022. Notably, there has been a significant rise among black Africans, whose completion rate tripled from 9.4% to 34.7%. The South African government points out that, although secondary school completion rates increased markedly—from 16.3% in 1996 to 37.6% in 2022—this growth has not fully translated into higher post-school enrolment or easier transition into employment [24, 25]. Structural barriers and disparities affecting marginalised groups, including black Africans, also create significant challenges in accessing quality healthcare in South Africa. This underscores ongoing challenges in the country’s journey towards Universal Health Coverage (UHC), as noted by Sharpley [26, 27], South African Government Communication Service [28], Mvikweni [29], and [30, 31].

Figure 2 indicates that the majority of people in the communities studied are unemployed, which helps explain the high reliance on social support grants, as shown in **Figure 3** below. In South Africa, the official unemployment rate rose to 32.9% in the first quarter of 2025, with youth unemployment particularly concerning at 62.4%

EMPLOYMENT STATUS

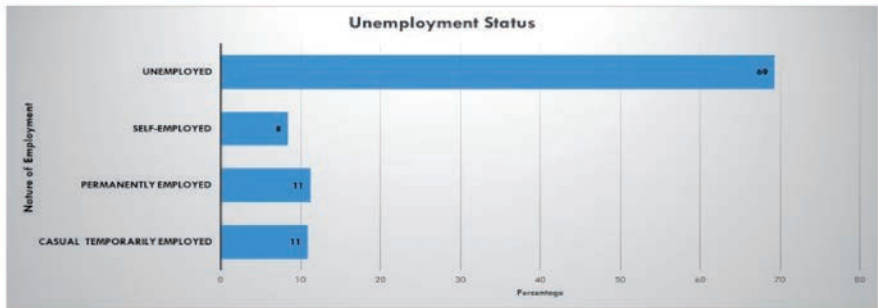


Figure 2.
Employment status. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

SOURCE OF HH INCOME

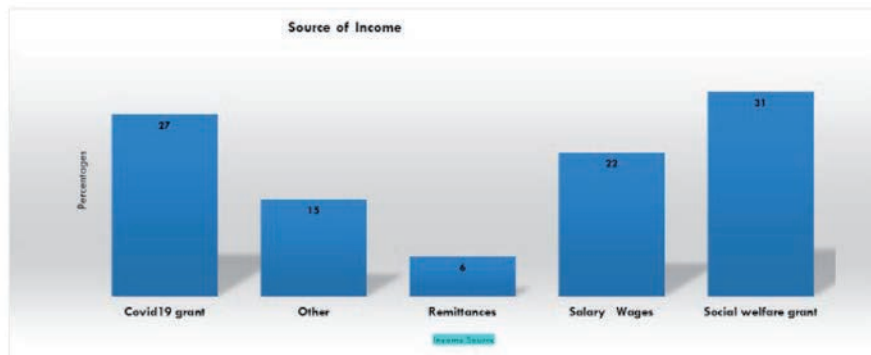


Figure 3.

Source of income. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

for those aged 15 to 24 years. This persistent high level of unemployment leads to significant dependence on social support grants in many communities. The unemployment crisis is especially pronounced in certain provinces, such as Mpumalanga and the Eastern Cape, which is the province where the study was done, where unemployment rates reach nearly 50% or higher. This situation exacerbates the reliance on social grants as a safety net for low-income populations [32–34].

Figure 3 shows that the primary sources of income in the studied communities are social welfare grants and the COVID-19 grant, indicating a significant reliance on the social security provided by the government. Official reports from Statistics South Africa confirm that sustained high unemployment and slow job creation are factors driving reliance on social grants across many communities, reflecting socio-economic challenges faced by the population [33, 35].

Figure 4 shows that the majority of the people preferred the combination of both traditional and Western Medicine, which speaks to the will of the people to make decisions on the type of medical support they choose. On the same a notable number preferred a purely biomedical Western medical support. The preference for combining traditional and Western medicine highlights individuals' desire to exercise choice and control over their healthcare, integrating biomedical protocols with culturally familiar practices. This dual usage also acknowledges the complementary strengths of each system, from biomedical diagnostics and pharmaceuticals to traditional medicines [36].

Figure 5 shows that most people indicated that discussions about vaccination were mostly done in the clinics where they visit for medical needs, followed by those who said it was done at funerals. A study conducted by Modi et al. [37] on preferred vaccination places and sources of information shows local clinics as important locations where patients learn about vaccination. In most cases, participants in the study indicated that vaccination at the clinics during the pandemic was primarily focused on implementation rather than on informing and educating users. As a result, they felt coerced and pressured to receive the vaccine in order to gain access to necessary healthcare services. Access to services was tied to vaccination status, meaning that

MEDICAL PREFERENCES IN THE SAMPLE

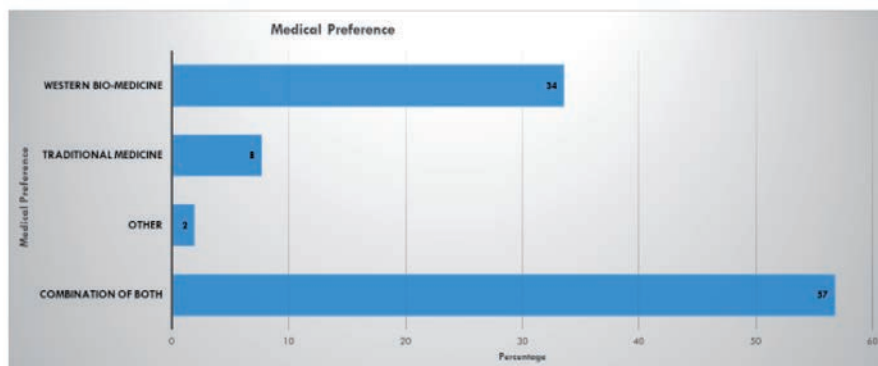


Figure 4.
Medical reference of the participants. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

VACCINATION DISCUSSED

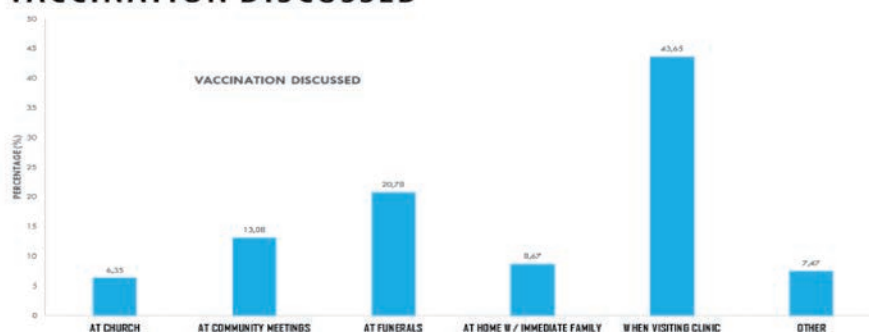


Figure 5.
The places that talk about the importance and need for vaccination was mostly done. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

individuals often had to show their willingness to get vaccinated before they could receive attention for other needs or reasons for visiting the healthcare facility in the first place (Chapter 5.1—[38, 39]).

In **Figure 6**, there is a reflection of either being decided, 48.92%, or coerced, 22.03%, towards a vaccination decision, compared to 29.05% of those who were vaccinated based on personal choice. Raman et al. [40] reported similar sentiments in a study about vaccine coercion in India that coercion was one of the determining factors for vaccine uptake. In the United States, Purvis et al. [41] confirm that vaccine uptake decisions are influenced by a mix of factors, including individual choice, social influence, and perceived or real coercion. Qualitative studies have documented that policies or mandates can make some individuals feel compelled, even when “personal choice” is an option, resulting in a spectrum between voluntary, coerced, and independently decided vaccination.

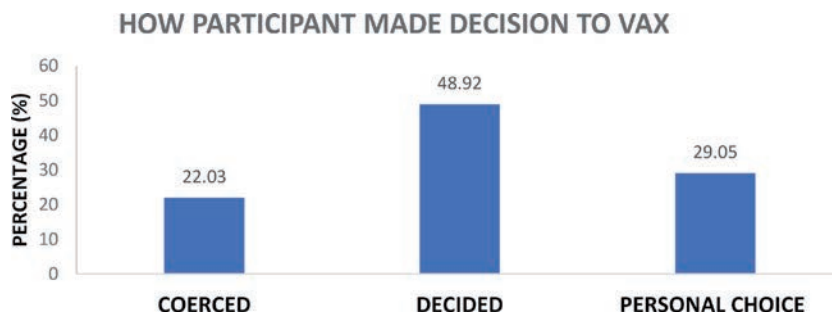


Figure 6.
How vaccination decisions were made. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

Figure 7 shows that although the government was the primary source of vaccination coercion, followed by social media and family, most people reported being influenced by family when deciding to vaccinate. This contradicts the common view held by the South African government and the Department of Health, which suggests that rural populations are ignorant and therefore viewed as deviants in their vaccination responses. Contrary to this popular perception, the family was the most effective agent in driving household vaccination and decision-making. Therefore, there is a need to rethink health promotion, favouring a people-centred strategy rather than a solely biomedical approach, which can be seen as coercive and as infringing on individuals' constitutional rights to make decisions about their own lives. On the same view, Wits University Research, Soweto [42] highlights low vaccine uptake among youth linked to barriers such as misinformation, lack of trust, and perceived coercion. Motivators included protecting loved ones, social reintegration, and access to essential services [42].

Figure 8 indicates that most participants who were persuaded or coerced into getting vaccinated were primarily persuaded by doctors and nurses, accounting for 37.02%. This correlates with **Figure 5**, which shows that many learned about vaccinations during clinic visits. Participants also noted that family members influenced their decisions towards vaccination, contrasting with the role of healthcare providers. This

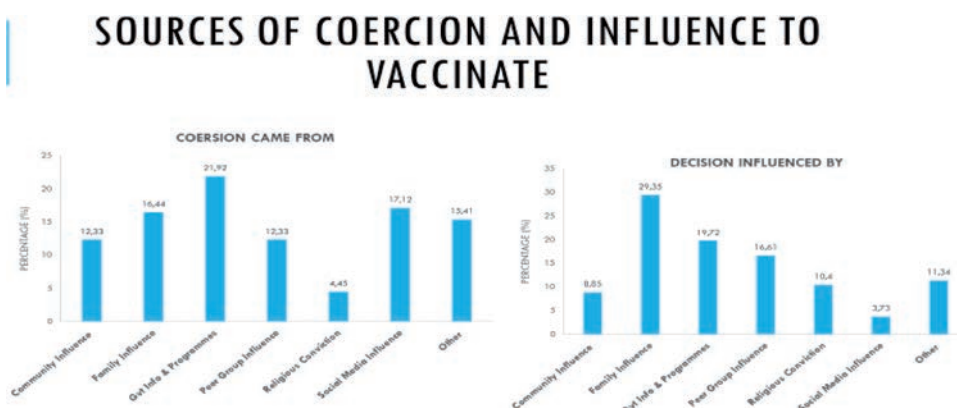


Figure 7.
Vaccination coercion against the decision influencer to vaccinate. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

PERSUASION AND THE PERSUADERS

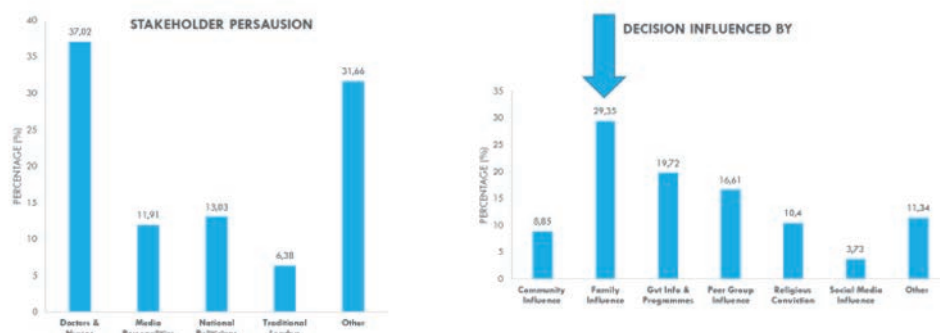
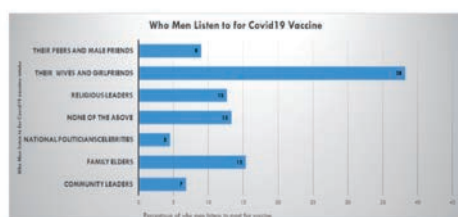


Figure 8.
Confirmed coercion and the persuader towards vaccination decision. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

reflects the concept of medicalisation, where medical professionals guide vaccination choices, implying a degree of authority in the decision-making process. Bardosh et al. [43] also argued that studies have shown how mandates restricting access to work or social activities impinge on human rights, promote stigma, and lead to social polarisation and distrust.

Figure 9 illustrates that men tend to listen to their wives and girlfriends when making the final decision to vaccinate, while women also consider their husbands or boyfriends. This highlights the importance of the immediate other in critical health-related choices, emphasising key players in health-seeking behaviour that influences one's life. Consequently, this chapter advocates for an inclusive, people-centred approach to healthcare, as opposed to the dominance of the expert perspective characteristic of the biomedical model of health promotion. In South Africa, particularly regarding primary healthcare in rural areas, there is evidence of inactive or non-existent clinic boards that include community members, resulting in the exclusion of the community's voice and interests in decisions about how healthcare is organised and delivered on the ground. Studies like that of Haricharan et al. [44], Hove et al. [45], and Gaede and Versteeg [46].

WHO DO MEN LISTEN TO FOR VACCINATION?



WHO DO WOMEN LISTEN TO FOR VACCINATION?



Figure 9.
Who men and women listened to for vaccination decision taken. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

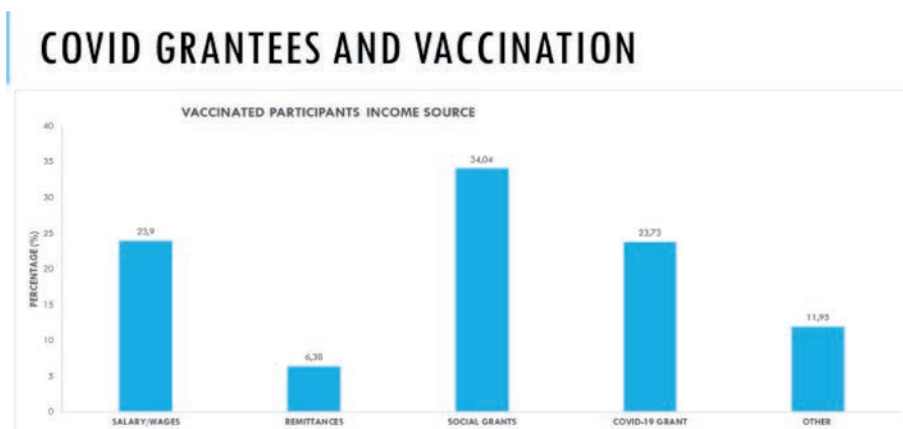


Figure 10.

Source of income and vaccination. Source EC Eastern Cape vaccine hesitancy study-HSRC-WSU STUDY 2022.

In **Figure 10**, there is a high vaccination uptake amongst more grant recipients. This might support the indication that people felt compelled or decided to take the vaccine due to the need to access basic necessities and to ensure access to social support systems, such as social grants. Several studies and governmental reports support the statement that higher vaccination uptake has been observed among social grant recipients, suggesting that people may have felt compelled or decided to get vaccinated due to the need to secure access to basic needs and social support systems in South Africa [38, 39].

5. Discussion

The COVID-19 pandemic exposed and exacerbated existing socio-economic vulnerabilities in South Africa, particularly in rural communities [47]. Carlitz and Makhura [4] highlight that while some communities complied with lockdown regulations, precarious living conditions severely limited their capacity to cope with the pandemic's impacts. The strict lockdown measures, though effective in curbing viral spread, precipitated widespread unemployment, poverty, and social isolation, stripping families of essential resources [1]. The South African government's response was characterised by a regulatory, biomedical approach, marked by centralised decision-making, strict enforcement of rules, and a focus on vaccination as the primary intervention [2, 3, 5]. However, this approach largely neglected the complex socio-cultural and economic realities of marginalised populations, particularly in rural areas.

Critics argue that the biomedical model, with its emphasis on expert authority and medicalisation, failed to incorporate community voices and overlooked the pandemic's broader social impacts [6, 7]. Rural residents were often stereotyped as uninformed or non-compliant, which justified top-down interventions that sometimes alienated these communities and eroded trust [8]. Ethical concerns also arose around mandatory vaccination policies, which raised issues of autonomy, consent, and stigmatisation [9, 48]. The experience in the Eastern Cape exemplifies these tensions, where short-term compliance was achieved but long-term trust was undermined amongst those who felt coerced to take the vaccine, as indicated in **Figures 6–10** above.

Vaccine hesitancy in South Africa, as in other African contexts, is multifaceted, influenced by distrust in government and science, misinformation, cultural beliefs, and historical experiences with healthcare [11, 12, 16, 17]. Family and peer networks emerged as crucial influencers in vaccination decisions, underscoring the importance of culturally sensitive, community-based health promotion strategies rather than solely top-down biomedical messaging [13]. This exposition is supported by the data presented in this chapter from **Figure 4**, where the combination of western and traditional practice is mostly preferred, showing a communal realisation of the choice of health support by the people and the ability to choose what treatment approach they prefer. Furthermore, **Figures 8** and **9** show a strong family influence on vaccine uptake despite the coercion experienced from the health and government authorities, and **Figures 8** and **9** show the influence of the family and significant others, like husband, wife, and one's life partner, in general, to influence one's vaccine uptake. The role of the community and the family was not recognised in the vaccination rollout during the surge of the COVID-19 pandemic in SA, which clearly shows the top-down biomedical approach embraced in SA healthcare provisioning. Even so, the role of community and family showed significant importance in embracing the care approach of not only informing on the need to vaccinate but also to walk daily with each other in making such a decision. Additionally, in the EC vaccination study we conducted, family members explained how they negotiated vaccine uptake. One of the male participants mentioned: *"We had to decide where our greatest loss would be if a particular member takes this vaccine and it becomes a hazard and a threat to one's life, since we do not know its safety. As the man of the house, I decided to be the one to take the vaccine because I am also the one who engages in limited public spaces, like going to town for family needs during lockdowns or representing the family at funerals and community gatherings. Meanwhile, my wife has to attend to our children, who need their mother most because they are still very young. We then agreed that, as the husband, I would take the risk while my wife remains protected to continue raising the children, especially if the vaccine were to harm me or affect my health. This is especially important because women are generally the stronger ones in raising children when the husband dies, and they are less likely to remarry after their husband's death, unlike us men."* Community members expressed a shared concern for those who largely rely on assistance for their daily needs. Many individuals felt compelled to get vaccinated when faced with specific circumstances that required it, such as seeking employment or accessing grants and basic services. These individuals felt they had no choice but to get vaccinated, as many essential services were unavailable to those considered unvaccinated threats. On a similar point, Solidarity Fund [49] pointed out that outreach vaccine programs that targeted social grant pay points and other government service centres were instrumental in increasing vaccination uptake, suggesting that access to social support was linked to vaccination status. By getting vaccinated, they could access these necessities and job search opportunities. We noted a number of interesting realities with how the family and immediate others played a significant role in determining who to get vaccinated and why, while most views expressed a lack of trust in government officials and the healthcare providers [50].

The Vaccine Hesitancy study in the rural Eastern Cape corroborates these insights. It reveals that despite high vaccination rates among social grant recipients, likely motivated by the need to secure basic necessities and social support, many participants felt coerced or persuaded rather than empowered to make fully informed choices. Clinics and healthcare workers were the primary sources of vaccine information, but family influence was paramount in decision-making. This challenges

government narratives that portray rural populations as ignorant or resistant, instead highlighting the nuanced social dynamics at play. On the same view, it has been noted in the body of literature that for socio-economically vulnerable populations, maintaining access to health services and social grants was a motivating factor that influenced vaccine acceptance, particularly when regulations made these services inaccessible to unvaccinated persons (Chapter 5.1—[38, 39, 51]).

Moreover, the preference for combining traditional and Western medicine among participants reflects the need for a more inclusive, people-centred health approach that respects local knowledge and cultural practices. The lack of active community participation in healthcare governance, evidenced by inactive clinic boards, further marginalises rural voices in health service delivery decisions [44–46]. The COVID-19 pandemic prompted a revealing examination of how primary healthcare in rural South Africa is more directed by biomedical authority, placing health users under the control of experts, with minimal or no space for a people-centred interactive health-care approach.

6. Conclusion

The South African COVID-19 response, dominated by a biomedical and regulatory framework, achieved some success in controlling the pandemic but overlooked critical social, cultural, and economic dimensions, particularly in rural communities. The centralised, expert-driven approach marginalised community participation, undermined trust, and sometimes coerced compliance, which may have contributed to vaccine hesitancy and resistance.

Findings from the Eastern Cape emphasise the importance of family and community networks in shaping health behaviours and vaccine acceptance. High vaccination uptake among social grant recipients suggests that socio-economic imperatives strongly influenced vaccination decisions, highlighting the intersection between health and social welfare.

To enhance the effectiveness and equity of public health interventions, South Africa must adopt a people-centred health promotion strategy that integrates biomedical measures with community engagement, respects cultural contexts, and empowers marginalised populations to participate meaningfully in healthcare governance [52, 53]. Strengthening local clinic boards and fostering inclusive decision-making processes are vital steps towards rebuilding trust and ensuring that health services respond to the lived realities of all South Africans.

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Additional information

The author's ORCID number: <https://orcid.org/0000-0001-7657-4033>.

Author details

Nelly Vuyokazi Sharpley
University of KwaZulu-Natal, Durban, South Africa

*Address all correspondence to: sharplesn@ukzn.ac.za

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Perspective Chapter: Aftermath of COVID-19 Pandemic on Mental Health of Individuals

Dillo Justin Ramoshaba

Abstract

This chapter provides a critical analysis on the aftermath of the COVID-19 pandemic on the mental health of individuals through extensive integrative literature review and authors' findings on mental health and COVID-19 pandemic. Literature shows that the COVID-19 pandemic has affected the mental health of many individuals negatively. As a result of the impact of the COVID-19 pandemic, many individuals were left with mental health issues to battle with. Many studies have been conducted on COVID-19 and mental health. However, there are quite a few studies that have rigorously focused on the mental health of individuals post-the-COVID-19 pandemic. There is a need for studies on the mental health of individuals post-the-COVID-19 pandemic to inform policies and programmes that will be helpful for mitigating natural disasters such as the COVID-19 pandemic. There is also a need for continued support services such as counselling for individuals who have experienced mental health issues due to the COVID-19 pandemic.

Keywords: COVID-19, pandemic, mental health, impact, natural disasters

1. Introduction

The scourge of the COVID-19 pandemic affected many parts of the world, leaving many individuals, families and communities with issues such as job loss and loss of life to deal with. In addition, the pandemic left many individuals with mental health issues such as stress and depression to deal with. During the COVID-19 pandemic, many individuals experienced changes in their daily activities, which increased their anxiety and stress resulting in the deterioration of their mental health [1]. The post-the-COVID-19 pandemic impact on the mental health of individuals remains under-researched and requires a critical analysis beyond the pandemic. This is because the issues are likely to persist beyond the pandemic as they normally do with other endemics and pandemics. This is confirmed by a study that highlights that previous pandemic increased mental health issues amongst different individuals beyond the era of the pandemic itself [2]. The study further highlights that mental health issues post pandemics may remain untreated and undiagnosed due to interrupted health

services and other challenges for mental health services during the post pandemic era. This raises concerns for the well-being and mental health of individuals across the world post-the-COVID-19 pandemic, which requires collaborative intervention by different stakeholders or multidisciplinary teams such as social workers and therapists, just to mention a few. Social and psychological services offered by social workers and psychologists are very crucial in the battle against mental health issues. The intervention and services of professionals such as social workers and psychologists post-the-COVID-19 pandemic can foster resilience within the individuals who are dealing with mental health issues and shape their thinking during their mental hardships. In the same breath, social and psychological services are seen as key as they help individuals to acquire knowledge themselves and of their own psychological problems to sustain their emotional growth and the optimal development of their own personal resources [2]. However, there is less literature on mental health of individuals post-the COVID-19 pandemic. The current literature highlights mental health issues during the COVID-19 pandemic, which leaves a gap for exploration of mental health issues beyond the pandemic. In this chapter, the researcher used a wide range of literature on mental health and pandemics to identify what is known and not known about the mental health of individuals post pandemics.

2. Factors that contributed to mental health issues during the COVID-19 pandemic

Through the lenses of the Ecological Systems and resilience theories, the following factors were identified as the ones that contributed to the Mental health issues that were experienced by individuals during the COVID-19 pandemic.

2.1 Stay-at-home regulations

It is necessary to curb the spread of viruses during humanitarian crises such as the COVID-19 pandemic by implementing or enforcing restrictions such as lockdown. However, such restrictions force individuals to be confined to their respective homes to stop the rapid spread of the virus. Although the main reason for enforcing restrictions such as lockdown is to save lives and avoid the negative impacts of the viruses or pandemics. It is unfortunate that, such restrictions can have an impact on the mental health of individuals as it was discovered with previous pandemics [3–5]. It is seeming that regulations such as lockdown save lives, but it is also important to note that such measures disrupt social support services, which are aimed at dealing with mental health issues amongst individuals. For instance, during strict lockdowns, individuals are unable to have social visits or visit their therapists, which can lead to mental health issues for such individuals. The COVID-19 pandemic was not exempted from this challenge, as governments across the globe had to impose lockdowns to curb the spread of the virus. Policies and restrictions such as lockdown and social distancing are implemented during humanitarian crises such as the COVID-19 pandemic and have negative impact on the economy, which normally result in job loss for some individuals [6]. This highlights the negative impact of the policies and restrictions that are implemented to manage Pandemics, making it clear that the policies do not only assist to manage but can also create challenge. On the contrary, a study reports that the implementation of such policies and early detection can assist to protect and save lives of citizens [7]. The researcher acknowledges the negative impacts that

result from policies and restrictions that are enforced to manage pandemics whilst not overlooking the importance of such restrictions because without them, the virus would spread at a high rate, resulting in more severe repercussions. The Ecological Systems Theory examines the relationship between individuals and the environment. Thus, the relationship between the environment that has restrictions, and the mental well-being of individuals can be explored within these lenses, in that the restrictions caused mental health issues for some individuals.

2.2 Quarantine and isolation

It is inevitable to implement measures such as quarantine and isolation during pandemics such as the COVID-19 pandemic because such measures assist to prevent the spread of the virus. Being in isolation or quarantine does not only prevent the spread of the virus but also do harm in some individuals as they may suffer from psychological issues, such as anxiety, stress, fear and frustration. Literature shows that with past pandemics some individuals suffered from post-traumatic stress disorder (PTSD) and depressive disorder, which resulted from them being in quarantine and isolation facilities. Literature also shows that some individuals who are either in quarantine or in isolation become suicidal [8]. Suicidal thoughts in some individuals are triggered by many factors, such as isolation, loneliness, fear of contracting the virus and fear of being a burden to their loved ones [9]. The COVID-19 preventative measures of quarantine and isolation were crucial in managing and controlling the spread of the virus. However, it must also be noted that the measures also caused mental health issues such as stress in some individuals. The importance of quarantine and isolation guidelines during pandemics cannot be overlooked as they assist to manage the spread of viruses and help to stop or avoid further damage by pandemics. On the contrary, the guidelines do not only help in managing the viruses but also create more problems such as increased mental health issues, which leave individuals requiring psychological services such as counselling [10]. Although quarantine and isolation can have negative impact on the mental health of individuals, it is important to note that pandemics cannot be effectively managed without quarantine and isolation guidelines and facilities.

2.3 Job loss

Pandemics such as the COVID-19 pandemic do not only disrupt human activities but also economic activities. The disruption in economic activities led some employers to cut costs by retrenching some of their employees. Such retrenchment results in some families losing their income, which will also cause the affected individuals to experience mental health issues such as anger and stress. Studies show that the COVID-19 pandemic has increased unemployment rate in many countries across the globe [9]. It is difficult for individuals who have lost their jobs to access economic resources, which may lead them to experience mental health issues such as depression. The COVID-19 also affected the health of many individuals, others experienced physical challenges whilst some experienced psychological distress due to job loss [11]. Previous studies show that there is a relationship between mental health and unemployment, in that unemployed people are at times without income, which causes frustrations to them [12]. It can be deduced that pandemics such as the COVID-19 pandemic cause great damage to the physical and psychological health of individuals. High rates of job loss can create behavioural health disorders for some individuals,

which might lead them to be suicidal [13]. On the other hand, some individuals when confronted with challenges such as job loss resort to negative coping strategies such as abusing substances to cope with their problem [14]. It is crucial to note that people do not deal with problems the same way, thus some individuals employ negative strategies such as using substances, which might create more problems such as health complications. On the other hand, others may employ positive coping strategies such as seeking for support or the necessary services that will help deal with their challenges.

2.4 Loss of life

The COVID-19 pandemic left many families in grief and emotional state due to the lives that were lost to the pandemic. Many individuals lost their loved ones during the COVID-19 pandemic and the mental health issues associated with losing a loved one cannot be ignored in this instance. The number of people who lost their lives was published daily during the peak of the virus and this posed possible panic and fear, which can foster stress and depression for some individuals. Thousands and thousands of lives were lost in different countries, in some instances the deceased were breadwinners, and this created more problems such as lack of income for some families. This is supported by a study that was conducted in 81 countries, which revealed that 1,279,866 lives were lost due to the pandemic [15]. The possible mental health issues that will be experienced because of lives that were lost due to the pandemic cannot be overlooked. It is unfortunate that, some people experience emotional and psychological challenges after losing their loved ones. Some individuals did not only have to deal with the pain of losing their loved ones but also had to battle with the thoughts of generating income after losing those who provided for them. The mental health issues that can be experienced because of losing a breadwinner cannot be ignored as they can result in losing more lives that might be instigated by mental health issues such as depression. Losing a family member does not only present emotional and psychological challenges but can also cause disorientation in some families leaving them disgruntled and dysfunctional [16]. It is important to provide support and services to families of individuals who lost their loved ones to help such families to remain functional and stable.

3. Mental health issues caused by the COVID-19 pandemic

The panic and worry that the COVID-19 pandemic brought to many people's lives raised concerns for the well-being and mental health of individuals. Many individuals and different organisations such as the World Health Organisation (WHO) raised concerns on the mental health and psychosocial consequences of the COVID-19 pandemic on individuals [17]. These concerns were coupled with predictions about possible continued mental health issues on individuals. The predictions were informed by the experiences of previous pandemics, which caused persistent mental health issues in some individuals [18]. The World Health Organisation also speculated that the new measures such as self-isolation and quarantine affected the normal activities, routines and livelihoods of individuals. Furthermore, it was reported that such changes may bring issues such as increased loneliness, anxiety, depression, insomnia, alcohol and drug use, self-harm or suicidal behaviours [17]. During the COVID-19 pandemic, many individuals faced mental issues such as stress and depression, which negatively affected their well-being and that of their families [2]. Issues such as stress

and depression, which were experienced due to the pandemic, confirmed the predictions that were made about pandemics and mental health of individuals. It is evident that individuals experienced mental health issues during the COVID-19 pandemic. To reflect on some of the mental health issues that were faced by individuals due to the COVID-19 pandemic, literature revealed the following:

3.1 Anxiety and depression

The COVID-19 cases were increasing daily across the globe, which caused panic and worry for some individuals. The panic and worry were instigated by the fear of contracting the virus. The fear of contracting the virus caused mental health distress amongst the general population. Some individuals experienced issues such as stress, anxiety disorders and depression due to the fear of the COVID-19 pandemic [19]. From a biological perspective, it is believed that traumatic life events such as losing a loved one or abuse can affect the psychological well-being of individuals [20]. Thus, the psychological impact of the COVID-19 pandemic on the well-being of individuals who experienced depression cannot be overlooked. Large volume and frequent circulation of false information and reports about the COVID-19 on social media platforms increased stress levels of some individuals [21]. Thus, some individuals became concerned about their health and the safety of their loved ones. Measures such as lockdown led to economic decline, which resulted in some individuals losing their jobs. Losing a job can be stressful for individuals who rely on their jobs as the only source of income. The anxieties and depressions that were experienced due to many factors such as job loss cannot be overlooked as many other factors disrupted the lives of many individuals, which also affected their mental health. It is important to note that individuals who experienced stress and depression due to the COVID-19 pandemic may not only have to battle with the psychological impacts of such but their relationships can also be affected, as well as their health and their daily activities.

3.2 Suicidal thoughts

Suicide is not a phenomenon that emerged with the COVID-19 pandemic, but it has been existing way before the emergence of the pandemic. People commit suicide for different reasons and amongst those reasons, the COVID-19 pandemic cannot be ruled out. This is mainly because individuals have different strengths and weaknesses, while others, when confronted with situations such as endemics and pandemics, prefer dealing with them by employing positive mechanisms such as seeking social support, others think about ending their lives. This is supported by a study, which found that suicidal risk amongst the general populace increased during the previous SARS epidemics [22]. The COVID-19 pandemic did not exempt individuals from this challenge. This is in line with a study, which reported that suicidal rates are going to increase beyond the COVID-19 pandemic. Factors such as neglect and domestic violence, which increased during the COVID-19 pandemic, are strong contributors to suicidal risk. The suicidal risks that were raised during the pandemic highlight the importance of support services such as counselling during epidemics and pandemics. Some individuals during the COVID-19 pandemic developed fear, others experienced loss of their loved ones, some lost their jobs, whilst some had to be in isolation, which can cause serious mental health issues and lead some of them to be suicidal. Thus, it must be noted that there were many factors that led people to be depressed and suicidal during the COVID-19 pandemic.

3.3 Sleep disorders

Some people, when they experience challenges, struggle to sleep and get overwhelmed by their challenges. This was the case during the COVID-19 pandemic, which caused mental health issues amongst some individuals by reducing the quality and quantity of their sleep [23]. The COVID-19 pandemic changed daily routines and activities of individuals, which can also affect the sleeping patterns of individuals. In addition, factors such as home confinement, which reduces an individual's changes of social interaction and increases social media usage, can cause sleep disturbances [24]. Sleep disturbances can also be caused by psychological factors, such as stress, loneliness and depression. Sleep disorders can have long-term effects on individuals, which can lead to various health problems. Issues such as fear of death and uncertainty of the future disrupted the sleeping patterns of individuals, which resulted in sleep disorders. Such issues signalled for intervention during the COVID-19 pandemic and post the pandemic. It is difficult for some individuals to sleep when they are bothered or living in fear and worry. The COVID-19 pandemic has caused fear and worry for some individuals, which instigated more issues such as sleep disorders.

3.4 Addictive behaviours

Some individuals experienced addiction problems, which were instigated by the impact of the COVID-19 pandemic on the lives of different individuals. Some individuals become antisocial, in that they preferred locking themselves in their rooms and being on their cell phones as opposed to spending time with their families. This became a habit or addiction for some individuals who resorted to negative coping strategies. This is supported by a study, which discovered that some individuals became addicted to substances that they used as a coping mechanism for the challenges experienced due to the COVID-19 pandemic [25]. During the COVID-19 pandemic, individuals were expected to cope with the demands of the environment, which was created by the pandemic. For some individuals, their coping mechanisms created addiction for them, such as those who resorted to being on their cell phones or those who resorted to negative coping mechanisms of abusing substances. The COVID-19 pandemic did not strike the world in a day, but the pandemic emerged and persisted for some time, which forced many individuals to develop coping mechanisms to be able to continue with their lives. However, as it persisted for a longer period some individuals became addicted to some of their behaviours, such as those who smoked or drank alcohol for coping. Such addictions may be assisting individuals to cope with the impact of the COVID-19 pandemic but their contributions to the already troubling social problems such as substance abuse cannot be overlooked. The resilience theory was key in this study as it allowed the researcher to zoom how addictive behaviours such as substance abuse as coping strategy influenced the resilience of some individuals.

3.5 High grief levels

The COVID-19 rules and regulations made it difficult for people to perform their usual rituals, beliefs and practices after losing their loved ones. The mental impact of being unable to perform usual practices during the grieving process cannot be overlooked as it has the potential to cause higher grief levels. This is supported by studies, which found that some individuals experienced higher grief levels due to COVID-19

compared to other causes of death [26, 27]. During the pandemic, many lives were lost in a short space of time compared to deaths that resulted from natural causes. There were many factors such as reduced social support and limited opportunities for death rituals, which might have disadvantaged the grief process for non-COVID-19-related bereavement. It must be noted that the COVID-19 pandemic rules and regulations did not have exceptions for non-COVID-19-related bereavement. Every individual or family was subjected to reducing the number of attendees during funerals, which prevented some families from getting social support. Some people at some point live-streamed funerals, whilst some were in-person but with tight attendance, which restricted some individuals and families from the opportunity of getting guidance and support from their close individuals. The COVID-19 pandemic denied some individuals their rights of practising their culture. Some beliefs and cultures were difficult to practice during the COVID-19 pandemic due to the restrictions and guidelines that were imposed by governments. The rights to freedom of religion and culture were infringed as the guidelines prevented some cultural and religious activities from happening.

4. The post-COVID-19 pandemic issues

4.1 Stigma related to COVID-19 pandemic on survivors

One of the biggest challenges across different societies is the issue of stigma. Individuals hold different stigmas for different situations. Stereotypes are inevitable as they are learned as part of growing up in a culture. The setback about stigmas is the impact that they have on the people who are being discriminated against. Stigmas can evoke or cause mental health issues for some individuals. During the COVID-19 pandemic, many individuals had stigmas about the virus and the people who contracted the virus. Some individuals perceived the survivors of the pandemic as a threat to their lives and that of others. In some instances, some people expressed their discomfort around people who recovered after contracting the virus. The discomforts include avoiding talking to or facing the survivors. A study found that the mental health of many individuals was affected by the stigmas associated with the COVID-19 pandemic [27]. The impact of the stigmas on the mental health of the COVID-19 survivors cannot only be looked at any point as they must be looked at beyond the COVID-19 pandemic. Stigma can deny individuals opportunities. For instance, some employers do not want to hire people because of the stigma that is associated with their conditions. This is supported by a study, which posits that people with mental health illness are at times denied employment because they are viewed as being dangerous [20]. Another study states that the public view is that individuals with mental illness are dangerous [28]. Thus, it can be noted that instead of receiving support during difficulties some people experience stigma, which creates more problems for their well-being.

4.2 Social anxiety disorder

It is apparent that the COVID-19 pandemic has disrupted the lives of many individuals and caused a lot of mental health issues. Some individuals had mental health issues already before the COVID-19 pandemic but for some they experienced them due to the pandemic. A study found that the COVID-19 pandemic caused stress

and social anxiety disorders for some individuals [19]. The impact of stress on the well-being of individuals cannot be overlooked. It can also be deduced that although social anxiety disorders were experienced during the COVID-19 pandemic, their persistence beyond the pandemic cannot be ignored. It would be dishonest to believe that the COVID-19 pandemic is going to end with all the mental health issues that it has brought in the lives of many individuals. The Pandemic disrupted many activities and resulted in a lot of changes in the society. Such disruptions can cause social anxiety disorders for some individuals beyond the pandemic. Social anxiety disorder is understood to be a condition that causes persistent, intense fear about situations. Although some individuals during the COVID-19 pandemic had social anxiety disorders, which forced them to avoid many settings and situations that caused them distress. It is unfortunate that some individuals beyond the COVID-19 pandemic are likely to panic whenever they face or hear of a situation that relates to the pandemic, which will impact their mental health well-being. It is also apparent that some individuals are going to battle with social anxiety disorder because of the emergence of the COVID-19 pandemic in their lives.

4.3 Post-traumatic stress disorder (PTSD)

The anxiety that was experienced by many individuals during the COVID-19 pandemic has the potential to lead to more mental health issues such as the post-traumatic stress disorder. Some individuals experienced traumatic experiences such as losing their loved ones whilst some survived the pandemic after hospitalisation. Although some individuals might have recovered from their traumatic experiences, it should be noted that for some individuals, the experiences will continue to interfere with their daily life, in the sense that some are going to keep on experiencing symptoms such as flashbacks of the incidents and increased anxiety. It was envisaged that some individuals are going to experience post-traumatic stress disorder by a study, which showed significant (96.2% of the sample) symptoms of PTSD in hospitalised patients [29]. Although the symptoms do not necessarily confirm cases of PTSD, such symptoms raised concerns for PTSD cases. This was supported by previous coronavirus outbreaks such as the 2003 SARS, which showed PTSD symptoms and diagnosis in survivors [30]. Thus, it can be deduced that after pandemics such as the COVID-19 pandemic, many individuals experience mental health issues such as post-traumatic stress disorder. The impact of the COVID-19 pandemic on the livelihood of many individuals is likely to cause them stress and depression even beyond the COVID-19 era.

4.4 Misinformation related to the COVID-19 pandemic

The spread of fake news was a concern during the COVID-19 pandemic in different countries. The impact of misinformation on mental health was experienced by many individuals. Some of the misinformation was received because of factors such as religious or political beliefs. There were a lot of conspiracy theories during the COVID-19 era, which are likely to continue beyond the pandemic. Most of the fake news or information was spread on social media platforms. Some individuals were unable to receive accurate information during the era of the pandemic, which impacted their mental health [31]. It would be dishonest to assume that fake news about the COVID-19 pandemic or any other related pandemic will end with the COVID-19 pandemic. Thus, health literacy is important in the dissemination of information during humanitarian crises such as the COVID-19 pandemic, as it can

assist to prevent some of the mental health issues. Misinformation does not only cause panic for individuals but also brings anxiety for some individuals, which impact their well-being and mental health. It is difficult to control what people say, particularly on the social media, which can result in misinformation about the real situations in the society. Some individuals can live with worry and stress because of the misinformation that they get either from the opinions of people or from the social media.

4.5 Limited access to mental health services

Global mental health was posed with a threat as the outbreak of the COVID-19 pandemic increased the need for mental health services. The need for mental health services increased, despite the existing challenge of access and limitation to services. In support, a study found that most of the people who require mental health services do not have access or are having limited access to the services [32]. The issue of lack of and limited mental health access existed way before the outbreak of the COVID-19 pandemic. It has been a concern before the emergence of the COVID-19 pandemic. Thus, it is obvious that the COVID-19 pandemic worsened the situation by leaving many individuals with mental health issues such as depression and stress to battle with. Some individuals cannot access mental health services due to limited facilities, whereas for some it is due to medical fees and human resources. Limited access to mental health services will persist beyond the COVID-19 pandemic as the issue started way before the outburst of the pandemic. The COVID-19 pandemic is supposed to serve as a wakeup call for many governments across the globe to invest in mental health care services. Immediate and special attention should be given to mental health care services. Some people who are getting low wages do not afford health insurance fees. They are not covered for crisis-intervention needs that affect many individuals and families during times of social and economic stress [33]. Such predicament can result in such individuals not being able to get better and best care in the event of natural disasters or humanitarian crises such as the COVID-19 pandemic. Medical health care insurance plays a crucial role in the lives of many individuals, in that they can access medical services without challenges of having to worry about expensive fees.

4.6 Continued social problems

Many individuals had to develop different coping strategies to mitigate the impact that the COVID-19 pandemic had on their lives. Some individuals used positive coping strategies such as prayer and looking for social support, whilst others resorted to negative coping mechanisms such as using alcohol and substances to cope [25]. The setback about the negative coping mechanisms such as using substances is that members can be addicted and depend on the substances for also coping with their other life situations. Some companies closed and left many individuals jobless, which affected their mental health issues. To date, some individuals are still unemployed because of the COVID-19 pandemic. The closure of many companies did not only present challenges for the victims but has also created more problems such as disorientation of families who lost their breadwinners to the pandemic. Those who coped with substances and became dependent on them have also contributed to the challenge of substance misuse. Some people who have lost their jobs may be forced to do anything within their means to survive such as mitigating the impact of their income loss by employing negative coping strategies such as engaging in criminal activities so that

they can put food on the table. Although the COVID-19 pandemic is not going to exist forever, it must be noted that the mental health issues that were experienced during the COVID-19 pandemic are likely to persist as it cannot be confirmed that mental health issues will not be experienced beyond the pandemic.

5. Theoretical frameworks and research methodology

5.1 Theoretical frameworks of the study

To critically reflect on the impact of the COVID-19 pandemic on the mental health of individuals, the study employed the Ecological Systems Theory, which was developed by Urie Bronfenbrenner in the 1970 and the resilience theory, which emerged from studies of vulnerability with one of its pioneers being Norman Garmezy, who founded it in 1974. Garmezy defines resilience as the capacity for recovery and adaptive behaviour by individuals upon encountering a stressful life event or adversities [34]. The Ecological Systems Theory examines the relationship between individuals and their environment, which could be their families, communities and societal factors. The researcher was able to explore and illuminate the impact of COVID-19 on the environment of individuals and their mental health with ease through the application of the Ecological Systems Theory. In addition, people become resilient when they have a relatively good outcome, despite having experienced serious stresses or hardships in their lives [35]. Thus, the researcher through the lenses of the resilience theory was able to analyse how individuals coped with the impact of the COVID-19 pandemic on their mental health.

5.2 Research methodology of the study

It is important when examining a particular phenomenon to follow the following key steps; (a) integrate and assess existing research studies, (b) establish connections amongst critical concepts, (c) identify areas of deficiency and (d) establish a course for probable research activities [36]. To achieve this, the study adopted the non-empirical research method, wherein integrative literature was conducted. The researcher reviewed and analysed documents on mental health and the COVID-19 pandemic from several journals using a purposive sampling technique since there are research papers on the subject matter. The data were sourced from research engines such as Google Scholar, EBSCOhost and ProQuest. The search was restricted to papers from 2020 to 2025 to ensure currency and relevancy of the information collected. Few exceptions were made for sources that were published before 2020 to allow academic rigorousness and reflections. Moreover, to ensure information richness the data collection was determined by data saturation. The data were then analysed thematically using Inductive Thematic Content Analysis (TCA). This method allowed the researcher to identify, analyse and report patterns within the data set, allowing for the descriptive organisation of the data in a way that facilitates the interpretation of various aspects [37]. The application of TCA enabled the researcher to organise, analyse, interpret and present findings logically and with ease.

6. Conclusions and recommendations

Literature confirms that the COVID-19 pandemic has affected the mental health of many individuals. It shows that rules and regulations such as lockdown rules have

also played a role in instigating mental health issues during the pandemic. Thus, it is important to develop programmes that are aimed at dealing with mental health issues that are faced by individuals during and post pandemics such as the COVID-19 pandemic.

It is also evident that many individuals lost their jobs and loved ones. The major impact of such losses can be noted in some individuals who experienced stress and depression, addictive behaviours, sleep disorders whilst some became suicidal because of their losses. It is imperative to ensure that individuals are supported during and after pandemics. Supporting individuals during and after these times will assist in mitigating the mental health issues that are instigated by the pandemics.

It is also evident that some issues will persist beyond the COVID-19 pandemic. Issues such as stigmas around the COVID-19 pandemic and its survivors and post-traumatic stress disorder. It is thus important to have effective awareness and training workshops on pandemics to help eliminate the stereotypes and negative views that some individuals hold against others and the pandemics. Awareness campaigns and workshops can also assist to deal with the issue of misinformation and fake news during and after the pandemic.

Literature also shows that there is limited access to mental health services, which raises concerns for the well-being of individuals during and after the COVID-19 era. There is a need to invest in mental health care facilities and practitioners who are going to assist in offering services to individuals during and post the COVID-19 pandemic. There is a need for medical health services such as counselling during and after pandemics.

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Conflict of interest

The author has no conflict of interest to declare.

Author details

Dillo Justin Ramoshaba
University of Limpopo, Polokwane, South Africa

*Address all correspondence to: justinramoshaba17@gmail.com;
justin.ramoshaba@ul.ac.za

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Chapter 4

Post-COVID-19 Pandemic Shift toward Health-Conscious Eating

*Kandasamy Karthikeyan, Surajmani Shalini
and Singaram Sudha*

Abstract

The COVID-19 pandemic dramatically altered worldwide food consumption habits, resulting in a major shift toward health-conscious eating. Having an emphasis on the increased knowledge of health and well-being, which emerged as a major issue during and after the pandemic, this abstract examines the post-pandemic shift in eating practices. As the world faced massive health crises, people began prioritizing nutrition, immunity-boosting foods, and mindful eating habits to strengthen their resilience to the virus and other illnesses. This shift is examined *via* the prism of shifting consumer tastes, such as a rise in the desire for organic, plant-based, and minimally processed meals. The significance of digital platforms and food delivery services in encouraging health-conscious choices is also explored, as many customers have resorted to online resources to learn about and obtain better alternatives. The study also explores the sociocultural effects of the pandemic, focusing on how it affected ideals associated with food, such as sustainability, local sourcing, and the rejection of processed, unhealthy foods. Finally, the shift toward health-conscious eating after COVID-19 represents a long-term change in consumer behavior, with significant implications for the global food industry and future public health initiatives. This change is examined in light of wider health trends, food innovation technology breakthroughs, and the continuous pursuit of individual well-being in the wake of the epidemic.

Keywords: immune-boosting foods, holistic nutrition, functional foods, plant-based diet, sustainable eating

1. Introduction

Global food consumption patterns have been significantly impacted by the COVID-19 pandemic, hastening the trend toward healthier eating. The demand for wholesome, immune-boosting foods, organic products, and plant-based substitutes increased noticeably as people were more conscious of the connection between nutrition and general health [1]. The shift toward better eating habits was further supported by lockdowns and restrictions, which also promoted home

cooking and gave people more control over the ingredients and meal preparation. It is anticipated that this trend would continue after the epidemic as people give sustainability and long-term health advantages top priority when making food choices [2].

Many people reevaluated their dietary habits in quest of foods that promote better health outcomes, since the virus highlighted the importance of strong immunity and overall well-being. According to research, the consumption of whole grains, fresh fruits and vegetables, and functional meals rich in vitamins and antioxidants has increased dramatically [3]. Concerns about underlying medical conditions, such as obesity and metabolic disorders, which have been linked to severe COVID-19 cases, influenced this change [4].

Additionally, the post-pandemic era has seen a continuous focus on food safety, nutrition education, and mindful eating. As governments and health organizations continue to promote healthy living, food firms have responded by introducing more health-conscious products and offering clear labeling [5]. This shift in food preferences suggests that the move toward healthier eating is not merely a temporary response to the epidemic, but rather a long-term change in consumer behavior brought on by heightened health knowledge and a preventive attitude to wellness.

1.1 Literature review

Numerous studies have found that since the COVID-19 outbreak, people's awareness of health issues has grown. According to Bhutani and Cooper's [6] research, consumers have become increasingly concerned about immune-boosting foods such as probiotics, zinc, and vitamins C and D [6]. Furthermore, the pandemic highlighted the need for a well-balanced diet in preventing chronic diseases and improving overall health [7]. Several populations have been observed to eat more fruits, vegetables, and whole grains [7].

Siegrist et al. [8] state that because of worries about zoonotic illnesses and food sustainability, the pandemic hastened the adoption of plant-based diets [8]. Galanakis [5] examines how organic, locally sourced, and minimally processed foods are becoming more and more popular among consumers [5]. According to a study by Van der Weele et al. [9], people looked for plant-based proteins as substitutes for conventional meat products because they were concerned about their health and the environment [9].

Prowse and Carsley [10] states that technology had a significant role in promoting healthy eating during and after the pandemic. The advent of digital health technology, such as nutrition applications and virtual nutritional consultations, facilitated access to personalized meal planning [10], Patwardhan et al. [11]. Additionally, social media platforms affected consumer choices by disseminating information on dietary trends, immune-boosting foods, and healthy recipes [11].

Di Renzo [12] Dietary decisions were impacted by the pandemic's psychological effects, with both good and negative patterns noted. As a result of stress and worry, some people developed improved eating habits, but others suffered emotional eating and increased consumption of ultra-processed foods [12]. Scarmozzino and Visioli [13] explore interventions like mindfulness-based techniques and nutrition education, however, have lessened the adverse impacts and promoted long-term, healthful eating patterns [13].

2. Increased demand for nutrient-dense foods

Since the COVID-19 pandemic, there has been a greater demand for foods high in nutrients due to better knowledge of the role that nutrition plays in immunity, disease prevention, and general health. Foods high in vital vitamins, minerals, and antioxidants are becoming more and more popular among consumers as a way to improve their health [13]. The following are some salient features of this shift.

2.1 Focus on immune-boosting foods

To lower the risk of the spread of infection, many people have turned to immune-boosting foods. According to an International Food Information Council (IFIC) poll conducted in 2022, more than 60% of consumers reported searching out foods with immune-boosting characteristics. Citrus fruits (high in vitamin C), turmeric (high in curcumin), and ginger (anti-inflammatory) are also popular alternatives [14].

Appropriate nutrients are constantly needed for immune cells to function healthily and correctly. Certain dietary guidelines are necessary to strengthen the body's defenses against inflammation and microbial diseases. The human body needs a variety of micronutrients at every stage of immunity. Certain nutrients, including vitamin C, vitamin D, zinc, selenium, iron, and protein, have been identified as necessary for the development and operation of immune cells. These ingredients are found in many plant and animal diets. The health of an immune system can be harmed by diets that are low in nutrients and variety, as well as by processed and minimally processed foods [15].

Western-style eating habits are characterized by a high intake of red, tender meat, refined white sugar, and a low intake of fruits and vegetables. These factors affect the gut's beneficial microbes, cause inflammation, and weaken the immune system. **Figure 1** shows a picture of the suggested diet to increase immunity during the COVID-19 infection [15].

2.1.1 The growing adoption of superfoods

Superfoods with high nutrient density became popular as a result of the pandemic. The most popular superfoods are:

- Blueberries and acai berries—rich in antioxidants.

- Chia seeds and flaxseeds—high in fiber and Omega-3 fatty acids.

- Quinoa and amaranth—protein-rich ancient grains.

- Moringa and spirulina—packed with vitamins and minerals.

The initial step was to use the keyword “superfoods” to search for the most well-known foods classed as “super” on Google, based on the superfood descriptor used in this work. To preserve the chapter's distinctiveness, only “exotic” superfoods those that are infrequently consumed or were first formed in far-flung regions, such as outside of Europe (using this region as a reference) were included. After scanning the top 11 websites, a list of superfoods was created. Because of the restrictions (only “exotic” superfoods), some items from the first list, such as salmon, olive oil, and chickpeas, were removed from the study [17].

Each product was studied separately to obtain information on its nutritional composition and characteristics (health benefits). Protein, fiber, total lipids or fats (categorized as saturated fatty acids or SFA, monounsaturated fatty acids or MUFA,



Figure 1.
Diet followed to increase immunity during COVID-19 infection [16]. Source: [generative AI, Adobe Express].

and polyunsaturated fatty acids of PUFA), total carbohydrates, sugars, and complex carbohydrates (starch), as well as cholesterol and ethanol content, were calculated for each product, along with energy (kcal and kJ) and water content. The minerals P, Na,

K, Ca, Mg, Fe, and Zn, as well as the vitamins A, thiamine (or vitamin B1), riboflavin (B2), niacin (B3), pyridoxin (B6), folate (B9), cobalamin (B12), C, D, and E, were all well studied [17].

Some phytochemicals were tested because some superfoods are known to be particularly bioactive in the body. Phytochemicals, or bioactive non-nutrient plant compounds, have been found to reduce the prevalence of significant chronic disorders. Because they are two of the most important classifications, the total phenolic content (TPC) and total carotenoid content (TCC) of each superfood were investigated. This job required the use of international and national datasets from the International Network of Food Data Systems (FAO/INFOODS). Because these databases often do not contain bioactive compounds, a literature search was performed to estimate the TPC and TCC [17].

Finally, these nutritional profiles were used to pick the best superfoods. Since no extraordinary amounts of any specific nutrient were discovered, numerous foods, including honey, were removed from the study. Following this review, 40 superfoods were considered eligible for inclusion (see **Figure 2**). They were added to a list that was arranged according to the Food Ex classification scheme proposed by

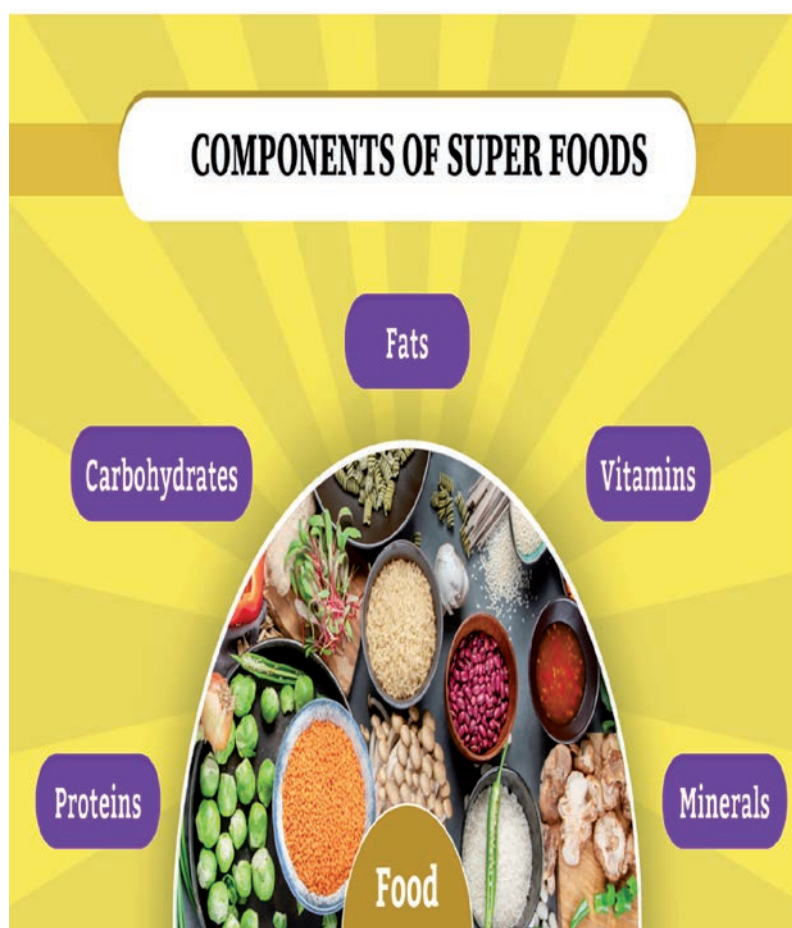


Figure 2.
Superfoods with high nutrient density [18]. Source: [generative AI, Adobe Express].

the European Food Safety Authority (EFSA-2011). Food Ex is a hierarchical system that includes both natural and processed foods and beverages. It is organized into 20 primary food categories that are further separated into smaller groups [17].

However, only six of the twenty specified categories could be applied to the selected items: The first five groups include fruits and their derivatives, vegetables and their derivatives (including those from the fungus family), grains and grain-based products, starchy roots and tubers, legumes, nuts, and seeds, and herbs, spices, and condiments. Furthermore, a new category named “others” was established to group food items such as bee or algae products that are not covered by this classification scheme. **Figure 2** represents superfoods with high nutrient density proposed by EFSA.

2.1.2 Probiotics and gut health

The importance of the gut microbiota for mental and immunological health is becoming increasingly apparent. This has increased demand for foods high in probiotics, including fermented vegetables like sauerkraut and kimchi, as well as foods like yogurt, kefir, and kombucha [7]. According to research published in *Nutrients* (2023), probiotic use may lower the severity of respiratory infections, which adds to their appeal in post-pandemic diets [19].

2.1.3 Growth of nootropics and adaptogens

Adaptogens, which assist the body in regulating stress, and nootropics, which improve cognitive performance, have become increasingly popular. Ashwagandha, ginseng, and reishi mushrooms are increasingly often used in dietary supplements, teas, and snack foods. The global adaptogen market is predicted to increase at an 8.5% CAGR from 2021 to 2028, indicating rising consumer demand [20].

2.1.4 Fortified and bioengineered foods

Food makers have implemented more fortified and bioengineered items to address dietary inadequacies, including plant-based meats with extra iron and B12, omega-3-fortified eggs, and dairy products enhanced with vitamin D. According to studies, these meals, especially for plant-based eaters, can address nutritional gaps in contemporary diets [21].

3. Global trends in health-conscious eating in the United Kingdom, the United States, and India

In the United Kingdom, snacking has decreased significantly, with at-home snacking reducing by 15% between 2020 and 2024. Economic factors and the return to office work are to blame for this decline. Traditional snacks such as biscuits and chocolates are losing popularity as customers opt for healthier alternatives such as fruits, nuts, protein bars, and yogurts. This trend has been driven by laws targeting high-fat and sugar-containing diets, as well as rising pricing for ingredients such as sugar and cocoa [22]. Protein-rich foods, such as cottage cheese and chicken breasts, are gaining popularity among Generation Z and health-conscious middle-class consumers. Over the last year, nearly half of the United Kingdom's individuals, particularly those aged 16–34, increased their protein intake. This shift is mostly

being driven by social media trends and increased awareness of the harmful health impacts of excessively processed meals. Natural protein sources such as Greek yogurt, egg whites, chicken, and tuna are gaining popularity as people prefer whole foods to manufactured ones [22]. **Figure 3** shows the United Kingdom’s snacking preferences during COVID-19 and after the pandemic.

In the face of constantly rising food prices, the US food industry has adapted to accommodate increasingly price-conscious consumers. Larger product sizes are becoming popular as a means of combating shrinkflation, and grocery stores and fast-food restaurants are offering packaged deals for added value. Trends in health and wellness have shifted toward “functional foods” that provide specific benefits such as improved gastrointestinal and mental health. Due to its low cost, chicken has become a popular meat choice as people seek a balanced diet and indulge guilt-free [23]. **Figure 4**, a pie chart, highlights constantly rising food prices in the US food industry after COVID-19.

3.1 Post-pandemic impact in India

Food options in India have changed significantly as a result of the outbreak. People are choosing grains, proteins, legumes, vegetables, and fruits as part of a diet that is more balanced and nutrient-dense. The goal of this change is to preserve general health and strengthen the immune system. In response to consumer desire for healthier options, the food sector has released creative recipes. Nowadays, consumers are increasingly aware of their eating patterns and look for foods that are both palatable and beneficial to their health [24].

3.1.1 Dietary shifts in post-pandemic

Globally, the epidemic has changed how people eat and drink. Home cooking saw a renaissance during lockdowns, and comfort foods like pasta bakes and casseroles became popular. But as things get back to normal, people are choosing

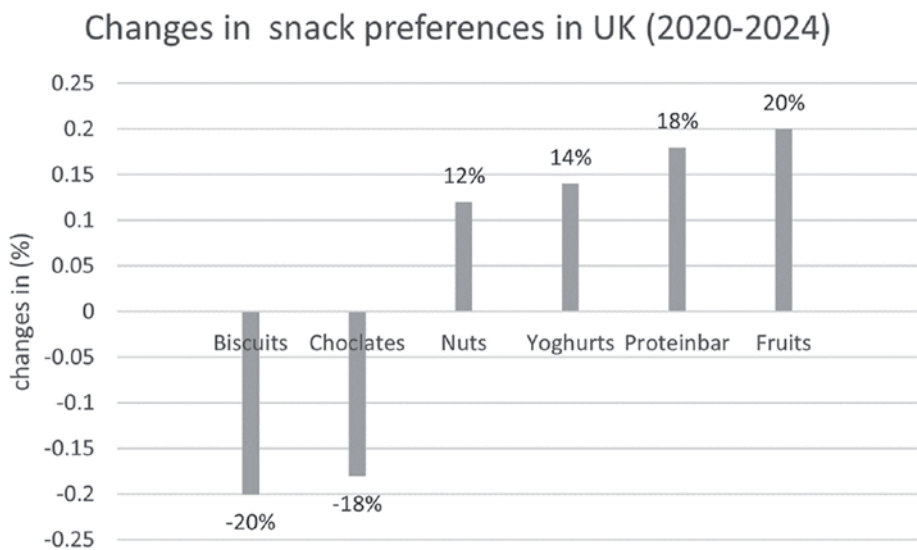


Figure 3.
The United Kingdom, snacking.

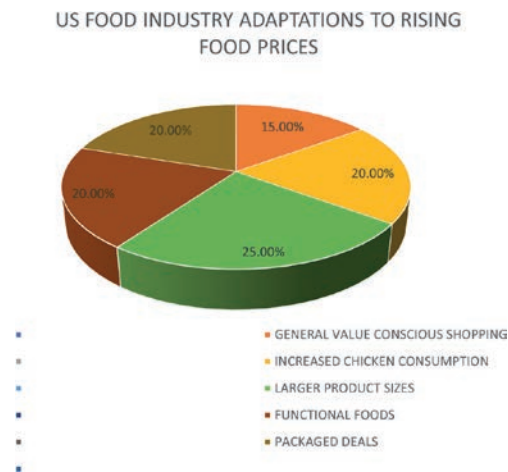


Figure 4.
Constantly rising food prices in the US food industry.

easier-to-prepare meals more and more, which is helping the convenience food industry. Additionally, customers are placing a greater focus on nutrition and health, looking for foods that promote physical, mental, and emotional well-being [25]. People are becoming more aware of what they eat, which has boosted the appeal of mindful eating. This includes reducing unwanted impulses, encouraging portion control, and paying attention to what and how you consume. Organic food and healthier meal options are more popular as a result of the pandemic's heightened awareness of the importance of a well-balanced, nutrient-dense diet [25].

3.1.2 Increased consumption of whole foods

During the pandemic, many Indian households reported a significant uptick in the intake of fresh fruits, vegetables, whole grains, and legumes. A cross-sectional study involving 450 participants revealed that 50% increased their consumption of green leafy vegetables, and 61.3% consumed more fruits. Additionally, 44.9% of respondents reported higher milk consumption, indicating a move toward nutrient-rich, unprocessed foods [26]. **Figure 5** represents an increase in consumption of nutrient-rich foods during COVID-19.

3.1.3 Emphasis on home-cooked meals

The necessity of home confinement led to a surge in home cooking, allowing individuals greater control over their dietary choices. An online survey of 1000 Indian adults found that 89% of participants consumed more home-cooked meals during the pandemic. This trend facilitated a reduction in the intake of processed and ready-to-eat foods, which are often high in unhealthy additives [27].

3.1.4 Adoption of traditional and functional foods

There was a renewed interest in traditional Indian foods known for their health benefits. Ingredients like turmeric, ginger, garlic, and various herbal teas gained popularity for their perceived immune-boosting properties. Ayurvedic practices

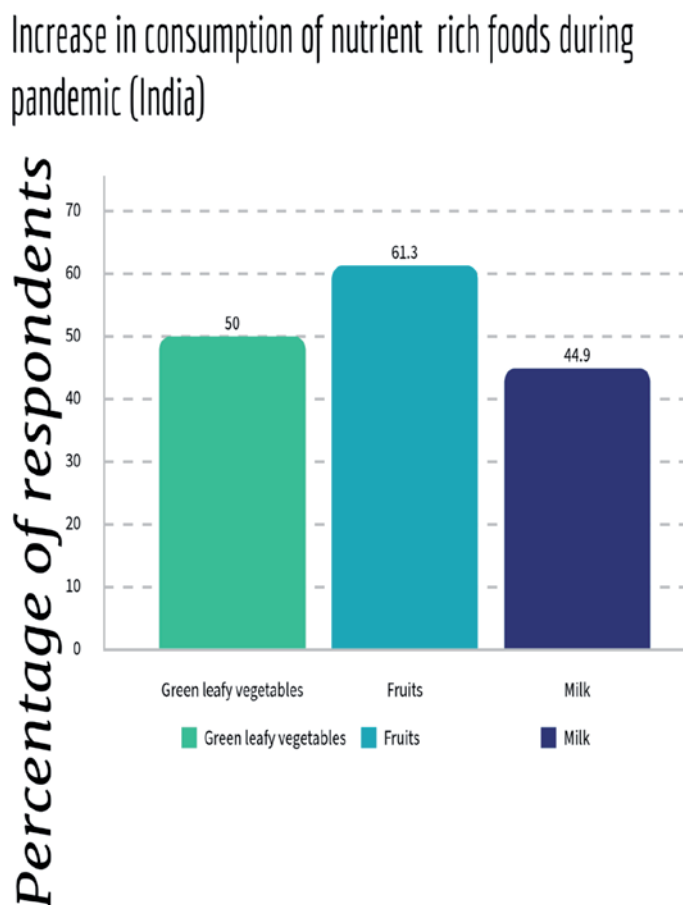


Figure 5.
Consumption of nutrient-rich food.

recommended the inclusion of these items to enhance overall well-being during and after COVID-19 recovery [28].

3.1.5 Regional variations and challenges

However, the shift toward whole foods was not uniform across all regions. A longitudinal survey in rural Bihar indicated a decline in diet diversity during lockdowns, with reduced consumption of nutrient-rich foods such as fruits, pulses, and animal products. This suggests that while urban areas may have experienced a positive shift, rural regions faced challenges in accessing a variety of unprocessed foods [29].

3.1.6 Market response and consumer behavior

The increased demand for healthier food options prompted packaged food companies to expand their portfolios to include more natural and organic products. Analysts observed that consumers became more vigilant about product labels, seeking items with health benefits and minimal processing. This behavioral shift is anticipated to have long-term implications for the food industry [30].

The pandemic has acted as a catalyst for a significant shift toward whole, unprocessed foods in India, driven by heightened health awareness and the necessity for home-cooked meals. While this trend is evident in urban centers, disparities in rural areas highlight the need for targeted interventions to ensure equitable access to nutritious foods across the country.

4. The surge in demand for health supplements and in-home food consumption in China post-pandemic

China has seen a significant increase in the demand for health supplements and in-home food consumption in the wake of the COVID-19 outbreak. Customers' increased health consciousness and Chinese people's increasing focus on preventive healthcare are the main causes of this change.

4.1 Rise in health supplement consumption

According to a June 2020 study, roughly 27% of Chinese participants said they had increased their purchases of food items with health claims after the epidemic. Notably, almost 30% more health and functional foods were consumed by those with digestive problems [31].

China's market for health supplements has expanded tremendously. Mineral supplements, particularly calcium supplements, accounted for more than 40% of all online sales in the maternal and baby health food category from 2020 to 2022 [32].

4.1.1 Surge in light meal consumption

According to data from Meituan Waimai, a significant Chinese food delivery service, orders for light food rose 50% year over year in the second half of 2020, while the number of establishments serving these meals increased by 27%. This increase is indicative of a larger trend among young consumers who are looking for meals that are higher in fiber and lower in calories, fat, and sugar [33].

4.1.2 Emergence of health-focused brands

Brands like Sharkfit, which specializes in foods like quick chicken breast that are geared toward fitness, have grown in popularity as a result of consumer demand for better food options. Sharkfit, which was founded in 2017, recorded sales of 210 million yuan (about \$32.5 million) in 2020 and is predicted to surpass 700 million yuan in the years that follow [33, 34].

4.1.3 Expansion of the light food market

Despite a size of more than 100 billion yuan (approximately \$14 billion) in 2022, China's light food industry has risen rapidly and now accounts for roughly 10% of total catering income during a five-year period. More than 2370 new light food-related firms were registered in the first half of 2023 alone, up 8.8% from the same time the previous year [33, 34].

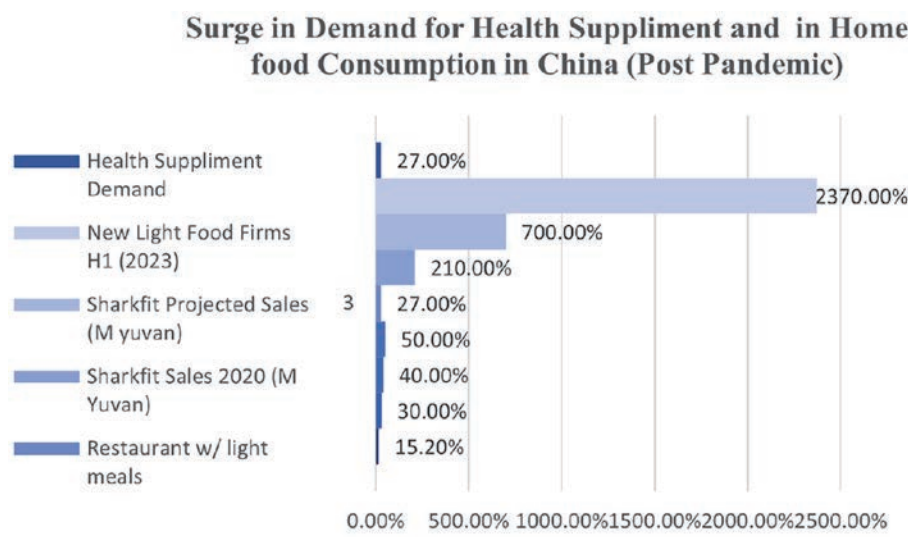


Figure 6.
 Surge in demand for health supplements from (2020 to 2023).

4.1.4 Cultural shift toward healthier eating

A significant cultural shift in China, where traditional diets often emphasized high-calorie and high-fat foods. The increasing popularity of light meals and low-calorie diets among young Chinese consumers underscores a growing awareness of health and wellness, influencing both individual choices and the broader food industry [35].

4.1.5 Surge in healthcare spending

China's public health fiscal expenditure increased in 2020. Despite a decline in total fiscal revenue, public health spending increased by 15.2% over the previous year, reaching 1.9 trillion yuan (approx. \$293 billion). This increase demonstrates the government's determination to improve healthcare infrastructure and services in response to the pandemic [36]. **Figure 6** exposes the surge in demand for health supplements from 2020 to 2023. Dietary habits in India experienced a significant shift toward nutrient-dense foods.

5. Conclusion

The COVID-19 pandemic has triggered a profound and enduring transformation in global food consumption patterns, catalyzing a shift toward health-conscious, sustainable, and preventive dietary behaviors. The crisis underscored the vital role of nutrition in immunity and overall well-being, compelling consumers to prioritize nutrient-dense foods, immune-boosting ingredients, and functional products such as superfoods, probiotics, and adaptogens. This newfound awareness was further reinforced by the rise of home cooking, technology-driven personalized nutrition, and a significant cultural revaluation of food choices.

Evidence from the literature reveals that these changes were not merely reactive but indicative of a larger movement toward long-term lifestyle modifications. The increasing popularity of plant-based diets, organic and locally sourced foods, and digital health tools signifies a shift in consumer values favoring sustainability, transparency, and personal health. However, the transition has not been uniformed. While urban populations across countries like India, the United Kingdom, and China experienced increased access to whole foods and health supplements, rural and economically disadvantaged groups faced constraints, highlighting persistent inequities in nutrition access.

Globally, the food industry has responded by innovating product offerings, expanding fortified and clean-label products, and adjusting marketing to align with health-driven consumer demands. Regional trends such as the decline of traditional snacks in the United Kingdom, increased consumption of light meals in China, and the resurgence of traditional foods in India demonstrate how cultural context shapes dietary adaptation.

Thus, the pandemic has not only redefined food consumption but has also embedded health-conscious eating into mainstream consumer behavior. While this shift offers significant public health benefits, it also necessitates continued efforts to ensure equitable access, nutritional education, and food security across diverse populations. Policymakers, health advocates, and food industries must collaborate to sustain and scale these positive dietary trends, making healthful eating both accessible and inclusive in the post-pandemic world.

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Conflict of interest

The authors declare no conflict of interest.

Notes/thanks/other declarations

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Acronyms and abbreviations

IFIC	international food information council
FAO/INFOODS	international network of food data systems
EFSA	the European food safety authority
SFA	saturated fatty acids
MUFA	monounsaturated fatty acids
TPC	total phenolic content
TCC	total carotenoid content

Author details

Kandasamy Karthikeyan^{1*}, Surajmani Shalini² and Singaram Sudha³

1 Periyar University, Salem, Tamil Nadu, India

2 Morappur Kongu Arts and Science, Periyar University, Dharmapuri, Tamil Nadu, India

3 Rajalakshmi Engineering College, Anna University, Chennai, India

*Address all correspondence to: profkarthi@periyaruniversity.ac.in

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Regional Responses to COVID-19 in Italy: A Comparative Analysis of Public Health Interventions and Their Impact

Bilal Kargi, Bekir Cihan Uçkaç and Mario Coccia

Abstract

The ongoing COVID-19 pandemic, with its rapidly evolving variants, poses a significant threat to global health and economies. In the absence of universally effective vaccines and treatments, public policy responses become crucial in mitigating the pandemic's impact. This study explores the diverse strategies adopted by Italian regions during the initial outbreak (January–July 2020). These regions, the first in Italy to experience a surge in COVID-19 cases and fatalities, provide valuable insights into effective public health interventions. Notably, Veneto, a region in northeastern Italy, implemented a successful strategy focused on widespread testing and robust contact tracing (epidemiological investigation units). This approach demonstrably reduced overall deaths and the overall burden of the pandemic on the healthcare system. Conversely, regions lacking a clear and targeted policy framework faced a more significant negative impact on public health. These contrasting experiences offer valuable lessons for designing effective, generalizable public policies that can prepare regional and national healthcare systems for future outbreaks and pandemics.

Keywords: COVID-19, crisis management, health policy, regional systems, policy responses, pandemic crisis, contact tracing system

1. Introduction

The global health crisis sparked by the emergence of SARS-CoV-2 in late 2019 has resulted in a widespread pandemic, COVID-19, characterized by significant morbidity and mortality worldwide [1]. While most individuals experience mild symptoms, a substantial portion of the global population has suffered severe respiratory illness and death due to COVID-19 [2].

The complex dynamics of COVID-19 transmission are influenced by a multitude of factors, including population density, air quality, commercial activity, environmental sustainability, socioeconomic determinants, climatic conditions, the

emergence of novel SARS-CoV-2 variants, healthcare expenditures, and the implementation of non-pharmaceutical interventions (NPIs) [3–10]. Beyond the public health challenge, the COVID-19 pandemic has triggered a cascading socioeconomic crisis with bleak global economic forecasts [11].

In the absence of effective pharmaceutical interventions and treatments, robust national and regional public policies play a crucial role in mitigating the impact of the COVID-19 pandemic. As outlined by Nicoll and Coulombier [12], strategies for managing pandemics can be broadly classified into containment and mitigation measures. Containment strategies aim to halt transmission by identifying imported cases and first-generation transmissions, followed by swift action to prevent sustained transmission chains. This necessitates vigorous contact tracing, treatment protocols, quarantine measures, and, in extreme cases, population lockdowns [13, 14]. Mitigation strategies, on the other hand, focus on reducing the overall impact of a pandemic by lessening the number of infected individuals, diminishing transmission rates, ensuring healthcare access, maximizing care for infected persons, and protecting vulnerable populations. Examples of mitigation measures include social distancing protocols, school closures, workplace distancing practices, and avoiding crowded spaces (World Health Organization [WHO]). The WHO strongly advocates for mitigation policies when containment becomes untenable due to widespread transmission. In response to the COVID-19 crisis, many countries initially adopted containment measures (quarantine and lockdowns) followed by the implementation of mitigation strategies such as social distancing, reduced isolation periods, disinfection protocols, mask mandates, and travel restrictions [15–17].

This study seeks to achieve two objectives. First, it aims to analyze the disparities in the strategies employed by Italian regions to control the COVID-19 pandemic. Second, it aims to identify the most effective regional strategies for managing the spread of COVID-19 in the absence of readily available pharmaceutical interventions and treatments. By examining the strengths and weaknesses of the various regional responses, this study can provide valuable insights to guide policymakers in formulating more effective regional and/or national public health policies to combat future epidemics akin to COVID-19.

2. Methodology

This research focuses on a comparative case study of Italian public policy responses to the COVID-19 pandemic in two northern Italian regions: Veneto and Piedmont. Employing a combination of qualitative and quantitative methods, the study analyzes national and regional public policies enacted during the crisis, drawing information from official decrees and orders. A narrative approach informed by Sebeok's [18] work is utilized to examine these policies, incorporating temporal and opportunity perspectives.

The temporal perspective (Chronos) focuses on the chronological evolution of anti-pandemic strategies, providing a granular understanding of how policy responses shifted and adapted over time. The opportunity perspective (Kairos) delves into the specific contextual factors that influenced the emergence and implementation of particular policies, examining the unique circumstances that created the "opportune moment" for specific policy interventions. By employing both perspectives within the narrative framework, the study aims to provide a comprehensive and critical explanation of the relationships underlying the public policies adopted by the

Italian government and the Veneto and Piedmont regional authorities in their efforts to combat the COVID-19 pandemic.

Furthermore, the study specifically focuses on a comparative analysis of the anti-COVID-19 public policies implemented in the Veneto and Piedmont regions. This selection is particularly apt as these regions share comparable demographic and socio-economic characteristics (as detailed in **Table 1**). This comparative approach allows for a more nuanced understanding of how regional variations in policy responses can potentially influence the effectiveness of pandemic control measures.

The study additionally incorporates quantitative techniques to assess the impact of public policy responses on the COVID-19 pandemic in Veneto and Piedmont. This analysis focuses on the dynamics of confirmed cases and deaths related to COVID-19 within these two regions, aiming to determine the ultimate societal impact of the implemented public policies [22–25].

Data on confirmed cases and fatalities associated with COVID-19 in Veneto and Piedmont are obtained from the Italian Ministry of Health [26] for the period of February–July 2020. This timeframe encompasses the initial outbreak and subsequent phases of the pandemic in Italy. The data will be presented in two ways:

- **Total and per capita figures:** The total number of confirmed cases and deaths will be reported for both regions, along with figures normalized per million people as of June 2020, which represents the tail end of the major outbreak period in Italy.
- **Daily trends and peak analysis:** The daily variations in confirmed cases and deaths for Veneto and Piedmont will be calculated using a difference equation (deaths/confirmed cases at time t – deaths/confirmed cases at time $t-1$). These trends will then be visualized as a function of time. Additionally, an ordinary least squares (OLS) regression with a quadratic model will be employed to estimate the underlying relationships between these variables in each region.

Furthermore, an optimization approach will be used to analyze the estimated relationships for Veneto and Piedmont. This will enable the calculation of the maximum number of deaths per million people during the peak of the COVID-19 pandemic crisis in both regions. This comprehensive quantitative analysis will shed light on the

Region	Italy	Population, 2019 ^a	Population density, inhabitants/km ² 2019 ^a	Gross domestic product per capita (Euro), 2017 ^a	Human Development Index, 2017 ^b	Regional health expenditure, 2018 (millions of Euro) ^c
Veneto	Northeast	4,909,013	~268	€33,100	0.890	8441,7
Piedmont	Northwest	4,356,406	~172	€30,300	0.887	9400,3

^aRef. [19].
^bRef. [20].
^cRef. [21].

Table 1.
Socioeconomic characteristics and demographic of Veneto and Piedmont in Italy.

ultimate public health impact of the COVID-19 pandemic in Veneto and Piedmont. By comparatively evaluating the regional public policy responses through the lens of these metrics, the study seeks to identify effective public interventions that can be adopted to manage future outbreaks of COVID-19 or similar viral agents.

3. Empirical results

The World Health Organization (WHO) declared COVID-19 a pandemic on January 30, 2020. Italy responded swiftly with restrictive health measures for air and ship traffic on February 1. The first confirmed case in Italy was identified on February 20, 2020, in Lodi, Lombardy. The number of confirmed cases escalated rapidly, with 36 infections reported the following day, and the spread of COVID-19 accelerated in specific cities across northern Italy.

Italy initially adopted a localized containment strategy targeting specific cities within the country. On February 23, 2020, the Italian government established “Red Zones” in areas experiencing coronavirus outbreaks. These zones encompassed lockdown measures for all commercial activities, restrictions on movement and personal freedoms, mandatory quarantine for confirmed cases, and appropriate home isolation for close contacts [27]. Initially, these containment measures were applied solely in two municipalities: Vò Euganeo in Veneto and Codogno in Lombardy. The Italian government subsequently expanded these measures to 11 municipalities and implemented broader mitigation measures across six regions in northern Italy: Emilia-Romagna, Friuli-Venezia Giulia, Lombardy, Veneto, Piedmont, and Liguria. On March 10, 2020, the Prime Minister issued a decree extending containment measures nationwide, including a nationwide quarantine and a lockdown of all nonessential activities. This period, designated as Phase 1 of containment, aimed to mitigate the peak of the COVID-19 pandemic in Italy [28].

The primary objective of the Italian government was to flatten the epidemic curve, thereby allowing healthcare systems more time to scale up and manage the crisis effectively. This approach ultimately aimed to reduce the overall burden of the COVID-19 epidemic [29–31].

Similar to measures implemented during the COVID-19 outbreak in Wuhan, China, Italy’s containment strategy included non-pharmaceutical interventions such as physical distancing, school closures, cancellations of sporting and cultural events, workplace distancing, and mask-wearing [31]. Containment and mitigation actions often overlap and are frequently implemented concurrently, as observed in Hubei (China) and more recently in European countries like France, Italy, and Spain [32]. While the national containment strategy was adopted by all 20 Italian regions, the implementation varied across regional health systems, leading to heterogeneous impacts on public health and society. Notably, Veneto implemented a unique containment strategy alongside national measures, characterized by proactive testing and extensive contact tracing of infected individuals. Investigating the Veneto strategy and its effectiveness in controlling and reducing SARS-CoV-2 infections could offer valuable insights into identifying the most effective public policies for managing the COVID-19 pandemic in the short and long term.

This section delves into a comparative analysis of regional policy responses implemented to constrain the COVID-19 pandemic crisis in Veneto and Piedmont, two northern Italian regions with comparable socioeconomic characteristics.

The Italian government designed national public health policies aimed at curtailing the spread of COVID-19 by delaying and flattening the epidemic curve. However, the implementation of these national guidelines varied across Italian regions. While many regions strictly adhered to the national containment measures, others leveraged their administrative autonomy to implement additional, potentially more robust interventions.

The case of Veneto exemplifies a proactive regional approach. On February 21, 2020, following a localized COVID-19 outbreak in the town of Vò Euganeo, the region implemented stringent containment measures, including a 14-day lockdown, quarantine protocols, and restrictions on population movement [33]. Notably, Veneto went beyond national guidelines by implementing widespread testing of the town's entire population using nasopharyngeal swabs. This initiative, spearheaded by the University of Padova, yielded crucial insights into the transmission dynamics of SARS-CoV-2, particularly the role of asymptomatic carriers in spreading the virus. This "learning process" informed the development of a more comprehensive containment strategy for Veneto. Notably, on February 29, 2020, testing revealed a 3% positivity rate within the Vò Euganeo population, with a significant number of asymptomatic individuals. These positive cases were subsequently placed in home isolation. By March 23, 2020, the proactive testing and isolation measures successfully halted the spread of COVID-19 in Vò Euganeo, with no new cases identified. This initial "medical trial" provided compelling evidence for the effectiveness of widespread testing, coupled with isolation, as a critical strategy for controlling the COVID-19 pandemic. Based on this success, the University of Padova advocated for the region-wide adoption of this proactive testing strategy, which was subsequently formalized through Regional Decree No.344 on February 17, 2020—predating the implementation of national containment measures on March 10, 2020 [34].

In contrast, Piedmont's initial response appeared more reactive. While the region's first confirmed case was identified on February 22, 2020, the initial response focused on adhering to national guidelines issued by the Italian Ministry of Health. These guidelines mandated the suspension of public and private gatherings, closure of educational institutions and cultural venues, and mandatory self-isolation with surveillance for individuals from high-risk areas bordering Lombardy (the region with the most severe outbreak in Italy) [35]. Notably, unlike Veneto, Piedmont did not implement widespread testing in the early stages. As the number of confirmed cases grew, five out of eight provinces in Piedmont were eventually declared red zones with full lockdowns on March 8, 2020.

This comparative analysis highlights the potential benefits of proactive regional policy responses in managing the COVID-19 pandemic. Veneto's early adoption of widespread testing, coupled with targeted isolation measures, stands in stark contrast to Piedmont's initial reactive approach. While both regions ultimately implemented lockdown measures, Veneto's proactive strategy appears to have yielded a more successful outcome in controlling the initial outbreak within Vò Euganeo. Further research is necessary to determine the long-term effectiveness of these contrasting regional approaches on the overall course of the pandemic in each region.

The Veneto region's strategy to combat COVID-19 possessed a distinct structure with a two-pronged approach: a general goal and specific sub-objectives [35]. The overarching objective was to effectively halt the transmission chain of the virus responsible for COVID-19 within the general population. This ambitious goal was to be achieved through the meticulous identification of both paucisymptomatic and asymptomatic individuals who harbored the virus. Additionally, the strategy

emphasized the importance of expanding home isolation measures surrounding confirmed cases to further limit viral spread.

The specific sub-objectives outlined a comprehensive plan of action. Firstly, it prioritized the identification of all potential cases, encompassing individuals with suspected, probable, and confirmed COVID-19 diagnoses. Secondly, it mandated quarantine and home isolation protocols for all individuals who had come into contact with infected persons. This decisive measure aimed to break the chain of transmission by isolating potential carriers before they could unknowingly infect others. Thirdly, the strategy advocated for the restructuring of the Regional Prevention Departments to bolster their capacity to effectively manage the COVID-19 crisis. Fourthly, it emphasized the crucial role of public health by mandating the screening of all employees within the Regional Health System and related entities. This proactive approach aimed to safeguard both healthcare workers and patients by minimizing the risk of nosocomial transmission (hospital-acquired infections). Finally, a critical sub-objective focused on identifying all positive COVID-19 cases among employees deemed essential service providers. This ensured the continued operation of vital services while mitigating the risk of viral spread within these crucial sectors.

The implementation of this multifaceted strategy, which distinguished itself from those employed by other Italian regions, relied on the collaborative efforts of several entities. The Veneto Prevention Departments spearheaded the initiative, working in close partnership with the esteemed University Hospital of Padova and the Italian Red Cross Committee. This collaboration ensured the efficient allocation of resources and expertise throughout the implementation process. Furthermore, the overall strategy was meticulously coordinated by the Prevention, Food Safety, and Veterinary Directorate of the Veneto region, guaranteeing a unified and effective approach across the entire region.

Here are the key elements that underpinned the successful execution of Veneto's anti-COVID-19 strategy:

Target population: The strategy adopted a two-tiered approach in defining the target population for testing. It encompassed the following:

Individuals potentially linked to a cluster or exposed to infected people. This category included family members, work colleagues, and those with social or occasional contacts (such as acquaintances or fellow attendees at gatherings) of confirmed or suspected cases. The investigative window focused on the critical 48-hour period preceding the initial symptoms of a confirmed case, extending up to their diagnosis and subsequent home isolation.

Healthcare workers and employees are deemed essential for maintaining societal functioning. This group included personnel working in shopping malls, fire departments, and law enforcement agencies.

Swab testing: the process for requesting swabs was streamlined and accessible. General physicians and pediatricians within Territorial Services played a pivotal role by initiating swab requests and transmitting relevant information to the Territorial Operational Unit (COT) of the local Health Unit. Additionally, other medical specialists were obligated to report potential cases to the Public Health Hygiene Service (SISP) or COT, depending on the established local protocols. Upon receiving requests, the COT and SISP would then communicate the list of individuals requiring testing to the designated laboratory.

Guidelines for subjects: The strategy established clear guidelines for individuals based on their symptoms. Symptomatic individuals were mandated to self-isolate at home until a swab test was conducted and the results were received. Home isolation

was also compulsory for people who had verifiable links to confirmed or suspected COVID-19 cases. Notably, the strategy advocated for testing asymptomatic individuals in specialized healthcare facilities.

Epidemiological investigation: A cornerstone of the strategy was the implementation of an in-depth epidemiological investigation. This investigation employed a concentric circle approach, commencing with the infected individual and progressively expanding outwards. The initial circle focused on high-risk contacts within the household and workplace. Subsequent circles encompassed social and occasional contacts, categorized as low-risk. In the presence of a confirmed case, all identified contacts were subject to mandatory home isolation. Confirmed cases were further monitored through a system of “active surveillance” during their isolation period. This involved daily follow-up via telephone calls or telemedicine services. This emphasis on rapid contact tracing aligns with established public health best practices, as advocated by Wells et al. [27], who highlight its importance in limiting human-to-human transmission outside of outbreak epicenters, alongside appropriate isolation of confirmed cases.

Testing infrastructure: The Veneto region possessed a significant advantage in its testing capabilities. It established a robust network of 13 laboratories dedicated to processing SARS-CoV-2 tests. The medical technology employed by these laboratories boasted high performance in terms of both the volume and speed of testing. This efficiency was attributed to ample stock of reagents and equipment for laboratory analysis. Notably, the Veneto laboratories adopted an “open technology” approach, which allowed them to utilize reagents from various brands, thereby enhancing flexibility and mitigating potential supply chain disruptions [36]. This adaptability proved crucial in ensuring uninterrupted testing throughout the crisis. Swab tests were conveniently offered in multiple locations—hospitals, patients’ homes, and even drive-through facilities.

In essence, the Veneto region implemented a proactive and comprehensive strategy that prioritized widespread swab testing for both symptomatic and asymptomatic individuals. This approach was coupled with in-depth epidemiological investigations to identify all potential contacts. Confirmed cases and suspected individuals were subsequently subjected to mandatory home isolation protocols. This multifaceted approach stands in stark contrast to the strategy employed by the Piedmont region.

Piedmont opted for a more reactive approach, adhering strictly to the national guidelines set forth by the Italian government. Their strategy primarily focused on confirmatory swabs for individuals who exhibited symptoms or were already suspected of having COVID-19. Unlike Veneto, Piedmont did not prioritize testing asymptomatic individuals to identify hidden chains of transmission within the community. This approach aligns with the concerns raised by Kucharski et al. [37] regarding the limitations of solely isolating confirmed cases and tracing contacts. They argue that the infectious period for COVID-19 can begin before the onset of symptoms [30]. Similarly, Hellewell et al. [38] emphasize the detrimental impact of delays between symptom onset and isolation, highlighting how such delays can significantly increase transmission before symptoms even appear.

Furthermore, while Piedmont eventually expanded its testing capabilities by opening new laboratories, this initiative came at a significant lag compared to Veneto. At the outset of the pandemic, Piedmont only possessed two active testing laboratories with a limited capacity of approximately 400 swabs per day. In stark contrast, Veneto had a well-established network of 13 operational laboratories from as early as February 17, 2020. This disparity in testing infrastructure undoubtedly played a role in the differing outcomes between the two regions.

It is important to note that despite eventually increasing its testing capacity, Piedmont did not implement a proactive case-finding strategy through widespread swab testing. Additionally, they did not conduct the in-depth epidemiological inquiries employed by Veneto to identify both symptomatic and asymptomatic cases among individuals with social and occasional contact with infected persons. This lack of a comprehensive approach likely hindered Piedmont's ability to effectively control the spread of COVID-19 within its region.

In conclusion, the Veneto region's anti-COVID-19 strategy stands out as a noteworthy example due to its proactive approach, robust testing infrastructure, and meticulous contact tracing efforts. This multifaceted approach stands in contrast to the more reactive strategy adopted by Piedmont. The contrasting outcomes between the two regions highlight the potential benefits of implementing a proactive and comprehensive strategy in mitigating the spread of COVID-19.

Both Veneto and Piedmont undertook significant efforts to adapt their healthcare systems to handle the surge in COVID-19 cases. A crucial element of this adaptation involved the establishment of specialized hospitals dedicated solely to the treatment of patients infected with the virus. This strategic move aimed to isolate and concentrate expertise in managing this novel disease. Additionally, both regions recognized the critical need to expand their intensive care unit (ICU) capacity. Here, Veneto displayed a remarkable proactive approach, increasing its ICU bed capacity from 494 to 825 by April 29, 2020. This represents a surge of nearly 67%, showcasing the region's commitment to preparedness. While Piedmont also augmented its ICU bed capacity, reaching 827 beds by the same date, the initial starting point of 327 beds suggests a potentially reactive approach compared to Veneto.

The stark disparity in testing capabilities between the two regions further highlights the contrasting strategies employed. Throughout the pandemic, Veneto maintained a robust network of 13 operational laboratories dedicated to processing SARS-CoV-2 tests. This extensive infrastructure allowed for a high volume of testing and facilitated rapid turnaround times for results. In stark contrast, Piedmont's testing capacity was severely limited at the outset of the crisis, with only two functioning laboratories. While they eventually expanded their network to encompass a total of 20 laboratories, this growth occurred during the "maturity phase" of the COVID-19 lifecycle, potentially signifying a missed opportunity for earlier intervention. This delay in scaling up testing infrastructure could have hampered Piedmont's ability to identify and isolate cases effectively during the critical initial stages of the outbreak.

The contrasting approaches adopted by Veneto and Piedmont offer valuable policy insights, as summarized in **Table 2**. While both regions adhered to the core containment measures outlined in the national guidelines set forth by the Italian government, Veneto demonstrably went beyond these baseline measures. They implemented a proactive and multifaceted strategy that combined containment measures with a robust testing regime and in-depth epidemiological investigations. This synergistic approach aimed to disrupt transmission chains as effectively as possible and minimize the occurrence of localized COVID-19 outbreaks. In essence, Veneto leveraged the learnings gleaned from their successful management of the initial outbreak in the town of Vò Euganeo to implement a comprehensive strategy focused on proactive testing and meticulous contact tracing. This approach stands in clear contrast to the more reactive strategy seemingly employed by Piedmont.

The important impact of public policy on pandemic containment is highlighted by a comparative study of COVID-19 dynamics in Veneto and Piedmont. This investigation delves into the case counts, fatalities, and testing trends across these two Italian

Dimensions	Veneto	Piedmont
General strategy	Containment oriented-reinforced	Containment oriented
Goal	To stop the transmission chain Find asymptomatic individuals Confirm symptomatic individuals Certify healed individuals	To reduce the impact of pandemic Confirm symptomatic individuals Certify healed individuals
Implementation	Proactive testing of SARS-CoV-2	Confirmative testing of SARS-CoV-2
Starting point of pandemics	Initial localized outbreak in town	No initial localized outbreak, but isolated cases
Population target	Symptomatic and asymptomatic	symptomatic
Epidemiologic inquiry	Yes, in-depth investigation to track all relationships of people infected, family, colleagues, social, and occasional	Basic, concerning only family and colleagues
Type of testing	Nasopharyngeal and oropharyngeal swabs	Nasopharyngeal and Oropharyngeal swabs + tentative serology test for COVID-19
Location for testing	Hospital Home (from March 17) Car (from March 23)	Hospital Home (from April 8) Car (from April 2)
People who authorize testing	General physician and pediatricians (from March 17th) Hospital medical staff	General physician (from May 11th) Hospital medical staff
Structure for authorizing the test	Territorial operational unit	Public health hygiene service
Rules for people infected	Quarantine Home isolation also for suspected people Hospitalization with symptoms	Quarantine Home isolation Hospitalization with symptoms
Number of initial ICUs*	494 (March 14, 2020)	327 (March 14, 2020)
Number of final ICUs*	825 (April 29, 2020)	827 (April 29, 2020)
Number of initial labs for testing	13 (March 17, 2020)	2 (February 22nd, 2020)
Number of final labs for testing	13 (June 2020)	20 (June 2020)
Actors involved	Crisis unit - Public health hygiene service – Universities	Crisis unit – Hospitals

*ICU = intensive care unit.

Table 2.
Comparative reactions to policies in the Piedmont and Veneto regions.

regions, encompassing the initial containment phase (approximately February–May 2020) and the subsequent mitigation phase that commenced in June 2020. By dissecting these trends, we can glean valuable insights into the effectiveness of the contrasting policy approaches adopted by each region.

Building upon the initial observation, **Figure 1** reveals a fascinating trend. While Veneto initially experienced a higher number of daily confirmed cases compared to Piedmont, the implementation of their proactive testing and tracing strategy demonstrably yielded positive results. Following the initiation of this strategy, Veneto

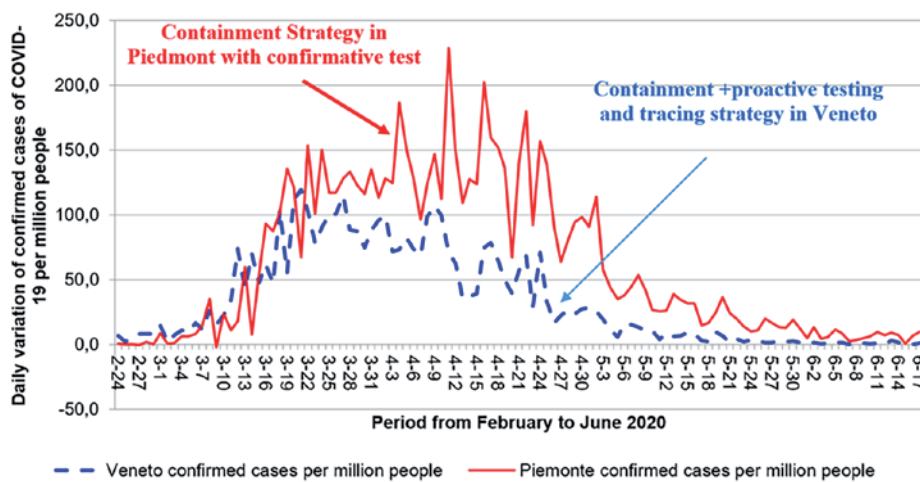


Figure 1.
Trends of daily confirmed cases of COVID-19 in Veneto e Piedmont.

consistently reported a lower number of daily confirmed cases than Piedmont. Furthermore, Veneto's case data exhibited reduced daily variations, suggesting a potentially greater degree of control over the spread of the virus. **Figure 2** further strengthens the argument for the effectiveness of Veneto's public health policies. This figure highlights a consistently higher number of swabs conducted in Veneto compared to Piedmont throughout the pandemic. This disparity underscores Veneto's commitment to widespread testing, a cornerstone of its proactive approach.

Perhaps the most compelling evidence lies in the realm of fatalities. Although both regions exhibited similar trends in deaths per million people at the outset of the outbreak (as depicted in **Figure 2**), a clear divergence emerges from mid-March onward. Veneto consistently recorded a lower number of total deaths compared to Piedmont. This suggests that Veneto's public policy interventions demonstrably mitigated the severity of the COVID-19 epidemic and ultimately resulted in a lower overall death toll. Taken together, the trends observed in confirmed cases, testing rates, and fatalities offer compelling evidence that the public policies implemented by Veneto were

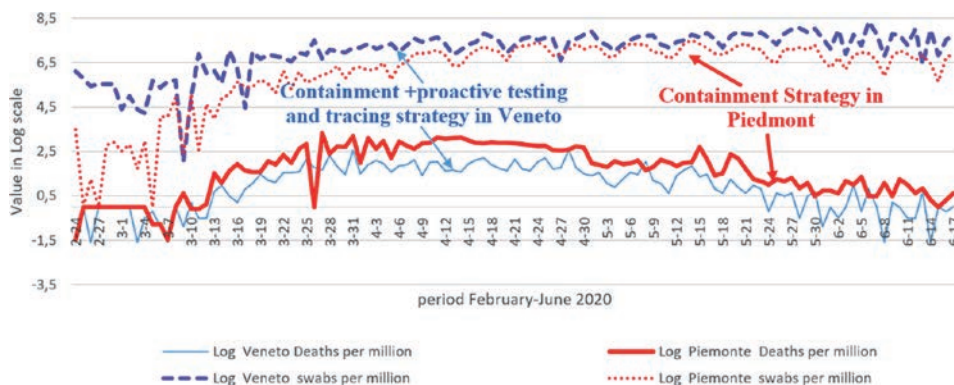


Figure 2.
Death and swab trends in Piedmont and Veneto.

demonstrably more effective in managing the COVID-19 pandemic. These policies, particularly the emphasis on proactive testing and tracing, appear to have successfully reduced the ultimate size of the COVID-19 epidemic on public health in the Veneto region (**Figure 3**).

To further substantiate these findings, the study employed quadratic models to estimate the temporal relationship between deaths per million people and time (as alluded to in **Table 3**). These models exhibited a high degree of goodness-of-fit, as evidenced by a strong coefficient of determination (R-squared). This implies that the independent variable of time can account for a considerable amount, almost 60% in this instance, of the variation in COVID-19 deaths that have been recorded. The researchers then applied optimization techniques to the derived equations. This analysis revealed a crucial finding: the peak number of deaths in both the Piedmont and Veneto regions occurred at approximately 56 days following February 24, 2020. This temporal coincidence, despite the contrasting policy approaches, warrants further investigation.

The most striking disparity between the two regions lies in the peak death tolls. The estimated relationships, as analyzed previously, reveal a critical difference. Veneto's peak deaths per million people were nearly halved compared to Piedmont. This translates to a remarkable reduction of approximately 50% in total deaths within Veneto. This divergence can likely be attributed to the implementation of their containment approach, which emphasized widespread testing for both symptomatic and asymptomatic individuals, coupled with in-depth epidemiological investigations. This multifaceted strategy employed by Veneto appears to have demonstrably mitigated the overall COVID-19 mortality rate within the region (**Table 4**).

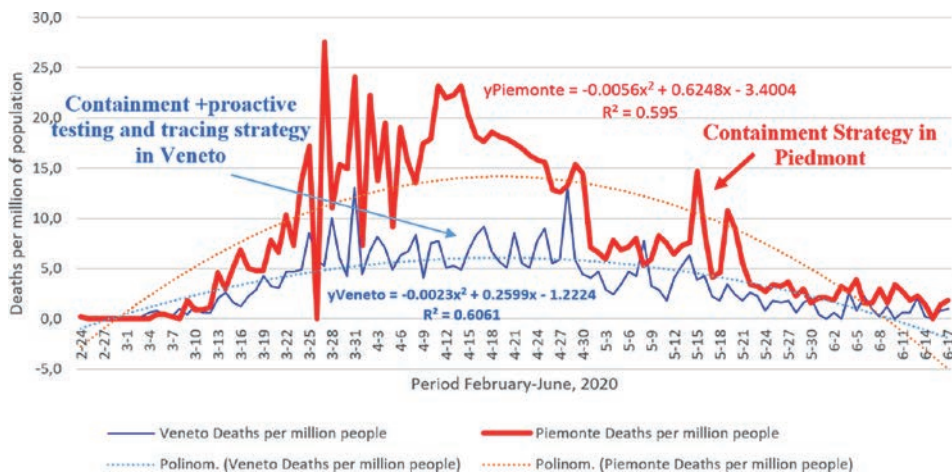


Figure 3.
Death patterns and their projected relationship over time in the areas of Veneto and Piedmont.

Estimated relationships (quadratic model)	R^2
Deaths per million people (Piedmont) = $-0.0056t^2 + 0.6248t - 3.4004$	0.5951
Deaths per million people (Veneto) = $-0.0023t^2 + 0.2599t - 1.2224$	0.6061

Note: The explanatory variable is time = t.

Table 3.
Piedmont and Vento's estimated overall death toll relationship (quadratic model).

	Veneto	Piedmont
Max number of total deaths per million people	6.12	14.02
$\Delta\%$ of Piedmont vs. Veneto	—	+129.09%

Table 4.
Maximum number of deaths overall per million population in the anticipated Veneto-Piedmont relationship.

Indicators of the pandemic	Veneto	Piedmont
Confirmed cases on July 7, 2020	19,327	31,429
Swabs on July 7, 2020, number	1,013,235	431,761
Total deaths on July 7, 2020	2014	4104
(Infected/swabs)% on July 7, 2020	1.91	7.28

Table 5.
Final size of COVID-19 pandemic crisis on public health in Veneto and Piedmont Region.

The efficacy of Veneto's regional policy solutions to the COVID-19 pandemic crisis is validated by **Table 5**. This public policy may offer a practical approach to managing COVID-19-like outbreaks in the future.

4. Discussions and conclusions

This study underscores the critical role of regional policy responses in effectively managing the multifaceted challenges posed by the COVID-19 pandemic. While national strategies provide a crucial foundation, the tailored actions implemented at the regional level significantly influence the course of the outbreak and its impact on public health and socioeconomic systems [1, 23–25]. Italy serves as a compelling case study in this regard. Despite adopting a national containment policy, individual regions within the country exhibited considerable variation in how they implemented and augmented these measures. This interplay between national guidelines and regional responses, coupled with the unique characteristics of each region's healthcare system, resulted in a diverse array of public interventions [39].

This study highlights a particularly significant distinction between the approaches adopted by Veneto and Piedmont, focusing specifically on testing strategies and epidemiological investigations (as illustrated in **Figure 4**). Veneto implemented a proactive testing strategy designed to identify not only confirmed cases but also individuals exhibiting suspicious or probable symptoms. Furthermore, the regional Public Health Hygiene Service played a pivotal role by employing specialized units within the Department of Prevention to conduct in-depth epidemiological investigations. This proactive approach ensured that even paucisymptomatic or temporarily asymptomatic individuals who could potentially be linked to a cluster were offered swab tests. This comprehensive strategy demonstrably reduced the time between symptom onset and isolation, thereby minimizing pre-symptomatic transmission and ultimately mitigating the negative impact on public health, as evidenced by a lower number of deaths [37, 38].

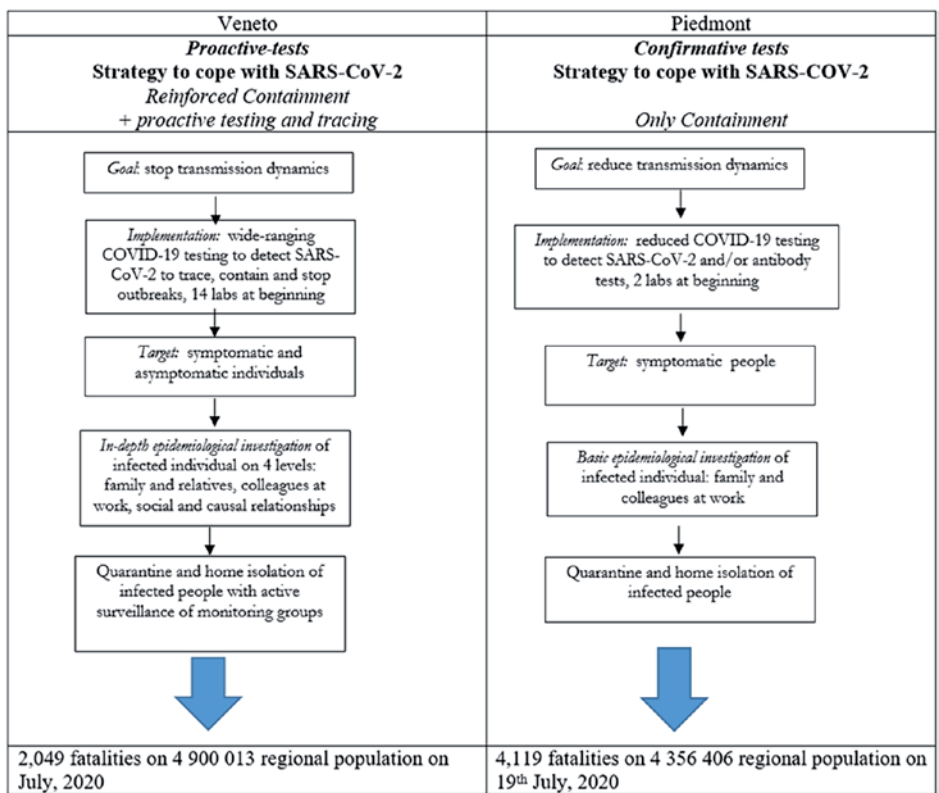


Figure 4.
Different approaches to the COVID-19 pandemic issue in terms of policy.

Piedmont, by contrast, did not, as Veneto did, adopted a supplemental approach based on extensive proactive testing and methodical epidemiological inquiries of all contacts of confirmed cases. Rather, they mostly followed the broad directives that came from the federal government. Notably, Piedmont limited their epidemiological investigations to identifying potential links within the family and workplace of confirmed cases. This more reactive approach resulted in a longer delay between symptom onset and isolation, consequently amplifying the transmission of COVID-19 and ultimately leading to a higher death toll [38].

The unprecedented complexity of the COVID-19 pandemic underscores the need for multifaceted policy responses tailored to address the specific challenges faced by cities, regions, and nations [40]. According to this study, containment measures should be the primary emphasis of effective public policy responses; however, these measures should be supplemented by a proactive, all-encompassing testing plan that covers a sizable population. Moreover, comprehensive epidemiological studies of every contact of verified cases are necessary to successfully manage the virus's transmission. Making decisions quickly is also essential to reducing the pandemic's short-, medium-, and long-term socioeconomic impacts [41–44].

Essentially, a comprehensive strategy that goes beyond simple lockdown, quarantine, and social distancing measures (containment and mitigation measures) is needed for a strong public policy response to COVID-19. It needs to be supplemented

with a proactive testing plan for a substantial percentage of the population, as well as thorough and exhaustive contact tracing operations.

This study offers valuable insights into the critical factors that contribute to effective public policy responses during a pandemic crisis, using the Veneto region's response to COVID-19 as a compelling case study. Effective strategies, as evidenced by Veneto's success, necessitate a multifaceted approach that transcends the mere implementation of containment and mitigation measures [42–44].

Key elements of effective public policy responses:

Multilevel collaboration: Using the knowledge of several operational levels is essential to success. This comprises emergency managers, biologists, epidemiologists, medical staff, and other experts who are immediately dealing with the pandemic's immediate concerns [45]. Political leadership plays a crucial role in this framework by assuming responsibility, making strategic decisions, allocating resources, and fostering coordination and collaboration across diverse entities (such as different departments and units within the government).

Network of innovators: A network of individuals with a broad range of expertise across various fields serves as a vital resource for informing policy decisions and their subsequent implementation [46]. The pivotal role played by the University of Padova and its leading professors in the Veneto case exemplifies this concept.

Scientific expertise: The need for scientific and technical expertise to inform policy decisions is growing in the face of crisis and increased uncertainty. This guarantees that the general interest, rather than particular special interests, will ultimately be served by policy decisions that are based on solid scientific evidence [47]. Numerous COVID-19 reaction decisions in the Veneto case and throughout Italy were influenced by academics and researchers from public research institutions. This cooperation helps to rationalize and legitimize government efforts to handle the intricate problems that the pandemic has brought forth. In these kinds of uncertain situations, academics are essential in providing justification for government involvement and in bolstering public policy responses [48].

Learning from experience: Developing effective policy solutions to complicated problems like pandemics requires the capacity to learn and adapt. Veneto's ability to control the first outbreak in the town of Vò Euganeo clearly influenced the way they developed creative and effective policy solutions [49].

Efficient execution: The triumphant execution of public policies is not an inherently self-governing procedure. The practical impact of a policy is greatly shaped by every aspect of its execution, from how administrators understand directions to how frontline staff operationalize them [48]. Collaboration between various organizational cultures and structures, such as those in academic and administrative organizations, is necessary for effective policy responses [50].

Veneto's success and the need for further research.

The study highlights the potential benefits of a proactive approach based on extensive testing and comprehensive epidemiological studies, along with containment and mitigation measures at the regional level. According to Veneto, this strategy may lower overall death rates and lessen the long-term effects of COVID-19 and related diseases on public health. Real-time execution of these investigations, however, comes with a number of difficulties. Data sources could only include a portion of the changing policy landscape or be insufficient. Furthermore, the idea of "bounded rationality" among decision-makers frequently informs public measures meant to mitigate the socioeconomic and health repercussions of the pandemic crisis. This concept posits that decision-makers often adopt a "satisficing" approach, aiming to achieve

an acceptable outcome within a context of uncertainty and limited time for deliberation [51–53]. Given the intricate challenges posed by the COVID-19 pandemic and its transmission dynamics, the conclusions drawn from this study must be considered tentative. There is a clear need for further research to illuminate the multifaceted relationships between novel viral agent pandemics, public policy interventions, and their impact on human health and society [54].

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Conflict of interest

The authors declare no conflict of interest.

Author details

Bilal Kargi^{1*}, Bekir Cihan Uçkaç² and Mario Coccia³

1 Sereflikoçhisar Faculty of Applied Sciences, Department of Finance and Banking, Ankara Yıldırım Beyazıt University, Ankara, Turkey

2 Independent Researcher, Ankara, Turkey

3 National Research Council of Italy, IRCRES-CNR-Turin Research Area CNR, Turin, Italy

*Address all correspondence to: bilalkargi@gmail.com

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Rethinking Public Health Policies: The Community-Led Responses during and after COVID-19 in Sub-Saharan Africa

Margaret Kaseje

Abstract

The post-COVID-19 society has brought changes across the globe, particularly in healthcare for communities in sub-Saharan Africa. As local communities adapt to these changes, the role of Community Health Workers (CHWs) has become increasingly important under health frameworks like One Health and Universal Health Coverage (UHC). Despite limited healthcare services, CHWs mobilized efforts to combat COVID-19, with emphasis on public education and skills acquisition during the pandemic. Community resilience has been bolstered through mental health initiatives and disaster preparedness training, underlining the importance of health education. Moreover, the perception of CHWs has evolved, as their contributions have led to calls for their formal inclusion in the health sector. Continuing challenges include the adaptability of communities in accessing healthcare amidst resource limitations, compounded by decreasing health funding to Africa. This exploration examines the interplay between local-level actions and broader societal changes in the wake of COVID-19.

Keywords: post-COVID-19 society, community health workers, one health, universal health coverage, health systems, community resilience, mental health, disaster preparedness, health education

1. Introduction

Global health systems have been greatly impacted by the COVID-19 pandemic, unearthing the weaknesses and disparities therein, as is the case for sub-Saharan Africa. WHO confirmed approximately 12 million cases of COVID-19 and 250,000 deaths in sub-Saharan Africa in early 2023. While such figures were reduced compared with other parts of the world, the toll of the virus on the healthcare system and on economic conditions was grim. The African Union's COVID-19 Response Fund noted that the virus had led to major setbacks in health services throughout Africa,

with some 90% of the continent's countries reporting disruptions to vital services, including vaccinations and maternal and child health consultations.

As countries confronted the virus's relentless spread, it became obvious how urgently effective public health policies were needed. Governments, global institutions, and health bodies worked together and employed measures to control the transmission of the virus, administer medical attention, and facilitate crisis management measures, such as in Kenya [1] and other countries across the continent. However, top-down methods, in contrast to traditional ones, were often ill-suited, as they did not stress community participation and local innovation in addressing public health issues.

Several factors made populations vulnerable to the virus. The risk was increased by social, economic, and health vulnerabilities. Job disruptions hit informal and formal sectors alike, despite minimal emergency provisions during the outbreak. The limitation of mobility resulted in the interruption of social connections and thus a reduction in social support. Social isolation increased risks further, especially among the elderly and families living in crowded conditions. Longstanding inequities in access to healthcare services hampered responses to the pandemic, with urban populations having greater access to information, personal protective equipment, and hospital services compared to rural populations.

Weak and fragile economic systems left many in a vulnerable state. The IMF indicated that sub-Saharan Africa's economy was projected to contract by 1.9% in 2020. Systems that were already overwhelmed were tested further in the pandemic. It also underscored the necessity of strong public health measures. Countries with robust health systems were better positioned to ensure coordinated responses, overlaying appropriate safety precautions and equitable access to vaccination, reinforcing the need for parallel and sustained investment for pandemic preparedness [2]. This episode underscored the necessity of effective public health practices for managing health crises. The countries that had invested in stronger health systems were ready to face the spread of the virus and reduce its effects when it hit.

Policy responses to COVID-19 in sub-Saharan Africa were characterised by adaptation to local circumstances. Nations mixed and matched health policies that they used during previous epidemics, such as Ebola, with fresh ideas tailored to the unique challenges of COVID-19. Certain country governments adopted COVID-19 health protection measures that involved community health personnel to educate citizens, facilitate quarantine measures, and trace contacts. Such strategies placed health services in the hands of local leadership, engaged Community Health Workers (CHWs) in health responses, and ultimately led to the containment of the virus within its early stages. In Kenya, the Ministry of Health modified its guidelines to include community-based interventions such as home-based care.

The community-led responses during COVID-19 demonstrate the necessity of health governance models that include local practices and knowledge. Rapidly evolving and locally driven development of health policy became necessary as communities began to "organise themselves" to respond to COVID-19 and to identify community-led responses to the health crisis. In addition, these community-based outreaches not only filled the gaps in formal health systems but also provided an example of health resilience that could shape the response policy of future public health agendas. The pandemic highlighted the importance of considering cultural contexts, health beliefs, and social networks when developing health interventions. Community participation during COVID-19 offered an opportunity for a responsive and context-tailored health policy design.

2. The role of CHWs during COVID-19

CHWs were prominent representatives of community engagement with the COVID-19 pandemic. They have become recognized service providers at lower levels of healthcare systems in sub-Saharan Africa and have gained prominence in public health. CHWs are generally chosen by the communities, and they undergo training on offering diverse services such as health promotion and education, as well as preventive and curative services, surveillance, and record keeping [3]. They also connect households with health facilities *via* referrals, which increases service uptake. The WHO suggests that CHWs can enhance health care access through outreach work and that where CHW programs are implemented well, immunization coverage can reach over 90%. This positions CHWs as essential actors for health education, preventive care, and health system strengthening, especially in rural and underserved areas. CHWs are increasingly acknowledged as health access facilitators; however, health systems do not officially incorporate them into the health workforce. The importance of CHWs to health systems is immeasurable particularly in Sub-Saharan Africa with challenged health systems and workforce [4]. Involving CHWs has the possibility to encourage the provision of primary health care where resource limitations are found. CHWs can contribute to UHC even in health inequities among the populations [5].

During the COVID-19 pandemic, it was important for there to be effective health communication. Governments and health organizations quickly deployed the CHWs to address healthcare delivery gaps and contain misinformation about the virus. In many countries, CHWs underwent expedited training programs focused on COVID-19 awareness, preventive measures, and proper protocols for interacting with suspected cases [6]. Ministries of Health, in conjunction with NGOs, developed training packages for CHWs regarding COVID-19 preventive measures [7]. Their training focused on learning how to recognize symptoms, wash their hands properly, and involve communities in reducing risk. Topics that were critical included: COVID-19 symptoms and how the virus spreads, promoting safe behaviors, home visits, and educating community members on preventive interventions like mask-wearing and hand-washing. CHWs held different roles during the pandemic:

- **Contact Tracing:** CHWs assisted with managing contacts and tracing of suspected cases of COVID-19 and referring them for testing to prevent spread within communities.
- **Testing and Referral:** CHWs screened for symptoms while referring patients to testing and healthcare services.
- **Vaccination drives:** CHWs were instrumental in community level vaccination drives as vaccines were made available, addressing vaccine hesitancy and access to hard-to-reach populations.

As demonstrated during the pandemic, CHWs mobilized community members, shared health information, and linked households to care during the COVID-19 pandemic. With training and oversight, CHWs helped to trace contacts, promote hygiene, and support vaccinations.

3. COVID-19 community response strategies

Using local knowledge, activating local resources, and supporting inclusive health responses, communities not only overcame the challenges posed by the pandemic but also built the foundation for resilient and stronger health systems. The pandemic also served as a wake-up call for public health policies to include community-led approaches in the context of public health emergencies.

Diverse approaches were applied by the communities to deal with challenges from the pandemic. Local knowledge and culture were used by communities and with support and involvement of the CHWs to generate community-driven responses to the pandemic in sub-Saharan Africa. In Kenya, for example, CHWs had social and behavior change communication (SBCC) roles including educating communities about COVID-19 preventative action to enable testing and vaccinations, and dispel myths about the virus. Community-based action, led by these health workers, helped to limit the impact of the pandemic and prove the possibility of community-led approaches as complementary to formal health systems.

With the COVID-19 pandemic, communities across the continent implemented various health-related strategies in response to the pandemic that they perceived as better meeting the interests of their own populations. The importance of indigenous knowledge, cultural practices, and community involvement increasingly became evident. Public health education campaigns, including grassroots health education campaigns, were used to address misinformation about COVID-19. Interventions involved local language material development (posters, pamphlets), radio announcements and talks, and community conversations facilitated by the CHWs to dispel myths and educate the public about prevention.

The training and use of CHWs emphasized the possibility of locally derived solutions that took local social and cultural dynamics into account. There was ample evidence of the impact of CHWs; areas where CHWs were in place already saw improved health indicators in terms of maternal and child mortality rates. A unique activity in Siaya County in Kenya was carried out and involved CHWs, who engaged in door-to-door sensitization, reduced rumors, improved compliance with public health recommendations, and enhanced people's access to health care services during the COVID-19 pandemic [7].

Local officials called on community resources to be deployed to assist in the health campaigns, using traditional ways that fit with cultural habits. Among these was the implementation of door-to-door health education campaigns that facilitated transmission of crucial information related to COVID-19 preventive measures. These actions also proved the potential of networks of governments, nongovernmental organizations, and community groups to work together in health emergencies.

Knowledge sharing through traditional ways, like community meetings, and local radio talk shows made it possible to spread important information about COVID-19. There was creative use of both traditional media (local radio and community meetings) and new digital platforms (such as WhatsApp groups) for information sharing and partnering with local radio stations to deliver health messages, along with social media to connect with younger individuals.

Communities adapted existing health practices that reinforced COVID-19 prevention, such as hand-washing practices that aligned with local customs, thereby enhancing hygiene following culturally accepted ways. Community vaccination programs were employed as one strategy to address vaccine hesitancy and increase vaccination rates when vaccine products became available.

The resilience and adaptability of some of the communities who, though affected by the pandemic, proved themselves more than capable of facing extreme disruption. The reaction to COVID-19 was more than a conduct of medical interventions. Public health campaigns drew on local customs and leaders.

Societies, particularly in communities where healthcare facilities were overburdened or unavailable, relied on traditional ways of passing information. During the pandemic, community health approaches utilized a variety of approaches that were rooted in localized solutions and leaned into existing networks, cultural entities, and local knowledge. In several sub-Saharan African countries, community responses involved public health messaging using songs, plays, and narratives that not only educated the public but also demystified the virus and raised awareness about preventive measures. Communities leveraged local radio as well as digital platforms, distributing health messages to younger audiences via social media. The health surveillance was actively performed by some community members visiting households and checking for symptoms to help identify symptomatic individuals for early testing and intervention. Vaccination campaigns were frequently integrated into community health fairs and were successful in achieving higher coverage in underprivileged populations. Education was paramount, with traditional community events and local radio reaching otherwise isolated populations with vital information about COVID-19. These efforts were intended to meet the complex issues of the pandemic and individual responses to the pandemic.

Community partnerships were established so that communities worked with stakeholders, which included NGOs, faith-based organizations and local administrations, to take on tasks of mobilizing resources such as food and Personal Protective Equipment (PPE). Familiar health habits as culturally-rooted styles of hand-washing were used to encourage hygienic habits. As vaccines were introduced, community-led programs were critical in overcoming vaccine hesitancy and increasing uptake.

The pandemic also highlighted the significance of mental health, which earlier was stigmatized in both urban and rural areas. Mental health community work already existed and built on existing HIV psychosocial support groups where CHWs served as facilitators for consultations and support for mental health, thus acknowledging that the pandemic took a psychological toll. The pandemic and its need to restrict movement, lockdowns, and less human contact showed us that mental health is an integral part of one's general health and social relations. The limitations, and reduction in social interaction, that were imposed by the pandemic highlighted the importance of mental health as part of holistic health and a society that is well [8].

The measures taken by the communities during the COVID-19 pandemic in sub-Saharan Africa demonstrated the importance of local solutions and involvement of the community for public health crises. By utilizing local wisdom, mobilizing existing resources, and promoting inclusive health care campaigns, communities were able not only to survive the pandemic but also to build foundations on which stronger health systems can be developed. There was a change in societal perceptions of community-based approaches and their relevance for a responsive and a service-delivery health system, especially during and after health crises.

4. Changes in society after COVID-19

Societal, cultural, and economic changes have taken place in the region as a result of the COVID-19 pandemic. These include health behavior of people, for example, as

more awareness was created on hygiene practices, instead of shaking hands, offering a closed fist was acceptable and not seen as demonstrating combativeness in some communities. On the technology front, digital platforms are more acceptable for social interactions and for work than before the pandemic.

The COVID-19 pandemic has had a profound impact on mental health, as it has brought about significant stressors such as isolation, anxiety over health risks, economic uncertainty, and grief from loss. These factors have led to an increased awareness of mental health issues, promoting society to prioritize mental well-being and fostering an environment where discussion about mental health are more open. This shift has contributed to a reduction in stigma, encouraging communities to be more open and supportive. Communities have strengthened their support systems and also use digital platforms to raise funds and to stay in touch in contrast to previous face to face meeting. The spaced for media has widened, and while print media continues to be present, radio stations have increased in dissemination of information in different languages, reaching to a wider audience. Use of digital tools for e-commerce and transactions for goods has increased, even among rural areas where internet is limited. Thus, the continent has seen substantial social, economic, and cultural changes that will provide opportunities for adaptations for future health and development challenges.

Post-COVID-19 shaped the way in which communities perceived and interacted with CHWs. Amid the pandemic, CHWs offered immediate assistance to homes and served as the initial point for health concerns. In other community settings, CHWs started to be called “doctors” to emphasize their credibility as health counselors. This emphasized the value of CHWs in providing advice, counseling and referring, demonstrating the potential for their full integration in the health system. The effective involvement of CHWs during the pandemic prompted discussion about formally integrating them into the health system human resource for health. There was also a growing realization among policymakers in the continent for the fuller integration of CHWs into the health workforce with improved training, compensation, and support systems. It spurred renewed questioning of the health workforce and their role in health crisis. Beyond the related policy dialog, there was reappraisal of the health workforce on the continent in light of emigration of health professionals from the continent to meet health workforce needs in other parts of the world.

5. Resource and health access constraints during COVID-19

Although community-driven activities have the potential to be transformative, the challenges that have long existed in sub-Saharan Africa, particularly concerning health infrastructure, worsened during the COVID-19 pandemic. Limited supplies of PPE and test kits especially in rural communities highlighted inequalities in health access. Vulnerable populations including women and those far from health facilities were adversely affected and experienced challenges in receiving health care during the pandemic, resulting in reduced care visits. These effects were predominantly a result of disrupted healthcare services and inadequate access to skilled birth attendants. In addition, lockdowns meant many women were forced into multiple roles of caregiving, preventing them from accessing essential health services. In certain scenarios, women were more likely than men to face delays in receiving care because of these domestic responsibilities.

Sub-Saharan Africa has limited medical resources, with some countries providing only around 0.2 hospital beds per 1000 people, as opposed to the average of 3.5

hospital beds per 1000 people in high-income countries. This huge gap badly affected the treatment of COVID-19 patients and health conditions overall. Furthermore, funding for health systems and structures was already insufficient pre-pandemic, with a disproportionate focus on responding to COVID-19 at the expense of much needed programs and services. In some cases at the peak of the pandemic, as much as 70% of health budgets in countries were diverted to the response, resulting in a drastic drop in resources for critical maternal and child health services.

Dependence on foreign aid and external financing from international organizations and donors has created fragilities in national health systems. In the absence of sustainable resources and strategic investments into its own health infrastructure, countries in sub-Sahara continue to be susceptible to health crises. The pandemic emphasized the urgent need for reconsideration on health financing especially for preventive and primary health services to improve the resilience of health systems. For a strong health system ready for pandemics, financing approaches for the building blocks of health systems are required [9].

The pandemic brought to the forefront gender gaps in health and socio-economic conditions. Women are typically the primary caregiver in many communities, making it difficult to access health services. In certain settings, women were also using the healthcare system less than men, despite the fact that women as well as men suffered from COVID-19, often more than men in terms of infection, vulnerability, and susceptibility to the after effects. Sectors that emphasized improvement of infrastructure, equity in health access, and greater community involvement in decision-making paired with public health interventions, including gender disparities, had better aggregate outcomes for women and children.

6. Redesigning health policies post COVID-19

Public health policy has traditionally a top-down approach that does not always include community knowledge and participation. The COVID-19 pandemic has made clear the importance of building a successful community engagement model that puts inclusion at the heart of policy formulation with local voices being central to shaping health interventions. For example, in Kenya, community input was utilized for formulating health policies, and the response was implementation at the policy level, and this led to the adoption of home-based care as an approach that complemented care being given in health facilities during times of high patient caseloads.

Traditional public health policy in the region was characterized by a lack of connection with community demand, and by policy-making environments that were based in government health ministries. There were often weak community engagement mechanisms in many sub-Saharan countries before the pandemic. They were largely tailored for urban health environments that do not consider the distinct circumstances in rural settings where CHWs are key health promoters. Post-COVID, there has been rethinking of governments to acknowledge the knowledge and expertise of local communities.

The need for strong engagement strategies was driven by the urgency of the pandemic. Governments were forced to move quickly, often deploying community health workers and local leaders to share information and roll out health interventions. This change is an opportunity to rethink how community voices enhance the effectiveness of policy. As sub-Saharan African countries transition from the COVID-19 crisis, there are opportunities to re-strategize local health policies. The pandemic compelled

health systems to be responsive and adaptable to rapidly changing contexts. Countries were successful at responding to the crisis when they were flexible with their policies and responses, and were innovative with their approaches. In Kenya, for instance, the government permitted community health workers to test for COVID-19 and trace contacts, in a major up-skill of frontline workers.

The pandemic also uncovered the underlying deficiencies in healthcare infrastructure and the urgent need for strong systems across the region. Countries with poor health infrastructure were challenged to cope with the flood of the COVID-19 cases, showing how critical it is to invest in health systems for future health emergencies. Sub-Saharan Africa was found to have less than 5% of the world's health workers and 25% of the public health infrastructure required.

Salient lessons learned during this time are the influential positioning of CHWs and local communities in generating best practices for public health responses. The pandemic highlighted and validated the role of CHWs in crisis, and the response also highlights how CHWs can act in crisis, mobilize local communities, communicate, and deliver services. Their flexibility, trust with community members, and responsiveness to immediate needs have been important and should be acknowledged in the planning for future public health emergencies. In the context of post-pandemic health policies, greater formal integration of CHWs into health systems will be necessary to ensure UHC and better health outcomes in vulnerable populations across the region. Strategic planning that proactively integrates CHWs is essential, and national policies should formally recognize and integrate CHWs into health systems [10], implementing these policies as more than just documents describing their roles, responsibilities, and training needs. The shifts in perception, policy discussions, and acknowledgement of the value and potential of CHWs represent a galvanizing change in community health in sub-Saharan Africa, arguably positioning the “new” CHW in the context of a more enduring health system.

The COVID-19 pandemic has hence called for a thorough proposition of public policies for public health in sub-Saharan Africa with a recognition of community-driven models. If stronger, more resilient health systems that are responsive to community needs—and leverage local capacity, including local knowledge—is to be achieved, then public health systems will need to evolve to something different and stronger. Lessons on health system resilience, the role of community in public health, the need for flexible interventions specific to local settings, and the relevance of empowering community-level health workers with training and support are rallying points for policy change.

Improving community-based health systems requires education and support for health interventions. The use of technology in delivering health education, tracking health data, and community engagement will improve how regional communities respond to future health crises in a post-COVID-19 world. As public health policies continue to adapt to the challenges presented by a post COVID-19 period, community engagement in health policymaking will be essential for promoting trust, compliance, and addressing health inequities.

7. Conclusion

After the COVID-19 pandemic, governments realized the need to review and realign their health systems to meet potential health crises more strongly, using the resources at their disposal. It was shown that communities can take care of their

health, even in crises. Countries that had inequalities had to confront these issues, as highlighted by the pandemic. For example, masks were generally more widely available for urban residents than for rural ones. The dependence on outside resources was exposed as communities needed to rely on their internal assets to mitigate the threat of the virus.

The sub-Saharan COVID-19 experience underscored the impact of community involvement on public health interventions. Communities leveraged their historical knowledge of previous health crises to rapidly adapt to new pandemic circumstances and show resilience against the new health crisis through hand hygiene and social distancing. CHWs acted as connectors, bridging communication, and referrals that influenced adherence to COVID-19 guidelines. It showed how community participation reinforces health responses. CHWs have been acknowledged as having crucial roles in the national health policies, but they are not fully absorbed into the formal health systems. The pandemic highlighted weak health infrastructure, especially in rural areas where medical supplies and equipment were in short supply. Addressing these vulnerabilities requires additional resources to strengthen capacity and infrastructure, and to build preparedness for future health crises. Advancements in technology also improved the response on health where reporting and follow-up using mobile tools supported CHWs in overcoming the constraints of traditional paper-based structures, strengthening efficiency and evidence-informed decision-making during the pandemic.

The inclusion of the aforementioned factors presents a model that is an option to achieve the goal of Universal Health Coverage [11] for underserved populations. The pandemic highlighted why health systems in sub-Saharan Africa need to be redefined. Focusing on community-led solutions could inform policymakers in establishing equitable and resilient health systems.

With countries emerging from the pandemic and challenges associated with funding cuts, sub-Saharan Africa should explore innovative financing mechanisms, such as community-based health insurance and public-private partnerships, to maintain and strengthen the health systems even during crises. The Abuja and Lusaka Declarations express the need to revitalize national health systems through greater domestic resource mobilization and government commitment and the including of community-led initiatives for resilient health systems.

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Conflict of interest

The author declares no conflict of interest.

Author details

Margaret Kaseje

Tropical Institute of Community Health and Development (TICH), Kisumu, Kenya

*Address all correspondence to: mkaseje@gmail.com

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Structural Adjustment Requirements of Higher Education Institutions to Sustain Service Delivery Post-COVID-19: A Grounded-Theoretical Approach

Lizl Steynberg and Jan P. Grundling

Abstract

On 11 March 2020, COVID-19 was designated a pandemic, disrupting institutions and individuals' lives globally. This is also true of higher education as an international phenomenon. Academic courses transitioned to online formats, overseas students were repatriated, faculty were restricted from international travel, conferences were deferred, and higher education institutions (HEIs) were closed. The research aims to identify key adjustment constructs required by HEIs at global and national levels to ensure sustainable service delivery post-COVID-19. It may serve as a guiding principle for HEIs and policymakers to develop appropriate service delivery strategies in times of crisis. The research followed a qualitative design and theoretical documentary sampling approach, utilizing the latest scientific articles and documents published since the COVID-19 outbreak till 6 April 2020. Thirty-six publications were coded and analyzed to identify four structural adjustment constructs: international student volatility, higher education institutional stability and agility, stewardship, and resource formation and development. The findings revealed the need to diversify HEIs' efforts and means. HEIs' stability and agility, as transformative drives, will fuel adjustments in learning, knowledge sharing, internationalization, and globalization. Stewardship demands uninterrupted teaching, learning, and service delivery, a drive toward online teaching platforms, and deepening constituency relationships. Resource formation and development require establishing an efficient and sustainable institutional system grounded in intellectual capacity, competitiveness, knowledge-sharing networks, continuous functional systems and contingency plan reassessments. Further research is required to improve alignment between COVID-19 data and the required response realities of HEIs.

Keywords: COVID-19, higher education, service delivery, internationalization, institutional stability and agility, stewardship, resources, grounded theory

1. Introduction

COVID-19, a Black Swan event, severely impacted higher education worldwide. It was recognized when China reported a novel coronavirus to the World Health Organization (WHO) on 31 December 2019 [1, 2]. Identified as nCoV (novel coronavirus) by the Laboratory of Virology at the Chinese Centre for Disease Control and Prevention on 7 January 2020 [1], the Centre shared the novel strain's genome data with the international community on 10 January 2020 [2, 3]. The WHO labeled the new virus 2019nCoV on 12 January 2020 and renamed the disease COVID-19 a month later [4]. When China confirmed their fourth death and human-to-human spread of the virus [2], the WHO called an emergency meeting on 21 January 2020. The consecutive lag times between notification, identification, and communication of the disease to the international community resulted in a disease hurricane sweeping the globe [3, 5, 6]. Another cause of public panic was due to the recognition of human-to-human transmission and the stringent quarantine rules; the WHO announced on 31 January 2020 that the coronavirus is a public health emergency of international concern [7]. On 11 March 2020, the WHO classified COVID-19 as a pandemic disease [8].

Its rapid spread led to unprecedented disruptions affecting approximately 220 million higher education students globally [9]. Higher education institutions (HEIs) faced significant challenges, including campus closures, transition to online learning, and financial strains. For instance, in the United States, freshman enrolment dropped by over 5% [10]. Similarly, Australian universities experienced decreased international student numbers and increased operational costs, prompting considerations of mergers to ensure financial viability.

When COVID-19 became the focus on 10 January 2020, it was unimaginable that the impending crisis had begun earlier and was already being transmitted abroad [5], posing a global human threat and severely disrupting people's lives [11, 12]. Day by day, cooperative solidarity between countries accumulates [3] to contain the virus using various strategies, control measures, and interventions [13]. This demand applies equally to HEIs globally. Worldwide, HEIs were closed, conferences postponed, international students evacuated and requested to return to their home countries, faculty prohibited from traveling abroad, and initiatives to transform many courses into online modes were launched [14, 15].

The pandemic also highlighted and exacerbated existing inequalities within higher education. Students from underrepresented, vulnerable, and disadvantaged backgrounds faced heightened challenges, leading to concerns about widening educational disparities [16]. Additionally, the shift to online education, while necessary, raised questions about the quality of learning and student engagement. Academics expressed concerns that this transition could lead to a depersonalized and transactional educational experience, potentially eroding academic standards [17].

These developments underscore the need for HEIs to reassess and adapt their strategies to ensure sustainable service delivery in a post-pandemic world. This research aims to identify the necessary adjustments required by HEIs to maintain service delivery at both global and domestic levels post-COVID-19. Limited research exists on HEIs' adjustments in response to pandemics to ensure continued service delivery to their constituents. Therefore, this study reviews current higher education COVID-19 responses to determine guiding adjustment constructs, aiming to develop appropriate service delivery strategies for higher education policymakers. As epidemics and pandemics are likely to recur, HEIs should be better prepared to guarantee uninterrupted, or at least minimal, service delivery to their constituencies. Higher education plays

an active role in times of crisis. This view is echoed by China's President Xi Jinping, as alluded to by [18], warning institutions to prepare for Black Swan events—rare and unexpected events that can cripple a system. Fear and anxiety provoked by pandemics like COVID-19 have serious consequences, such as xenophobia, lasting changes in sentiments, verbal insults, and physical attacks [19, 20].

This chapter is organized as follows: The first section explains the role of HEIs in intellectual capacity development, enhanced competitiveness, and national development. It also discusses the functional responsibilities of HEIs and provides the rationale for adopting a grounded-theoretical approach. Given the unprecedented nature of the COVID-19 pandemic and its profound impact on higher education, traditional theoretical frameworks may not fully capture the emerging challenges and necessary adaptations. Grounded theory is particularly suitable in such contexts as it allows for the development of theories directly from data, especially when existing theories are inadequate or nonexistent. This approach enables researchers to generate hypotheses and theories about people's experiences, rather than merely testing and validating existing theories [21]. The second section discusses the research methodology and the necessity of an exploratory research approach, considering the rapid spread of COVID-19, its complex nature, and its direct impact on higher education. A transformative response is needed to provide rapid baseline information to guide further research and inform higher education decision-makers post-COVID-19. In section three, the identified adjustment constructs are discussed and interpreted in context. We offer a perspective on the findings and their links to higher education in the context of COVID-19. Finally, the manuscript concludes with ideas for future research.

2. The service role of higher education institutions

The chapter employs a grounded-theory approach, as outlined by [22, 23], allowing for the use of discipline-based knowledge, provided it aligns with the data and does not misdirect researchers or hinder findings, as emphasized by [23, 24]. Consequently, the literature aims to raise awareness and understanding of potential factors influencing the service role of HEIs. Both [23, 24] caution against conducting exhaustive literature reviews in grounded-theoretical studies.

HEIs play a pivotal role in identifying and nurturing talent to bolster global competitiveness and national development. Robust social and cultural networks emerge through inclusive, supportive, and rich knowledge-sharing stimuli in a multinational context [25–27]. These networks necessitate an internationalized character of HEIs, aligning with contemporary perspectives [28–30]. The global COVID-19 pandemic represents a phenomenon that requires integration into the service goals, content, and delivery of higher education through dynamic network engagements, encompassing all higher educational functions [31].

At the functional level, higher education's core service delivery responsibilities encompass teaching, research, and community services [32]. The advent of modern technologies, particularly emerging technologies, facilitates the creation of educational spaces with mixed-virtual-reality environments, thereby intelligently enhancing teaching, learning, and services within higher education. In the teaching domain, traditional methods can be integrated with online instruction, data support for educators and students, automated task reminders, and personalized reports [33, 34]. Fostering international partnerships enables cross-sectoral participation, involving

individuals and businesses, to generate greater collective benefits [35]. Establishing domestic and global educational hubs is crucial for collaboration during crises, while acknowledging contextual differences and needs [36, 37].

Beyond teaching and research, HEIs provide a spectrum of services to students and communities, including mental health support, career counseling, and community outreach programs. During crises such as the COVID-19 pandemic, these services have adapted to meet evolving needs. For instance, universities have significantly increased their mental health budgets to address rising concerns among students. Some institutions have reported increases of up to 600% in their mental health spending over the past 5 years, compensating for gaps in external support systems [38]. Additionally, HEIs have implemented flexible academic policies, such as adjusted deadlines and hybrid learning models, to accommodate the diverse circumstances of students during the pandemic [39]. Community engagement initiatives have also been reimagined, with universities leveraging digital platforms to continue outreach and support services, ensuring continuity and accessibility despite physical distancing measures.

Various theoretical frameworks are utilized in pandemic studies, including Transboundary Crisis Theory, the Theory of Planned Behavior, and Protection Motivation Theory. Transboundary Crisis Theory examines crises with global impacts, focusing on societal interpretations and the social contexts in which they occur [40]. In contrast, the Theory of Planned Behavior identifies, addresses, and measures behavioral determinants during a pandemic, while the Protection Motivation Theory posits that excessive fear appeals may trigger maladaptive responses, such as denial and avoidance [41]. HEIs often concentrate on emergency management, physical safety, and technology crises, potentially overlooking continuity planning for their core functions [42]. Due to the limited research on pandemic management in higher education, a grounded-theoretical approach is beneficial to refine and contribute to concept and theory-building for pandemic management in HEIs. Developing concepts and theories necessitates inductive reasoning, with researchers playing an active and central role. Existing literature serves as a valuable data source, and in such circumstances, data sources include interviews, focus groups, field notes, memorandums, research literature, policy documents, and popular documents, providing rich and diverse perspectives [13, 15]. Employing grounded theory is particularly pertinent when existing literature is exploratory and lacks rigor, thereby accommodating the diverse population groups affected by higher education service delivery.

3. Qualitative content analysis of higher education institution service delivery adaptations post-COVID-19

The rapid spread of COVID-19 necessitated an exploratory research approach to identify guiding principles for sustained service delivery by HEIs. Recognizing that no single country could provide all solutions to the challenges faced by HEIs during the pandemic, as the initial response is based on moment-in-time descriptions of the realities that exist at the time of the research. Our research acknowledges the complex and swiftly changing realities of this period. Consequently, we adopted an interpretivist paradigm and the epistemological belief, grounded in the belief that individuals construct social reality differently [43].

Our central research question—“What adjustment constructs will influence higher education service delivery post-COVID-19?”—was explored through

qualitative content analysis. Although content analysis often relies on word frequency counts to infer significant topics, this method has limitations, as recurring items may not always be significant in qualitative studies [30, 44]. To address this, we integrated quantitative word frequency analysis with qualitative interpretation, ensuring a nuanced understanding of the data.

Given the pivotal role of various publications, including social media, in disseminating information during the pandemic, our research design incorporated these sources to explore adjustment constructs for higher education service delivery post-COVID-19. Acknowledging the potential for misinformation, we implemented a rigorous evaluation process to assess the credibility and relevance of these sources, cross-referencing them with established fact-checking organizations and considering the expertise of content creators. Such measures are critical, as studies have shown that much health advice on social media diverges from public health guidelines, underscoring the need for careful evaluation.

The research focused on the latest scientific publications from 2020, including those from social media, to explore adjustment constructs influencing post-COVID-19 higher education service delivery. These publications represent a theoretical sampling, where texts from a corpus of sources were analyzed. The research was exempt from Ethics Committee scrutiny due to its reliance on open-access secondary data.

Our data mining spanned from 1 January to 6 April 2020, focusing on three key concepts: adjustment constructs, service delivery, and higher education. An adjustment construct refers to any factor that enhances higher education post-pandemic. Service delivery includes traditional functions of higher education such as teaching, research, international participation, and community service. In the context of higher education, an institution that awards academic degrees or professional certifications is considered an HEI.

We used purposive sampling to ensure a comprehensive representation of perspectives on higher education adaptations post-COVID-19. This approach allowed us to select information-rich cases that aligned with qualitative research best practices, enhancing the transferability of our findings for global application.

To capture diverse insights, we included various publications, including social media, recognizing their role in disseminating information during the initial pandemic phase. Google Scholar was used for scientific publications, while Google was used for popular higher education publications like World University News. Keywords like “higher education,” “university,” “coronavirus,” “COVID-19,” “governance,” “pandemic,” and “medRxiv” guided our search for articles published in 2020.

Although exempt from Ethics Committee review due to the use of open-access secondary data, we remained vigilant about ethical considerations. When using social media sources, issues related to data privacy and consent arise, even if the information is publicly accessible. To address these concerns, we adhered to ethical guidelines for internet-mediated research, ensuring that user privacy was respected and that data was used responsibly. This approach aligns with recommendations from the UK Research Integrity Office, which emphasizes the importance of considering ethical issues in research using social media [45].

Our qualitative analysis followed a two-phase coding process. First, we conducted a preliminary reading of articles to develop sensitivity to the literature, identifying recurring themes and concepts before importing the data into NVivo version 12, a computer-assisted qualitative data analysis software. NVivo facilitated the organization and coding of data, enabling the integration of various techniques to identify adjustment constructs for higher education service delivery.

First-level coding involved selecting small data segments and assigning them to specific codes, representing data fragmentation and reduction to initiate emergent themes. Two qualified social scientists independently coded excerpts, discussed discrepancies, and agreed on free-node labels and content. Related extracts were then combined into single nodes, enhancing coding consistency through inter-coder agreement. This process resulted in 18 first-level defined codes from 36 analyzed publications.

In the second phase, we performed a cluster analysis using Jaccard's coefficients to assess similarities between data sets based on the co-occurrence of specific values [46]. This reduced the 18 nodes to four clustered adjustment constructs. It is important to note that this exploratory study's clustering approach did not assign importance weights to the adjustment constructs. Eventually, research will be conducted when the published information corpus has become more mature and reliable. For this reason, the findings aim to provide actionable insights to improve higher education service delivery worldwide.

4. Adjustment constructs influencing post-COVID-19 higher education services

A word cloud analysis identified "student education" as the primary construct influencing adjustments in higher education. Consequently, four adjustment constructs were identified: international student volatility, higher education institutional stability and agility, stewardship, and resource formation and development, which will be discussed in the following sections. The first construct pertains to the international student population, while the remaining three focus on institutional adjustments.

4.1 International student volatility

International higher education holds substantial commercial value. Ref. [14] estimated this global industry to be worth US\$300 billion annually. The COVID-19 pandemic caused an immediate and significant disruption, resulting in a US\$600 billion loss [47], particularly affecting student flows from China and India to the United States [48]. New international student enrolments in the United States decreased by 72% compared to 2019 levels, highlighting the pandemic's profound impact on global student mobility [49]. As certain student cohorts choose to study closer to home, HEIs face significant challenges in the short term. This trend is especially evident among Asian students considering intra-regional universities, such as those in Malaysia [14, 50].

Recent developments further underscore the importance of understanding international student dynamics. In the United Kingdom, universities have been urged to provide better support for Chinese students, who constitute a quarter of all international students and contribute £2.3 billion in fees annually. Challenges such as lower proficiency in spoken English and reliance on Chinese social media platforms have led to "ethnic clustering," highlighting the need for targeted support initiatives [51].

Moreover, Australian universities are experiencing record-high dropout rates among domestic students, with only 62% completing their degrees within 6 years. In contrast, international students show a higher completion rate of 79%, emphasizing the significant role of international students in sustaining university enrolments and revenues [52]. S&P Global has warned that reductions in international student

numbers could pressure Australian universities' credit ratings, given the substantial revenue these students generate [53].

While it is desirable not to view international higher education solely as an income generator for HEIs, the authors in Ref. [14] suggest that this perception persists. Supporting this view, the authors in Refs. [14, 54, 55] note that:

- i. Studying abroad remains a long-term plan for many prospective international students.
- ii. Students continue to favor the experience of studying abroad and seeking employment opportunities internationally.
- iii. Transnational and international education has a proven track record of success.
- iv. HEIs involved in recruiting international students will strive to diversify their efforts and methods to attract them.

4.2 Higher education institutional stability and agility

Central to higher education is the transformative drive that fuels adaptation to changes in learning, knowledge sharing, internationalization, and globalization. This drive continues to influence and set new standards for countries' higher education systems [30].

In their 2019 study, the authors in Ref. [30] examine the rationale for the internationalization of higher education, highlighting how global engagement shapes institutional policies and practices. They argue that internationalization is essential for enhancing educational quality and relevance in a globalized world [30]. The authors in Ref. [56] support this view, highlighting that HEIs exhibit increased flexibility in several areas: providing diverse learning paths, accommodating a wide range of students, offering various learning delivery modes, providing options for part-time, distance, and online learning, and participating in national higher education frameworks, including roles in quality assurance, transfer systems, and credit accumulation procedures.

This flexibility enhances HEIs' ability to respond effectively to crises and pandemics. The importance of agility is further recognized in the 2030 Agenda and Sustainable Development Goal 4. The findings also reveal a need to adapt higher education policies systematically to foster greater agility. Achieving this requires clearly defined objectives supported by political will, leadership, and financial resources. The author in Ref. [54] underscores the critical role of experts, expertise, and science in higher education policy-making, a significance underscored by the COVID-19 pandemic.

4.3 Stewardship

HEIs play a pivotal role in delivering social services to various constituencies, including staff, students, their families, alumni, and the broader socio-economic environment. They are responsible for ensuring uninterrupted teaching and learning while maintaining their traditional commitments to social service provision, scientific research, and talent development [2]. These multifaceted responsibilities present unique challenges under both normal and crisis conditions.

Recognizing these challenges, it becomes imperative to examine the specific obstacles HEIs face in transitioning to online education:

- i. The *digital divide* refers to the gap between individuals with access to modern information and communication technology and those without it, which became pronounced during the COVID-19 pandemic. Not all students can afford devices like smartphones and laptops necessary for online learning, hindering effective participation. In response, universities invested in providing these devices to ensure continuity in learning.
- ii. Limited *Wi-Fi bandwidth* in remote areas hinders students' access to online platforms due to inadequate internet connectivity, exacerbating educational inequalities.
- iii. Challenges such as limited space, household noise, and unreliable electricity can significantly impede students' ability to engage effectively in online learning. These *environmental distractions* disrupt concentration and reduce the effectiveness of remote education.
- iv. Disruptions in education can lead to reduced *motivation* among students and, in some cases, complete disengagement from academic activities, potentially resulting in long-term socio-economic consequences.
- v. The shift to online learning modalities necessitated significant changes in *teaching strategies*, challenging traditional face-to-face pedagogies. Educators rapidly adapted by incorporating interactive technologies and rethinking course delivery to maintain student engagement in a virtual environment.

To adapt to evolving educational landscapes, HEIs have implemented online teaching platforms, facilitating a seamless transition between face-to-face interactions and online modalities [47]. This shift has necessitated significant changes in teaching strategies, challenging traditional pedagogies and requiring rapid adaptation by educators [57]. Specific initiatives include:

- i. HEIs have partnered with various institutions to provide resources such as innovative teaching strategies, comprehensive training programs, robust information technology support, and case studies on epidemic and pandemic prevention. For example, the University of Wisconsin-Madison deployed software to replace traditional lectures with streaming video, enhancing flexibility and accessibility.
- ii. Recognizing the need for technological proficiency, HEIs have equipped staff with essential skills for effective online teaching design and delivery. This includes training in the use of interactive technologies and the development of engaging digital content.
- iii. Participation in programs like the International Association of Universities' (IAU) Executive Leadership Program has equipped university leaders with skills to address pressing administrative, ethical, and societal issues through a blend of in-person sessions and online learning. This program emphasizes strategic leadership in navigating complex challenges [58].

- iv. HEIs have adopted Lean management principles to improve efficiency and effectiveness in both administrative and academic services. Institutions such as Cardiff University and the University of St. Andrews have applied Lean thinking to enhance operations, resulting in streamlined processes and improved service delivery [59].

Through these strategic initiatives, HEIs have enhanced their ability to navigate challenges and continue fulfilling their educational missions effectively. Additionally, student consumption has significantly stimulated economic growth in sectors such as catering, entertainment, shopping, and technology within local economies [2].

The proactive measures undertaken by HEIs, including strategic collaborations, resource provisioning, and community engagement, have reinforced their stewardship roles. This comprehensive approach ensures the continuity of quality education and supports the socio-economic well-being of their constituencies, particularly during crises. Engaging with local businesses fosters vital and sustainable communities, and maintaining essential operations—such as housing, catering, and security—at reduced costs during crises is crucial. Effective communication strategies that address all constituencies—staff, students, alumni, employers, policymakers, and embassies—are essential to ensure mutual interests are met [5].

4.4 Resource formation and development

Becoming a reputable and internationalized HEI depends on establishing an efficient and sustainable institutional system. This system should integrate intellectual capacity, local and global competitiveness, and robust social, cultural, and knowledge-sharing networks into institutional policies, objectives, and delivery mechanisms [30]. The COVID-19 pandemic highlighted several critical aspects that require HEI leaders' focused attention to strengthen institutional systems. These aspects include rethinking student application and recruitment methods, revising student access and exit policies, managing campus restrictions, promoting sustainable teaching and research practices, optimizing conference management, facilitating student and staff mobility, fostering international research collaborations, and ensuring institutional well-being and stability [14, 47, 48, 50, 54, 55, 60].

The pandemic underscored the importance of contingency planning [60]. Establishing a permanent Risk and Pandemic Response Committee is essential to guide HEIs in detecting, preventing, and responding to crises. This committee should oversee awareness-raising efforts, issue timely warnings, and coordinate welfare support, including counseling and helplines. Collaboration with local authorities, international student associations, student representative bodies, labor unions, medical schools, hospitals, and campus clinics would enhance the committee's effectiveness [20, 48, 60, 61]. The committee should ensure compliance with government policies and protocols, promote humane and respectful crisis responses, and, when the crisis subsides, develop comprehensive recovery plans [54].

To support institutional development aspirations, HEIs must rethink staff recruitment strategies and enhance responsiveness to evolving circumstances. This includes embracing online outreach, revising qualification requirements, introducing flexible application deadlines and academic start dates, diversifying short-term course offerings, ensuring continued student progress during crises, establishing reliable communication systems, offering tuition discounts, and forming global admission partnerships [50, 54, 56, 62].

The findings indicate that COVID-19 has profoundly transformed teaching and learning practices in HEIs, with lasting effects beyond the pandemic. Despite disruptions, teaching and learning will continue as an ongoing, adaptable process. This means institutions should create mechanisms for switching teaching activities, rethinking effective training methods, and integrating diverse teaching resources. These resources include online teaching, broadcast lectures, and large online Open Course Network Platforms (MOOC platforms). HEIs should provide flexible teaching schedules, support students in planning home-based studies, cultivate and develop independent learning skills, ensure equitable learning opportunities, and provide better responsiveness to course offerings to minimize talent development homogeneity and prevent learning cessation [19, 50, 57, 63].

Alongside adapting teaching practices, HEIs must also enhance their research capabilities to contribute to societal resilience during crises. During pandemics, research becomes crucial for guiding social decision-making and advancing scientific knowledge [8]. Collaborative research efforts should be encouraged to achieve rapid, high-impact results, share findings, and disseminate information through appropriate channels. Research priorities should include pandemic prevention and control, long-term societal consequences, and contextual insights [2, 8]. Academic publishers, such as Springer, Elsevier, Emerald, and Taylor & Francis, should collaborate to provide open access to resources and expedite peer review processes, enabling faster knowledge dissemination to support policymakers and researchers [8].

5. Conclusion

Higher education systems vary across countries, making it difficult to apply universal recommendations. However, findings from this study offer valuable insights into addressing service delivery challenges faced by HEIs during crises. By leveraging key adjustment constructs—such as international student volatility, institutional stability and agility, stewardship, and resource development—decision-makers and institutional leaders can develop effective strategies to enhance service performance and strengthen decision-making during disruptions.

In designing interventions, university administrators and policy advisors should also consider historical, political, and economic factors. A balanced approach that integrates these elements with key adjustment constructs will help ensure institutional responses are not only effective but also compatible, harmonized, and transferable across diverse higher education systems.

While this study focused on the impact of COVID-19 on higher education service delivery, its findings provide a foundation for managing future disruptions. A significant challenge was aligning data with the rapidly evolving demands of the pandemic. Nevertheless, the insights gained contribute to a broader understanding of how HEIs can adapt in uncertain environments.

Initial post-COVID-19 research largely emphasized student education, often overlooking critical aspects of internationalization, such as student and faculty exchanges and global partnerships. Similarly, studies primarily addressed immediate pandemic-related challenges, with limited exploration of how collaborative research would evolve in the long term. Addressing these gaps is essential for a more comprehensive understanding of higher education's transformation.

This study is not without limitations. A primary challenge lies in aligning data with the fluid and evolving nature of the responses necessitated by the dynamic

context of the pandemic. The rapid progression of the crisis and the continuous adaptation of HEIs posed difficulties in capturing a stable and comprehensive view of the adjustments. However, the foundational understanding developed here is crucial in illustrating how higher education can be supported and how lessons can be applied in similarly evolving situations.

Early research on post-COVID-19 higher education primarily addressed student education, often overlooking broader aspects of internationalization, such as student and faculty exchanges and global partnerships. Additionally, most studies focused on immediate pandemic-related challenges, with limited attention to how collaborative research would evolve in the long term. Addressing these gaps is essential for a more comprehensive understanding of higher education's transformation.

Despite these limitations, the COVID-19 pandemic has undeniably provided the impetus for a “new normal” in higher education, marked by transformations in online teaching, admission processes, and institutional management. As research in this field evolves, future studies should prioritize improving analytical reliability, identifying emerging trends, and refining an adaptable adjustment framework for HEIs. Developing a robust, evidence-based adjustment theory will provide institutions with a structured approach to navigating future disruptions while maintaining academic excellence and effective service delivery. Strengthening this knowledge base will enable HEIs to respond proactively to crises, fostering resilience and long-term institutional sustainability.

Conflict of interest

The authors declare no conflict of interest.

Author details

Lizl Steynberg^{1*} and Jan P. Grundling^{2,3}

1 Department of Management and Entrepreneurship, Faculty of Management Sciences, Tshwane University of Technology, Pretoria, South Africa

2 Centre for Local Economic Development (CENLED), School of Economics, College of Business and Economics, University of Johannesburg, Johannesburg, South Africa

3 PASCAL International Observatory (Africa), Johannesburg, South Africa

*Address all correspondence to: steynbergl@tut.ac.za

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Vehicle Registration Dynamics in India across the COVID-19 Timeline

Mukti Advani, Niraj Sharma and Ankit Pandey

Abstract

The impact of the COVID-19 pandemic on India's transportation sector through a comprehensive analysis of vehicle registration data, road accidents, air quality indices, bicycle market trends, road infrastructure development, and fuel consumption patterns. The research spans the pre-COVID (2016–2019), COVID (2020–2021), and post-COVID (2022–2023) periods, revealing significant disruptions and subsequent recoveries across multiple transportation parameters. Findings demonstrate notable declines in vehicle registrations and road accidents during pandemic lockdowns, accompanied by improved air quality metrics. The post-pandemic period shows rebounding trends in vehicle registrations and fuel consumption, with certain segments like bicycle production experiencing sustained growth due to changed consumer preferences. The chapter provides valuable insights into the pandemic's transformative effects on mobility patterns, transportation infrastructure utilization, and environmental quality in India, offering important perspectives for transportation planning and policy formulation in the post-pandemic era.

Keywords: India, COVID transportation impact, vehicle registration, road accidents, air quality index, fuel consumption

1. Introduction

The initial cases of COVID-19 in India were reported in January 2020. The pandemic subsequently unfolded in three distinct waves: the first from July 16, 2020, to January 31, 2021; the second from March 16 to May 6, 2021; and the third from January 1 to February 20, 2022. During these periods, the Government of India implemented comprehensive public health interventions including national and state level lockdowns, work from home mandates, suspension of in person education, and restrictions on commercial activity to contain viral transmission.

These interventions significantly altered mobility patterns across the country. With both public and private transportation systems disrupted, the pandemic reshaped commuting behaviors, freight movement, and travel demand. This chapter examines the multidimensional impact of COVID-19 on India's transportation ecosystem, analyzing changes in vehicle registrations, road accidents, air quality (AQI),

fuel consumption, road infrastructure development, and the bicycle market across pre-pandemic (2016–2019), pandemic (2020–2021), and post-pandemic (2022–2023) periods.

By contextualizing these parameters within the pandemic timeline, the chapter aims to provide evidence-based insights into how large-scale public health crises can trigger both disruptions and transitions in transport systems, offering important lessons for future mobility planning, sustainability, and policy formulation.

2. Methodology

This study employs a comprehensive mixed methods approach to analyze the impacts of COVID-19 on India's transportation sector across three distinct time periods: pre-COVID (2016–2019), COVID (2020–2021), and post-COVID (2022–2023). The research design facilitates temporal comparison to identify pandemic-induced disruptions and subsequent recovery patterns across multiple transportation parameters.

2.1 Data collection

The study utilizes secondary data from multiple authoritative sources to ensure comprehensive coverage of transportation sector indicators:

1. *Vehicle registration data*: Time series data on vehicle registrations (total vehicles, two-wheelers, and light motor vehicles) was sourced from the Vahan Portal (Vahan.parivahan.gov.in) [1], India's national vehicle registration database maintained by the Ministry of Road Transport and Highways.
2. *Road safety statistics*: Data on road accidents, fatalities, and injuries were extracted from "Road Accidents in India 2022" [2], the official publication of the Ministry of Road Transport and Highways (MoRTH).
3. *Air quality measurements*: Monthly Air Quality Index (AQI) values across all reporting cities were collected from the Central Pollution Control Board (CPCB) of India's monitoring network [3, 4].
4. *Bicycle market trends*: Production volumes and year-on-year growth figures were compiled from the Annual Reports (2018–2023) of the Department for Promotion of Industry and Internal Trade [5–7].
5. *Road infrastructure development*: National highway construction and expansion data were obtained from Press Information Bureau releases and the Ministry of Road Transport and Highways' "Basic Road Statistics of India" [8].
6. *Fuel consumption patterns*: Temporal data on motor spirit (petrol) consumption was collected from the Petroleum Planning & Analysis Cell of the Government of India [9].

2.2 Data analysis

The following analytical procedures were implemented:

- 1. *Aggregation of registration data:* Annual vehicle registration figures were compiled and categorized by vehicle type to identify segment-specific impacts.
- 2. *Accident rate computation:* Road safety data were analyzed to calculate accident frequencies, fatality rates, and injury statistics across the three study periods.
- 3. *Air quality assessment:* Monthly and annual AQI averages were calculated to quantify air quality variations in relation to changing mobility patterns.
- 4. *Growth rate calculation:* Year-on-year percentage changes were computed for bicycle production, road infrastructure development, and fuel consumption to quantify the magnitude of COVID-induced disruptions and subsequent recoveries.
- 5. *Comparative benchmarking:* Pre-COVID figures were used as baseline values to measure the extent of change during and after the pandemic.

This methodological approach provides a robust framework for examining the multifaceted impacts of the COVID-19 pandemic on India’s transportation landscape, offering valuable insights for transportation planning, policy formulation, and environmental management in the post-pandemic era.

3. Vehicle registrations in India: Pre and post-COVID

The analysis of Indian vehicle registration data was obtained from the Vahan portal [1]. Vehicle registration data were compiled annually and categorized by type to assess the impact across different vehicle segments. As illustrated in **Figure 1**, the data

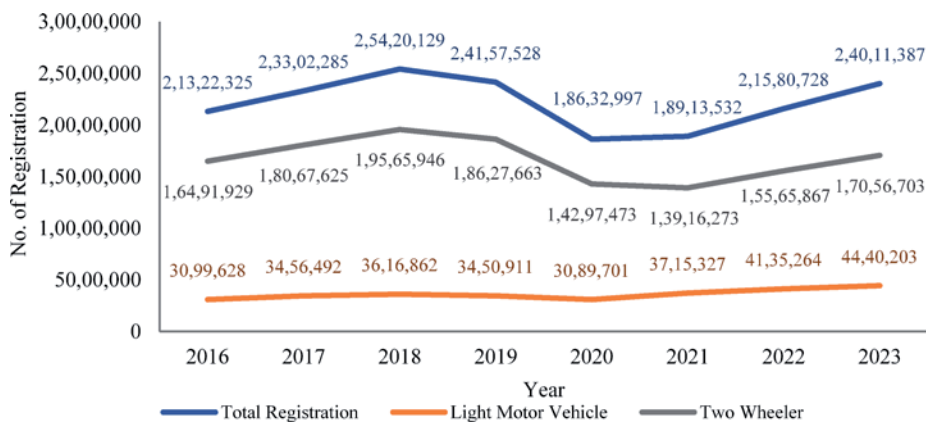


Figure 1. Annual vehicle registrations in India (2016–2023), showing trends for total vehicles, two-wheelers, and light motor vehicles.

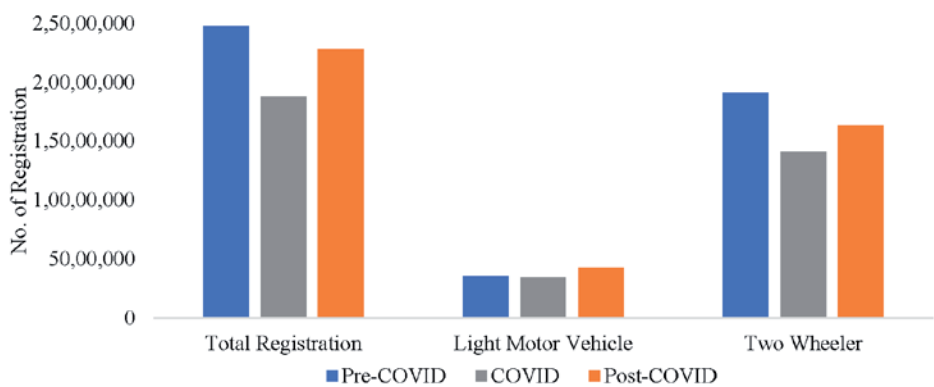


Figure 2.
Comparison of vehicle registration in pre-COVID, COVID, and post-COVID per year.

have been extracted from the compiled vehicle registration records available on the Vahan portal. Vehicle registration statistics spanning 2016–2018 established a baseline for comparison with subsequent periods.

The graphical data illustrate a clear trend in vehicle registrations across India from 2016 to 2023. A notable increase is observed up to 2018, followed by a significant decline between 2020 and 2021, which aligns with the onset and peak impact of the COVID-19 pandemic. This decline can be attributed to widespread mobility restrictions, economic slowdown, and vehicle production and sales disruptions. Specifically, registrations of total vehicles, two-wheelers, and light motor vehicles all dipped during this period. However, from 2022 onward, the data show a marked recovery, with vehicle registrations rebounding as economic activities resumed and consumer confidence improved in the post-COVID era.

The comparative analysis of vehicle registration data across pre-COVID, COVID, and post-COVID periods provides valuable insights into the pandemic’s impact on India’s transport sector. **Figure 2** presents a comparative overview of vehicle registrations in pre-COVID, COVID, and post-COVID per year. The data clearly illustrate a decline in registrations during the COVID phase across all categories, total registrations, light motor vehicles, and two-wheelers, reflecting the pandemic’s disruptive effects on mobility and the economy. In contrast, the post-COVID phase shows a visible rebound in registrations, indicating a recovery in consumer demand and a resumption of manufacturing and transport activities.

4. Accidents in India: Pre and post-COVID

The road accident data for India have been sourced from *Road Accidents in India 2022* [2], the latest report published by the Ministry of Road Transport and Highways (MoRTH), which reveals notable temporal patterns in traffic incidents. Accident rate analysis involved evaluating road safety data to compute accident frequencies, fatality rates, and injury statistics across the three study periods. As depicted in **Figure 3**, the information is derived from the data presented in the Road Accidents in India 2022 report [2]; the longitudinal trends in accident frequency, fatality counts, and injury statistics from 2016 to 2022 establish a pre-pandemic baseline.

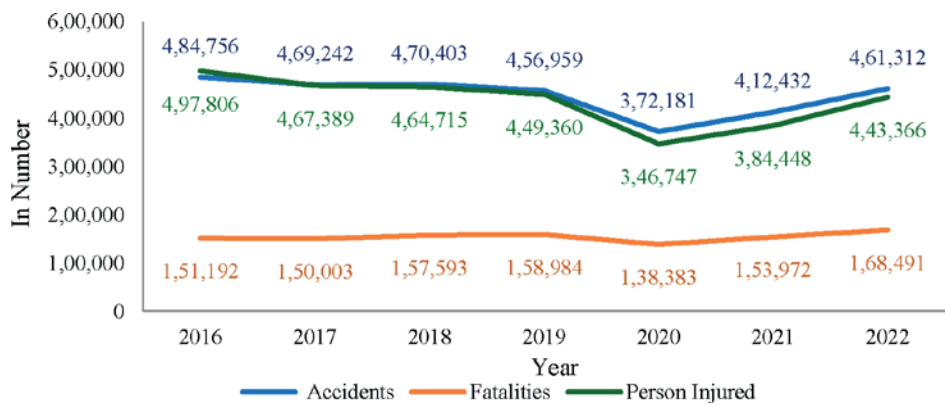


Figure 3.
Trends in number of accidents, fatalities, and persons injured (2018–2022).

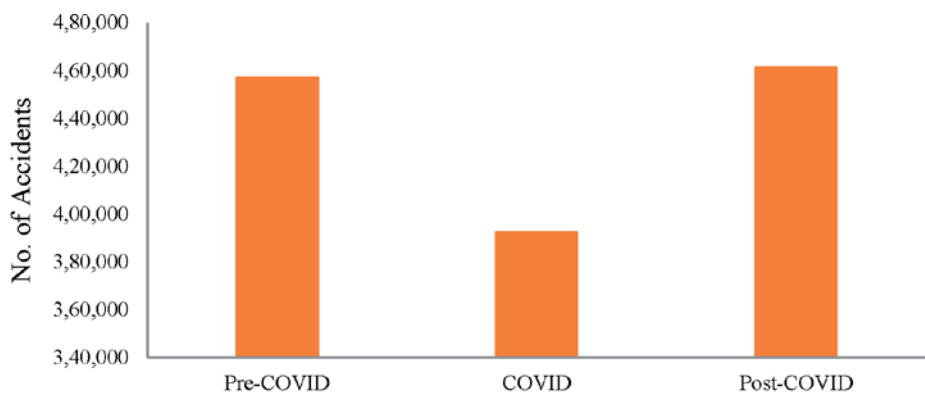


Figure 4.
Comparison of number of accidents in pre-COVID, COVID, and post-COVID per year.

Figure 4 compares the number of road accidents per year during the pre-COVID, COVID, and post-COVID periods. As shown, there was a significant decline in the number of accidents during the COVID period, likely due to reduced vehicular movement and restrictions on travel. However, the number of accidents rose again in the post-COVID phase, exceeding even the pre-COVID levels. This trend highlights the influence of mobility patterns on road safety and the need for reinforced traffic management and safety measures in the post-pandemic era.

5. Trends in vehicle growth and accident rates in India

The relationship between vehicle registrations and road accident rates in India, as depicted from 2017 to 2022, highlights a dynamic and synchronized pattern. The graph shows that percentage changes in both parameters follow similar trajectories, confirming a moderate to strong positive correlation. When vehicle registration growth dipped, accident rates followed suit; when it rebounded, accident rates similarly rose, as shown in **Figure 5**. The graph illustrates parallel trends, with both indicators sharply declining during the COVID-19 pandemic (2020) and rebounding

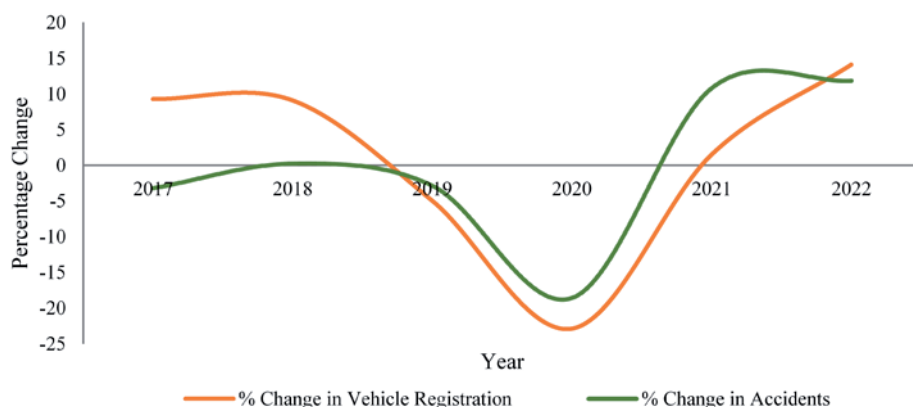


Figure 5.
Percentage change in annual vehicle registrations and road accidents in India from 2017 to 2022.

in the post-pandemic years. The most significant changes occurred in 2020 (sharpest decline) and 2022 (highest rebound) [1, 2].

During the pre-COVID years (2017–2019), both vehicle registrations and accidents displayed minor fluctuations but remained relatively stable, with modest positive growth. However, in 2020—a year dominated by pandemic-induced lockdowns, India experienced the most pronounced negative change, with vehicle registrations plummeting by over 20% and accidents declining by a similar margin. This suggests that restricted mobility, supply chain interruptions, and reduced traffic exposure were the primary drivers behind the drop in road incidents.

A sharp recovery is evident in 2021 and 2022, where both metrics surged. By 2022, vehicle registrations had risen by approximately 15%, with road accident growth following closely. This rebound aligns with economic reopening, increased demand for personal transport (especially two-wheelers and private cars), and resumed intercity and freight movements. However, the near-parallel rise in accident rates indicates a lack of proportionate advancement in road safety measures, traffic enforcement, and infrastructure adaptation.

In a global context, many nations witnessed a similar V-shaped pattern in mobility and accident data post-COVID, though India’s rebound in accident rates appears steeper. This underscores the urgent need for policy recalibration—balancing vehicle ownership growth with enhanced investment in safer road environments, driver education, and intelligent traffic management systems.

6. Air Quality Index of India: Pre and post-COVID

The Air Quality Index (AQI) serves as a critical instrument for communicating air pollution levels to the public through health-related advisories. In 2014, India adopted a standardized AQI methodology and subsequently began issuing daily AQI bulletins in 2015. Air quality was assessed by calculating monthly and annual AQI averages to quantify variations linked to changing mobility patterns [4]. **Table 1** presents the monthly average AQI values across all reporting cities monitored by the Central Pollution Control Board (CPCB) of India [3].

The data reveal distinct seasonal patterns in air quality measurements. Overall, India’s air quality fluctuates primarily between “Moderate” and “Satisfactory”

Year	January	February	March	April	May	June	July	August	September	October	November	December
2016	252	190	149	162	139	118	84	72	82	152	225	234
2017	208	188	148	147	144	111	85	82	99	164	215	204
2018	209	177	159	141	143	126	77	79	87	157	202	211
2019	203	155	134	143	149	122	86	68	70	139	186	183
2020	157	145	98	85	93	77	61	53	78	147	179	180
2021	173	157	142	126	91	86	69	67	57	109	185	179
2022	155	138	144	141	122	106	61	65	70	111	164	174
2023	172	145	115	114	103	88	65	77	71	114	167	153

Table 1.
All India monthly average AQI (2016–2023) [4].

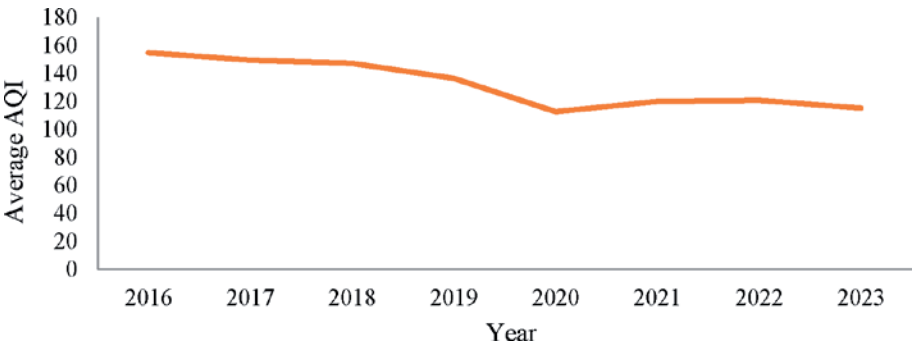


Figure 6.
Trend of average AQI of all India (2016–2023).

classifications. Winter months (December through February) consistently demonstrate poorer air quality compared to summer and monsoon months (June through September), which typically record more favorable conditions.

Figure 6 shows the trend of the average Air Quality Index (AQI) in India from 2016 to 2023. A gradual decline in AQI is observed from 2016 to 2019. A significant dip occurred in 2020, corresponding to the COVID pandemic period, when restrictions on transport and industry led to reduced emissions. Post-lockdown, a slight increase in average AQI is noticeable, although it remains lower than the pre-pandemic levels.

7. Fuel consumption in India

Before the COVID-19 pandemic, fuel consumption in India had been steadily rising, driven by increasing vehicle ownership, rapid urbanization, and economic growth. The road transport sector, being heavily reliant on fossil fuels, especially diesel and petrol, contributed significantly to the country’s total energy consumption and greenhouse gas emissions.

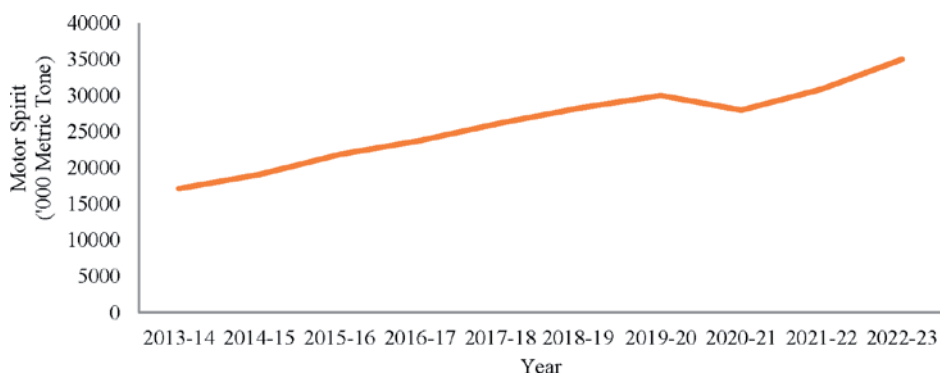


Figure 7.
Trend in consumption of motor spirit in India from 2013 to 2023.

Temporal data on motor spirit (petrol) consumption were collected from the Petroleum Planning & Analysis Cell of the Government of India [9]. **Figure 7** represents the trend consumption of motor spirit in India from 2013 to 2023. In India, “motor spirit” is a technical term for petrol or gasoline.

The graphical trend reveals several key inflection points. From 2013 to 2019, fuel consumption increased consistently, reflecting India’s growing dependence on motorized transport amid rapid urbanization and economic expansion. The most notable disruption occurred in 2020, when national lockdowns led to a sharp, unprecedented dip in fuel demand. This decline is directly correlated with reduced vehicular movement, industrial slowdowns, and restrictions on both intercity and intracity travel. Importantly, the fuel consumption downturn aligned temporally with significant improvements in national air quality indicators.

Post-pandemic years (2021–2023) demonstrate a clear V-shaped recovery in consumption patterns. As restrictions eased and economic activity resumed, fuel demand rebounded rapidly. By 2022–2023, motor spirit consumption not only recovered but exceeded pre-pandemic levels, indicating a persistent shift in mobility behavior. The continued preference for personal vehicles over public transport driven by health concerns, remote work adaptation, and last-mile delivery demand contributed to this rise.

The long-term implication of this trend is a potential reversal of the temporary environmental benefits gained during the pandemic. Without a structural shift toward clean energy alternatives, growing motor fuel consumption will likely exacerbate air pollution, carbon emissions, and energy security concerns. Hence, the graph underscores the urgent need for scalable policies promoting electric vehicles (EVs), enhanced public transport, and modal integration to mitigate the environmental impact of India’s transport sector.

8. Linking fuel consumption and air quality trends in India

The interplay between fuel consumption and ambient air quality, as measured by the Air Quality Index (AQI), offers a compelling lens into the environmental impact of transport activity in India. From 2017 to 2019, a consistent decrease in AQI (implying improved air quality) contrasts with a slight but steady rise in fuel consumption, suggesting that other factors such as industrial emissions and seasonal meteorology

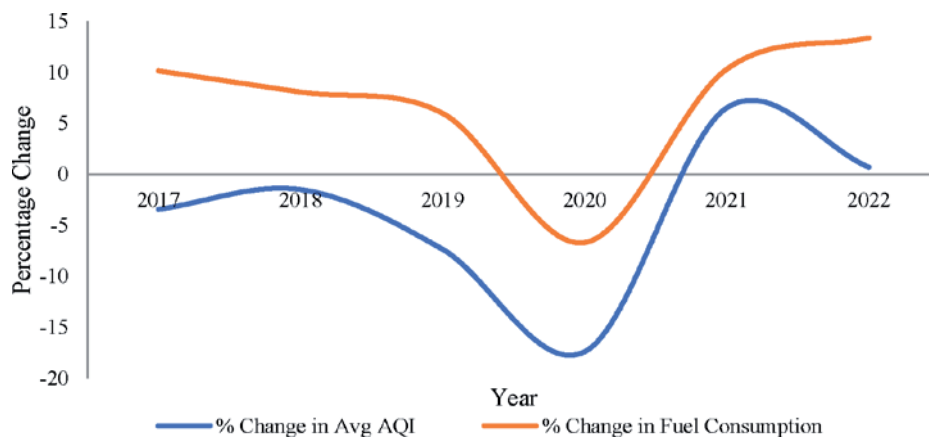


Figure 8.
Percentage change in India's average Air Quality Index (AQI) and fuel consumption from 2017 to 2022.

may have moderated transport related pollution gains. **Figure 8** illustrates the percentage change in India's average Air Quality Index (AQI) and fuel consumption from 2017 to 2022. The graph reveals an inverse relationship, with AQI improving and fuel use dropping significantly in 2020 due to COVID-19 lockdowns. The post-pandemic years (2021–2022) show fuel consumption rising again, accompanied by a partial deterioration in air quality [3, 9].

A clear inflection point occurred in 2020, coinciding with the COVID-19 lockdown. Both variables exhibit their most dramatic changes during this year: fuel consumption plummeted by nearly 20%, while AQI improved by a similar margin. The symmetry of these trends strongly indicates a causal relationship between reduced vehicular movement due to restricted mobility and a significant drop in petrol and diesel combustion emissions, improving air quality across urban centers.

Post-pandemic recovery is evident in 2021 and 2022. Fuel consumption rebounded rapidly, driven by increased private vehicle usage and freight movement. Correspondingly, AQI worsened, although it did not return to pre-pandemic levels, suggesting a partial but not full reversion in emission loads. Notably, the steeper rebound in fuel consumption relative to AQI deterioration may be attributed to improved fuel efficiency standards, continued use of non-motorized transport (e.g., bicycles), and adaptive policies promoting cleaner mobility in some regions.

The Indian trend parallels global patterns, where lockdowns led to temporary air quality improvements followed by gradual deterioration. However, India's post-COVID rebound in fuel use and its direct impact on AQI reaffirms the necessity for long-term emission reduction strategies—transitioning toward electric mobility, sustainable fuels, and mass transit systems to decouple transport growth from environmental degradation.

9. The change in the bicycle market of India

The bicycle market in India has historically been a crucial segment, catering to diverse demographics from daily commuters in rural areas to fitness enthusiasts in urban regions. However, the onset of the COVID-19 pandemic in early 2020 brought profound changes in consumer behavior, health consciousness, and urban mobility

preferences, significantly impacting this market. Production volumes and year-on-year growth data were sourced from the Annual Reports (2018–2023) published by the Department for Promotion of Industry and Internal Trade [5–7]. **Table 2** and **Figure 9** illustrate the trends in bicycle production in India.

Table 2 and **Figure 9** illustrate the annual bicycle production volumes in India from 2018 to 2023, highlighting both absolute production levels and year-on-year growth rates. The graph captures a pivotal shift triggered by the COVID-19 pandemic. While production declined slightly in 2019–2020, a sharp increase was observed in 2020–2021 and 2021–2022, corresponding to the peak pandemic years. This surge—almost 20% in 2020–2021—is indicative of changing consumer behavior marked by increased health consciousness, a preference for socially distanced personal mobility, and a rise in recreational cycling.

The continued growth in 2022–2023, though at a more moderate pace, suggests that this shift was not merely transitory. Instead, it points to the emergence of a sustained demand for bicycles, especially in urban and peri-urban areas. Factors such as supportive government schemes, expansion of cycling infrastructure, and increasing environmental awareness have contributed to the bicycle market’s resilience and evolution during and after the pandemic.

The data underscore the adaptability of the non-motorized transport (NMT) sector and its potential role in promoting sustainable mobility in India. The trends also reflect global parallels where cycling witnessed a resurgence during the pandemic, prompting several cities to institutionalize infrastructure for active transport modes.

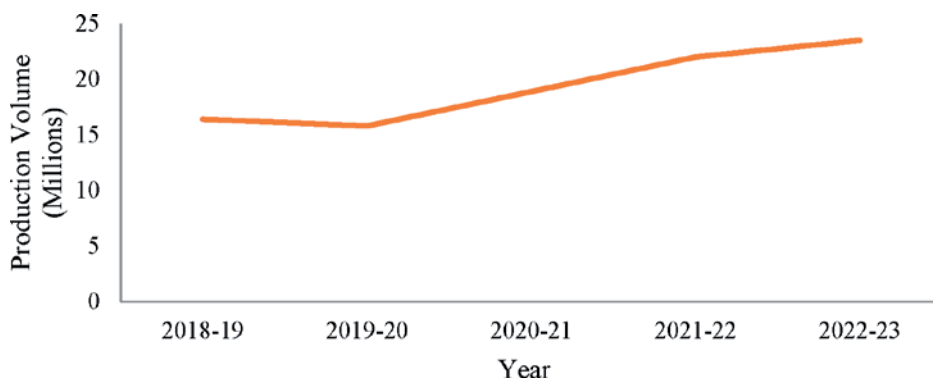


Figure 9.
Annual bicycle production volumes and year-on-year growth rates in India from 2018 to 2023.

Year	Production volume (millions)	Year-on-year growth (%)
2018–2019	16.4	4.50
2019–2020	15.8	–3.70
2020–2021	18.9	19.60
2021–2022	22	16.40
2022–2023	23.5	6.80

Table 2.
India bicycle production trends.

10. Road infrastructure

India possesses an extensive road network spanning approximately 6671 million kilometers, making it the second largest in the world. The distribution of road types is as follows [10]:

- National Highways (NH): 146,145 km
- State Highways (SH): 179,535 km
- Other Roads: 6,345,403 km

National Highways serve as the backbone of the country's transportation infrastructure. They play a pivotal role in fostering economic growth and social development by facilitating the efficient movement of freight and passengers and by enhancing connectivity to markets, industries, and remote regions. National highway construction and expansion data was obtained from Press Information Bureau releases and the Ministry of Road Transport and Highways' [10] "Basic Road Statistics of India" [8]. **Figures 10** and **11** depict the year-wise trend in the total length of National Highways and the annual length of National Highways constructed, respectively.

Figure 10 illustrates the cumulative expansion of India's National Highway (NH) network from year to year. The graph likely shows a steadily increasing trend, reflecting consistent investment in road infrastructure development. This growth underscores the government's strategic focus on enhancing connectivity, facilitating freight and passenger mobility, and supporting economic development across regions.

Figure 11, on the other hand, presents the annual length of National Highways constructed, which serves as a direct indicator of implementation pace. This graph is useful for identifying year-on-year fluctuations in construction activity. Notably, a dip during the COVID-19 pandemic years (2020–2021) likely reflects labor shortages, supply chain disruptions, and lockdown related delays. However, a recovery post-2021 demonstrates resilience in infrastructure delivery and the

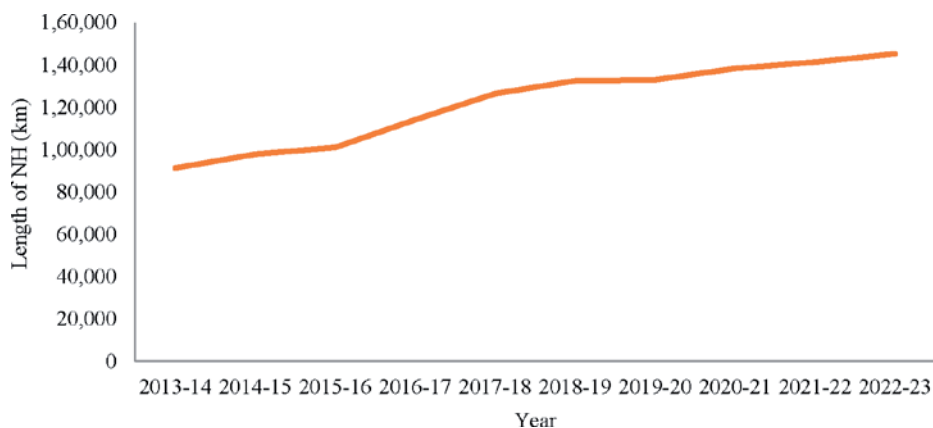


Figure 10.
 Cumulative length of National Highways (NH) in India over time.

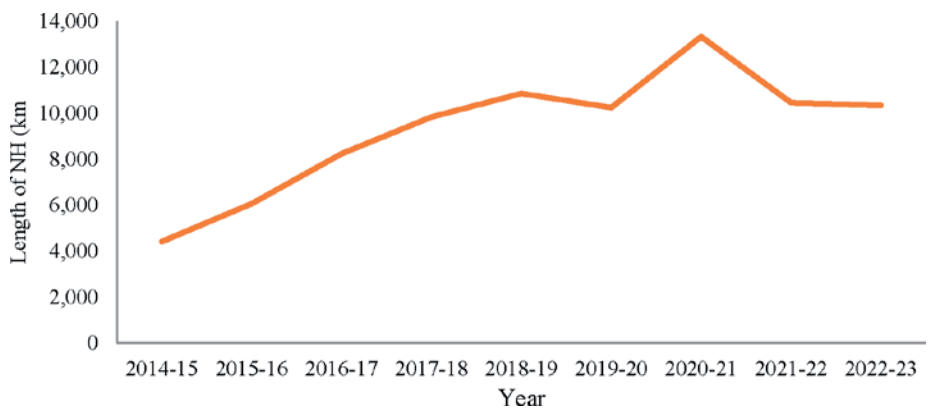


Figure 11.
Annual length of National Highways constructed in India from 2016 to 2023.

government's prioritization of transport infrastructure in the economic revival strategy.

Together, these figures offer a comprehensive view of both cumulative network expansion and yearly performance, providing critical context for analyzing mobility improvements and the broader role of infrastructure in shaping transport patterns.

11. Correlation analysis

Table 3 presents the correlation matrix for various parameters discussed in this study. As it can be observed, there is highly significant correlation (at the level of 0.05) between vehicle registration and annual average AQI levels (0.118). Additionally, bicycle production is highly significant for COVID/non-COVID period (0.012).

Further, at the significance level around 0.1, there was a significant drop in fuel consumption during COVID period, and on the other hand, there is a correlation between vehicle registrations and the number of accidents (sig. value 0.057).

12. Summary

This comprehensive analysis of India's transportation sector across pre-COVID (2016–2019), COVID (2020–2021), and post-COVID (2022–2023) periods reveals significant disruptions and subsequent transformations in mobility patterns, infrastructure utilization, and environmental impacts. The research findings demonstrate several key trends that collectively illustrate the pandemic's profound influence on transportation dynamics in India.

Vehicle registration data exhibit a clear V-shaped pattern, robust growth until 2018, followed by a sharp decline during 2020–2021 and a substantial recovery from 2022 onward. This pattern reflects the direct impact of pandemic-induced restrictions on mobility, economic activities, and consumer confidence. Similarly, road accident statistics demonstrate a parallel trend, with accident rates declining during lockdown periods and rebounding as mobility resumed, highlighting the strong correlation between traffic volumes and safety outcomes.

		Year	Vehicle_Registered	Accidents	AQI	Bicycle_Production	Fuel_Consumption	NH_Construction
Year	Pearson correlation	1	-.671	-.239	-.782	.954*	.801	.426
	Sig. (2-tailed)		.215	.699	.118	.012	.104	.475
	N	5	5	5	5	5	5	5
Vehicle_Registered	Pearson correlation	-.671	1	.868	.953*	-.636	-.095	-.521
	Sig. (2-tailed)	.215		.057	.012	.249	.879	.368
	N	5	5	5	5	5	5	5
Accidents	Pearson correlation	-.239	.868	1	.781	-.187	.383	-.277
	Sig. (2-tailed)	.699	.057		.119	.764	.525	.652
	N	5	5	5	5	5	5	5
AQI	Pearson correlation	-.782	.953*	.781	1	-.697	-.275	-.350
	Sig. (2-tailed)	.118	.012	.119		.191	.655	.564
	N	5	5	5	5	5	5	5
Bicycle_Production	Pearson correlation	.954*	-.636	-.187	-.697	1	.762	.439
	Sig. (2-tailed)	.012	.249	.764	.191		.134	.460
	N	5	5	5	5	5	5	5
Fuel_Consumption	Pearson correlation	.801	-.095	.383	-.275	.762	1	.190
	Sig. (2-tailed)	.104	.879	.525	.655	.134		.760
	N	5	5	5	5	5	5	5
NH_Construction	Pearson correlation	.426	-.521	-.277	-.350	.439	.190	1
	Sig. (2-tailed)	.475	.368	.652	.564	.460	.760	
	N	5	5	5	5	5	5	5

*Correlation is significant at the 0.05 level (2-tailed).

Table 3.
 Correlation matrix illustrating relationships between various transportation parameters analyzed in the study.

Air quality measurements revealed a notable improvement during the pandemic period, with the national Air Quality Index (AQI) showing its lowest values in 2020. This improvement directly corresponded with reduced fuel consumption, which plummeted by approximately 20% during peak lockdowns. The inverse relationship between these metrics underscores the significant environmental impact of transportation emissions on India's air quality.

The bicycle market emerged as a unique sector that experienced sustained growth during and after the pandemic. Production volumes surged by nearly 20% in 2020–2021 and continued to increase in subsequent years, albeit at a more moderate pace. This trend reflects a shift in consumer preferences toward healthier, more sustainable, and socially distanced transportation options, a change that appears to have endured beyond the immediate pandemic period.

Road infrastructure development, while temporarily slowed during 2020–2021 due to construction challenges, demonstrated resilience with recovery in national highway construction rates post-pandemic. This continued infrastructure expansion is likely to support the increasing vehicular population and changing mobility patterns in the coming years.

These findings collectively suggest that while many transportation parameters have returned to or exceeded pre-pandemic levels, certain changes, such as increased bicycle adoption and heightened awareness of transportation's environmental impacts, may represent lasting shifts in India's mobility landscape. The temporary improvements in air quality during lockdown periods provide valuable insights into the potential environmental benefits of reduced vehicle emissions, offering important considerations for future transportation policy and planning.

The study highlights the need for balanced approaches to transportation development that address the growing demand for mobility while incorporating lessons learned during the pandemic about environmental sustainability, alternative transportation modes, and the adaptability of transportation systems to external shocks. As India continues its post-pandemic recovery, these insights can inform more resilient, inclusive, and sustainable transportation strategies that better serve both human mobility needs and environmental goals.

The research contributes to the broader understanding of how major disruptions can reshape transportation systems and patterns, providing valuable lessons for transportation planners, policymakers, and researchers globally as they navigate the post-pandemic era and prepare for future challenges.

Author details

Mukti Advani*, Niraj Sharma and Ankit Pandey
CSIR—Central Road Research Institute, New Delhi, India

*Address all correspondence to: mukti7@gmail.com and mukti.crri@nic.in

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Post-COVID-19 Society and Profound Societal Shifts is a collective work that explores the multiple layers of social transformation left by the most disruptive pandemic of the 21st century. From a Global South perspective, the chapters gathered in this volume analyze the effects of COVID-19 not only as a health crisis but also as a syndemic—a convergence of disease, structural inequality, and institutional fragility. Featuring case studies primarily from Africa and other regions that have been historically marginalized in global discourse, the book offers a critical examination of the impacts of lockdowns, the erosion of community ties, and state responses to the emergency. The authors address urgent issues such as school dropout, food insecurity, gaps in vaccine access, the collapse of basic infrastructure, and the deterioration of mental health in rural and peri-urban communities. This book is a vital contribution for researchers studying the social consequences of the pandemic, as well as for policymakers, public health professionals, and community actors seeking to reimagine the future based on local experiences and collective resilience.

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