

Socioeconomic related Covid-19 outcome disparities in South African districts

Mini-dissertation presented for the degree of Master of Public Health (Health Economics) in  
the

Health Economics Division, School of Public Health and Family Medicine

University of Cape Town



Student number : TSHANZ006

Student name: Dr Anza Tshipetane

**Supervisor** : Dr Olufunke Alaba

The copyright of this thesis vests in the author. No quotation from it or information derived from it is to be published without full acknowledgement of the source. The thesis is to be used for private study or non-commercial research purposes only.

Published by the University of Cape Town (UCT) in terms of the non-exclusive license granted to UCT by the author.

## Plagiarism Declaration

I, Anza Tshipetane , hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

Student number	TSHANZ006
Student name	Dr Anza Tshipetane
Signature of Student	<input type="text" value="Signed by candidate"/>
Date:	4 <sup>th</sup> April 2024.

## Dedication

This dissertation is dedicated to the diligent students facing physical and learning disabilities, valiantly pursuing education despite these limitations. I have often said that a true lover of knowledge conquers enduring perpetual excruciating pain. I acknowledge the formidable challenges inherent in academic pursuits, particularly when compounded by other impediments.

My achievement of a dual degrees—MBCHB and this MPH—amidst the backdrop of a diagnosis of Attention Deficit Disorder and Chronic Myofascial Pain Syndrome was a labour of love for my education but also a story to be shared with students in similar circumstances. In a our current setting, where systemic structures often neglect the needs of neurodivergent students and students with visible and invisible physical disabilities, I want to advocate for concerted efforts towards fostering an inclusive and accessible educational landscape.

Lastly, It was excruciating to sit down and write this dissertation, and even more challenging to read all the academic material required for this research. I often relied on AI digital programs to convert text to audio. For this reason, I believe it is important for me to make this dissertation as inclusive as possible by providing it as an audio file for students who struggle to read long texts.

# Abstract

**Background:** This research tackled the crucial issue of socioeconomic inequalities in COVID-19 outcomes at the district level in South Africa. While previous literature has frequently relied on income as a measure of socioeconomic status, it's essential to recognize that socioeconomic standing is multifaceted and dynamic. In this study, we delved into these multidimensional factors shaping a population's SES, employing an intersectional approach that considers demographic, economic, and structural aspects of socioeconomic status. Our analysis aimed to understand how each of these dimensions, as well as their collective influence, impacts COVID-19 cases, recoveries, and deaths. The insights underline the need for targeted policy interventions that bolster support for vulnerable groups, enhance economic resilience through job creation and social grants, and improve public infrastructure to reduce overcrowding and ensure equitable access to basic utilities. The study advocates for an intersectional policy approach to address the multifaceted nature of health disparities effectively.

**Methods:** The study utilised data amalgamated by the National Policy Data Observatory (NPDO), which synthesizes information from the National COVID-19 outcomes surveillance spanning from November 2019 to July 2022 and socioeconomic indicator data from the 2021 General Household Survey (GHS). The study analysed 12 socioeconomic indicators across 53 districts to create four analytically backed domains of socioeconomic standing namely: sociodemographic index (average number of persons per household, proportion of female-headed households, and age dependency ratio and proportion of individuals over the age of 60), economic index (income, subsidised households, poverty and adult unemployment), infrastructural index (water, electricity, toilets and proportion of informal dwellings) and overall district socioeconomic index using the Principal Component Analysis technique. The relationship between these indices with COVID-19 cases, recoveries, and fatalities were further investigated using the Wagstaff concentration index of inequality and concentration curves.

**Results:** Using factor loadings attained from PCA, we grouped our variables into the 3 domains of socioeconomic standing, validating the intersectional framework conceptualised in the study. The analysis revealed that when districts were ranked by the sociodemographic index, COVID-19 outcomes showed a pro-poor distribution across cases, recoveries, and fatalities, with concentration indices of -0.27 (p=0.01), -0.27 (p=0.01), and -0.16 (p=0.08) respectively. Groups experiencing greater sociodemographic deprivation, including those in complex households such as households with the elderly and female-headed households, suffered severe outcomes. The results showed a similar pattern with the economic index, with concentration indices of -0.22 (p=0.04), -0.21 (p=0.04), and -0.16 (p=0.07) for cases, recoveries, and mortalities respectively. This aligns with empirical literature where unemployment and lack of income exacerbated poor outcomes.

The infrastructural index showed a pro-rich distribution with the concentration curve below the line of equality and concentration indices of +0.34 ( $p=0.0005$ ), +0.34 ( $p=0.0006$ ), and +0.30 ( $p=0.005$ ) for cases, recoveries, and mortalities respectively. This along with evidence of dense population in metropolitans such as city of Johannesburg, eThekweni and City of Cape Town suggests that urbanization and subsequent overcrowding in well-developed areas increased the risk of spreading infection and worsening COVID-19 outcomes, supporting the narrative of calling COVID-19 the urban disease.

Finally, the multidimensional SES index produced an overall pro-poor distribution with the concentration curve lying above the line of equality and concentration indices of -0.28 ( $p=0.01$ ), -0.27 ( $p=0.01$ ), and -0.20 ( $p=0.02$ ) for cases, recoveries, and mortalities respectively. Using the sociodemographic, economic, and infrastructural indices, the analysis provided a statistically significant description of inequality in cases and recoveries but not in mortalities.

**Conclusion:** The research provides compelling evidence of a 'social gradient' in health at the district level in South Africa. The results clearly demonstrate that poor socioeconomic status, as indicated by our broad multidimensional SES index, exacerbates negative health outcomes, with the main drivers being sociodemographic characteristics and economic deprivation. The study concludes that a combined approach—strengthening public health infrastructure, implementing housing reforms, and providing targeted economic support—can mitigate public health crises and reduce socioeconomic disparities. However, policy challenges such as resource allocation conflicts, stakeholder resistance, dependency on external support, and financial sustainability threaten effective implementation. Addressing these issues requires coordinated efforts, sustainable funding, and equitable distribution frameworks to ensure that reforms have lasting impact, particularly in underserved and rural areas. The study emphasizes the importance of adaptable policies and stakeholder engagement to overcome barriers and achieve long-term public health resilience.

## Acknowledgements

I begin by expressing my heartfelt gratitude to my God, YAWEH, whose abundant provision of knowledge and wisdom, as outlined in James 1:5, has guided me throughout this journey.

I extend my deepest appreciation to my family for their unwavering support and for cultivating an environment where I could flourish holistically. To my beloved mother, Vho-Gladys Lutanani Tshipetane, my father, Vho-Ntshavheni Steven Mainganye, my late grandmother Vho-Mutshekwa Nthangeni, my sisters, and Azwinndini Neluvhalani, Andani Tshipetane, and my cherished nephews, Khokha Neluvhalani and Mulondoli Neluvhalani, as well as my niece, Huande Tshipetane, your love and encouragement have been my anchor. I am also deeply grateful to my mentor, Dr. Mbilaelo Tshamiswe, whose inspiration and guidance have empowered me to carve out my own path as a woman in medicine. To each of you, I offer my profound gratitude for your contributions to my journey. Your influence has been immeasurable, and I am forever indebted to you all

I also extend my sincere appreciation to the David and Ellaine Potter Foundation for their generous financial support. Their belief in my passion for civil society and their investment in my academic pursuits have been instrumental in realizing my dreams.

Special thanks are also due to my supervisor, Dr. Olufunke Alaba, for her invaluable guidance and unwavering support, which have played a pivotal role in shaping both my mind and this research endeavor. I am also immensely grateful to the entire family at the Health Economics Unit at the University of Cape Town. It has been a joy to walk this journey alongside them. I must acknowledge Dr. Lucy Cunnama, the first health economist I encountered in the unit, and Prof. Edina Sinanovic, who introduced me to the subject area and ignited my passion for health economics.

Furthermore, I express my gratitude to Prof. Leslie Landon for providing me with the opportunity and accepting me to pursue an intercalated MPH alongside my MBCHB.

1	Table of Contents	
2	<b><i>Section A: Literature Review</i></b> .....	<b>13</b>
3	<b><i>Introduction</i></b> .....	<b>13</b>
4	<b><i>Background: COVID-19 pandemic and socioeconomic consequences</i></b> .....	<b>13</b>
5	<b><i>Theoretical literature review</i></b> .....	<b>14</b>
5.1	<b>Theory of the Social Determinants of Health (SDH)</b> .....	<b>14</b>
5.2	<b>Causal theories of health inequality</b> .....	<b>15</b>
5.2.1	Social causation .....	16
5.2.2	Life course theory .....	17
5.3	<b>Equity and (In)equality</b> .....	<b>17</b>
6	<b><i>Conceptual Framework</i></b> .....	<b>18</b>
6.1	<b>Intersectionality framework and social determinants of health</b> .....	<b>18</b>
6.2	<b>Conceptualising the intersectionality framework in quantitative health inequality studies</b> <b>20</b>	
7	<b><i>Empirical Review of COVID-19 Health Disparities</i></b> .....	<b>21</b>
7.1	<b>Introduction</b> .....	<b>21</b>
7.2	<b>Literature Search Strategy:</b> .....	<b>21</b>
7.3	<b>Inclusion and Exclusion Criteria</b> .....	<b>21</b>
7.4	<b>Preliminary findings</b> .....	<b>21</b>
7.4.1	Aggravation of Existing Inequalities: A Global Perspective.....	21
7.4.2	Social determinates of health and COVID-19 outcomes.....	22
7.5	<b>Assessment of Inequality Measures in COVID-19 Outcome Studies</b> .....	<b>22</b>
7.5.1	Concentration index as a measure on socioeconomic inequality in health.....	23
7.5.2	The use of other measures of socioeconomic inequality .....	25
7.6	<b>Research Gaps</b> .....	<b>26</b>
7.7	<b>Conclusion</b> .....	<b>27</b>
8	<b><i>Methodological Review</i></b> .....	<b>28</b>
8.1	<b>Measurements of socioeconomic status</b> .....	<b>28</b>
8.2	<b>Transitioning from Income to Asset/Wealth Indexes and Multidimensional Socioeconomic Indicators</b> .....	<b>28</b>
8.3	<b>Approach to Composite Socioeconomic measures</b> .....	<b>29</b>
8.3.1	“Arbitrary” approach .....	29
8.3.2	Multidimensional approach : PCA, CFA, MCA .....	29

<b>8.4</b>	<b>Constructing a Population-Level Socioeconomic Deprivation Index: Bridging the Gap in Health Inequality Research</b> .....	<b>30</b>
<b>8.5</b>	<b>Constructing socioeconomic index using principal component analysis</b> .....	<b>32</b>
<b>8.6</b>	<b>Methodological approaches for assessing equality</b> .....	<b>33</b>
8.6.1	The slope index (SII) .....	33
8.6.2	Relative Index of Inequality (RII) .....	34
8.6.3	Generalised Concentration index .....	34
<b>8.7</b>	<b>Limitations</b> .....	<b>34</b>
<b>8.8</b>	<b>Summary from inequality studies</b> .....	<b>36</b>
<b>9</b>	<b>References</b> .....	<b>38</b>
<b>10</b>	<b>Annexures</b> .....	<b>38</b>
<b>11</b>	<b>Section B: Journal Manuscript</b> .....	<b>46</b>
<b>1</b>	<b>Abstract</b> .....	<b>46</b>
<b>2</b>	<b>Introduction</b> .....	<b>47</b>
<b>3</b>	<b>Background</b> .....	<b>47</b>
<b>4</b>	<b>Theoretical Framework</b> .....	<b>48</b>
4.1	Theory of social determinants of health .....	48
4.2	Social causation .....	48
<b>5</b>	<b>Conceptual framework</b> .....	<b>49</b>
5.1	Sociodemographic factors .....	49
5.2	Economic Factors .....	49
5.3	Infrastructural factors .....	50
<b>6</b>	<b>Analytical method</b> .....	<b>57</b>
6.1	Data normalisation .....	57
6.2	Principal Component Analysis (PCA) notation .....	57
6.3	Derivation of Socioeconomic Status (SES) Indices Using Principal Component Analysis in Stata .....	58
6.4	Understanding the Variable-Specific Nature of Concentration Index Calculations ..	59
6.4.1	The standardised Concentration index .....	59
6.4.2	Modified concentration index .....	59
6.5	Computing Concentration Indices in Stata .....	60
<b>7</b>	<b>Results</b> .....	<b>60</b>
7.1	Validation of conceptual framework .....	62

7.2	<b>Sociodemographic index.....</b>	<b>64</b>
7.3	<b>Economic index.....</b>	<b>66</b>
7.4	<b>Infrastructural index .....</b>	<b>70</b>
7.5	<b>Multidimensional District level socioeconomic index .....</b>	<b>72</b>
<b>8</b>	<b><i>Discussion .....</i></b>	<b>75</b>
8.1	<b>Sociodemographic Index .....</b>	<b>75</b>
8.2	<b>Economic Index .....</b>	<b>76</b>
8.3	<b>Infrastructural Index.....</b>	<b>77</b>
8.4	<b>Multidimensional District-level Socioeconomic Status Index.....</b>	<b>79</b>
<b>9</b>	<b><i>Limitations and Future Research .....</i></b>	<b>79</b>
<b>10</b>	<b><i>Declaration of conflict of interest.....</i></b>	<b>80</b>
<b>11</b>	<b><i>Conclusion .....</i></b>	<b>80</b>
<b>12</b>	<b><i>Annexures 1 .....</i></b>	<b>81</b>
<b>13</b>	<b><i>References .....</i></b>	<b>82</b>
<b>14</b>	<b><i>Section C: Policy brief.....</i></b>	<b>90</b>
<b>15</b>	<b><i>Section D: Research Proposal .....</i></b>	<b>93</b>
<b>1</b>	<b><i>Background.....</i></b>	<b>94</b>
<b>2</b>	<b><i>Problem Statement and Rationale for Research .....</i></b>	<b>94</b>
<b>3</b>	<b><i>Literature review .....</i></b>	<b>95</b>
3.1	<b>Theoretical literature review.....</b>	<b>95</b>
3.1.1	Theory of the Social Determinants of Health (SDH).....	95
3.1.2	Causal Theories of Health Inequality .....	95
3.2	<b>Conceptual framework – Intersectionality.....</b>	<b>96</b>
3.3	<b>Empirical Literature Review .....</b>	<b>98</b>
<b>4</b>	<b><i>Aims and Objectives .....</i></b>	<b>99</b>
<b>5</b>	<b><i>Methodology.....</i></b>	<b>100</b>
5.1	<b>Data source.....</b>	<b>100</b>
5.2	<b>Study population.....</b>	<b>100</b>
5.3	<b>Study variables .....</b>	<b>100</b>
5.3.1	Exposure variables .....	100
5.3.2	Outcome Variables .....	101
5.4	<b>Data analysis plan .....</b>	<b>101</b>

5.4.1	Principal component analysis .....	102
5.4.2	Generalised Concentration index .....	103
5.4.3	Concentration curves .....	103
<b>6</b>	<b><i>Limitations</i></b> .....	<b>103</b>
<b>7</b>	<b><i>Ethical consideration</i></b> .....	<b>103</b>
<b>8</b>	<b><i>Conclusion</i></b> .....	<b>104</b>
<b>9</b>	<b><i>Time frame</i></b> .....	<b>104</b>
<b>10</b>	<b><i>References</i></b> .....	<b>104</b>
<b>11</b>	<b><i>Section E: Ethics Approval</i></b> .....	<b>108</b>
<b>12</b>	<b><i>Section F: Journal Instructions</i></b> .....	<b>110</b>
<b>13</b>	<b><i>Section G: Instructions on how to access the data and data analysis</i></b> .....	<b>118</b>

## List of Tables

### Section A: Literature review

Table 1: Summary of studies on inequalities in COVID-19 outcomes .....	43
--	----

### Section B: Journal Manuscript

Table 1: Description of infrastructural factors.....	53
Table 2: Description of economic factors.....	54
Table 3: Description of sociodemographic factors .....	55
Table 4: Descriptive statistics of independent variables.....	61
Table 5: Descriptive statistics of dependent variables .....	61
Table 6: Outcomes of the Principal Component Analysis on Sociodemographic Factors .....	64
Table 7: Table of Factor Loadings of each factor from Principal Component Analysis .....	64
Table 8: concentration index values sociodemographic index ranking.....	65
Table 9: Outcomes of the Principal Component Analysis on Economic Factors.....	66
Table 10: Table of Factor Loadings of each factor from Principal Component Analysis .....	67
Table 11: concentration index using economic index ranking .....	68
Table 12: Outcomes of the Principal Component Analysis on Infrastructural Factors .....	70
Table 13: Table of Factor Loadings of each factor from Principal Component Analysis .....	70
Table 14: concentration index using infrastructural index ranking .....	71
Table 15: PCA results for all domains of socioeconomic standing .....	72
Table 17: concentration index using district level socioeconomic status index ranking.....	74
Table 18: Index values by district.....	81

## List of figures

### Section A: Literature review

Figure 1: Intersectionality framework and social determinants of health .....	19
---	----

### Section B: Journal Manuscript

Figure 2: Intersectionality of socioeconomic factors .....	51
Figure 3: Distribution of COVID-19 outcomes by sociodemographic index quintile .....	65
Figure 4: Concentration curve sociodemographic index ranking.....	65
Figure 5: Distribution of COVID-19 outcomes by Economic Index quintiles.....	67
Figure 6: concentration curve using the economic index ranking.....	69
Figure 7: Distribution of COVID-19 outcomes by Infrastructural index quintiles .....	70
Figure 8: Concentration curve using infrastructural index ranking.....	71
Figure 9: Scree Plot from Principal Component Analysis of ALL SES Variables .....	72

Figure 10: Distribution of COVI-D-19 outcomes by multidimensional SES index  
quintiles ..... 74  
Figure 11: concentration curve using district level socioeconomic status index ranking ..... 74

**Abbreviations**

- CC** Concentration Curve
- CI** Concentration Index
- COVID-19** Coronavirus Pandemic
- GHS** General Household Survey
- NPDO** National Policy Data Observatory
- PCA** Principal Component Analysis
- RII** Relative Index of Inequality
- SES** Socioeconomic Status
- SSI** Slope index of inequality
- WHO** World Health Organisation

## **2 Section A: Literature Review**

### **3 Introduction**

The 2019 emergence of the coronavirus infection, known as COVID-19, posed unprecedented challenges to global healthcare systems, including that of South Africa, which experienced one of the highest infection rates in Africa. Contributing factors included prevalent poverty and restricted healthcare access (Khambule, 2021). This literature review adopts theoretical and conceptual frameworks to explore the socioeconomic disparities in COVID-19 outcomes within South Africa. Initially, the review will examine the theoretical framework illustrating the relationship between social inequality and health outcomes. Subsequently, it will consider the intersectionality framework, demonstrating the combined influence of multiple domains of socioeconomic factors on COVID-19 outcomes.

### **4 Background: COVID-19 pandemic and socioeconomic consequences**

The pandemic adversely affected the global economy, exacerbating existing inequalities and revealing vulnerabilities in healthcare systems and social protection policies. These effects were disproportionately felt by already disadvantaged populations including the unemployed, those in precarious employment, and residents of low-income neighbourhoods (Amin and Mahabeer, 2021; Khambule, 2022). These circumstances mirror the decline in labour demand observed globally, with the United States experiencing a significant reduction in job vacancies and subsequent employment losses exceeding those of previous recessions (Glover et al., 2020). The financial repercussions were profound, with many reporting COVID-19 as a primary cause for their financial difficulties, as indicated by the US Kilts Nielsen Consumer Panel (Bruce et al., 2022).

In response to the pandemic, South Africa implemented stringent lockdown measures, significantly curtailing economic activities and movement. The negative economic impact was profound, with Statistics South Africa reporting widespread business disruptions and intentions to reduce workforce (Chitiga et al., 2021). Additionally, the pandemic directly and indirectly impacted income, leading to a significant portion of the population experiencing a drop in earnings or complete loss of income (Rocha et al., 2021). Job losses were substantial, exacerbating the plight of the poor and vulnerable. The correlation between economic strain and health is undeniable. Income losses restrict access to healthcare, nutritious food, and essential utilities, adversely affecting health (Kim and Bostwick, 2020). This was evident during South Africa's lockdown, with a substantial increase in the percentage of adults going to bed hungry compared to pre-pandemic levels, as reported by the 2020 South African COVID-19 Democracy Survey (Cloete et al., 2021).

South Africa emerged as one of the epicentres of the COVID-19 pandemic on the African continent, recording the highest number of confirmed cases and deaths. By mid-2022, it accounted for a substantial proportion of the continent's total cases and fatalities. This

prominent position can be attributed to various factors despite having a relatively well-established healthcare system compared to many other African nations.

The rapid spread of the virus in Johannesburg and Cape Town can be attributed to dense population including overcrowded living conditions which significantly hindered effective social distancing measures (Cloete et al., 2021). These urban areas, characterized by high population density, created environments where individuals were often unable to maintain the recommended physical distance, facilitating the transmission of the virus.

Additionally, the widespread prevalence of comorbidities such as HIV/AIDS and tuberculosis, alongside non-communicable diseases, further complicated the public health response. The situation was exacerbated by economic hardships and rising unemployment rates due to the pandemic, which placed additional strain on already limited public health resources (Turok & Visagie, 2021). This combination of factors not only worsened health outcomes but also highlighted systemic vulnerabilities within the healthcare infrastructure, making it increasingly difficult to manage and mitigate the effects of the virus effectively.

These challenges underscore the critical need for comprehensive public health strategies that address both immediate health concerns and the broader socioeconomic factors contributing to health disparities.

Whilst the pre-existing burden of disease (including both communicable and non-communicable diseases) impacted the outcome of COVID-19, this work will focus only on socioeconomic factors as it is an area in health economics that needs to be further studied. The current literature will explore how pre-existing social disparities were exposed during the COVID-19 pandemic and examine their influence on the outcomes experienced by different socioeconomic groups affected by the virus.

## **5 Theoretical literature review**

The theoretical literature review for this study includes the Social Determinants of Health (SDH) theory, which explains how socioeconomic conditions influence health outcomes. Additionally, the review examines causal theories of health inequalities to further illustrate how socioeconomic factors contribute to and impact health disparities.

### **5.1 Theory of the Social Determinants of Health (SDH)**

The Social Determinants of Health (SDH) theory emphasises how social and economic factors, such as income, education, occupation, and housing conditions, influence health outcomes (World Health Organization(WHO), 2011). Social Determinants of Health are barriers to uniform healthcare access caused by unequal opportunities and resources, leading to disparities in health and disease (Arcaya et al., 2015). Moreover, it has been estimated that the impact of non-health sectors on population health outcomes surpasses that of the health

sector (shifa et.al, 2021). Effectively addressing social determinants of health (SDH) is a crucial step towards enhancing health outcomes and mitigating persistent health disparities. This necessitates collaborative efforts from all sectors and civil society (Arcaya et al., 2015; shifa et.al, 2021).

Understanding the relationship between social inequality and health outcomes may be facilitated by the use of the theory of social determinants of health (SDH). It is believed that the environments in which a person is born, develops, resides, works, and ages, as well as the circumstances surrounding their ageing, all have an impact on the health consequences they experience (Rossouw et al., 2020). These are defined as socio-economic factors such as income, education, neighbourhood, physical environment, job, social support networks, and access to medical treatment (Gordon et al., 2020). According to Ataguba et.al (2015), it is crucial to have a comprehensive understanding of the Social Determinants of Health, which requires taking into consideration both the material and psychological elements. Despite the fact that material factors such as wealth and education have a direct influence on health outcomes, psychological factors such as social networks and social support also play a key role in determining health outcomes (Ataguba et al., 2015). This is consistent with the findings of research by Omotoso & Koch (2018) who claim that poverty and inequality cause a social gradient in health outcomes, with the most marginalized and low-income people experiencing the worst health outcomes (Omotoso & Koch, 2018).

Poverty is one of the most important socioeconomic factors that has had a significant impact on the outcomes of COVID-19 in South Africa. According to the findings of a study by Kholwa and colleagues (2022), low income was a significant factor in the development of COVID-19 cases in South Africa. The results of the study indicate that there was a substantial correlation between the degrees of poverty, the presence of rural settlements, the amount of overcrowding in an area and the incidence of COVID-19 cases (Khowa et al., 2022). The authors' working hypotheses suggest that a greater number of cases of COVID-19 may be caused, at least in part, by poverty and the factors connected to it, such as malnutrition and subpar housing (Nwosu & Oyenubi, 2021). Another study found that the likelihood of passing away because of COVID-19 was demonstrated to increase with decreasing socioeconomic levels in South Africa (Achoki et al., 2021). People who come from lower socioeconomic categories have less access to medical care and other resources, which in turn raises the probability that they may die from COVID-19 (Ashraf, 2020). The findings of this study shed light on the significant role that socioeconomic factors had in determining the results of the COVID-19. These findings give ground to the current study using the theory of social determinants of health as its roots.

## **5.2 Causal theories of health inequality**

While health inequalities are widely recognised as a significant concern in public health, there is ongoing discussion surrounding the fundamental mechanisms that contribute to these disparities (Hoffmann et al., 2018). The discussion centres on the relative importance of

social causality and health selection in influencing health outcomes. Social causation theories, such as the fundamental cause and cumulative inequality theory, propose that health outcomes are significantly influenced by societal structures and factors (Galama & van Kippersluis, 2018). On the other hand, the social drift hypothesis or the health selection model posits that an individual's socioeconomic status can be influenced by their health conditions, resulting in a downward movement in socioeconomic standing for those experiencing poorer health (Warren, 2009). Moreover, the life course model presents a holistic perspective, positing that health outcomes are influenced by a complex interplay of various factors across an individual's lifespan (Warren, 2009). These frameworks provide unique perspectives for analysing and comprehending the complex interplay between society and health.

### **5.2.1 Social causation**

The theoretical framework known as "social causation" suggests that a range of factors, encompassing material, psycho-social, and behavioural elements, contribute to the observed variations in health outcomes among diverse groups (Hoffmann et al., 2018). Material considerations span a wide range of income levels and investments in infrastructure that confer benefits to the community. Psychosocial issues encompass the enduring pressures that arise from an individual's views and interactions with their social standing within a society marked by disparities (Chandola et al., 2003). This perspective highlights how social determinants of health can impact the outcomes of diseases, including conditions like COVID-19 (Hoffmann et al., 2018). There are 2 social causation theories that we discuss in this study are the fundamental cause theory and the cumulative disadvantage theory.

#### **5.2.1.1 Fundamental cause theory**

The theory of fundamental causes was developed to better explain the link between socioeconomic status (SES) and health and mortality rates. Race, ethnicity, and gender are examples of social statuses that go beyond financial status (Kollamparambil & Oyenubi, 2021). The authors further indicate that these statuses can also show enduring linkages with resources like wealth, education, authority, reputation, and favourable social networks, and may thus be underlying causes. In the unlikely event that this is not the case, race and ethnicity have a strong relationship with resources and are thus anticipated to behave similarly to SES in research that concentrate on the current state of health. This is not particularly difficult to infer in the South African context. According to COVID-19, those with higher SES may have easier access to medical treatment, information, and safety nets (Phelan & Link, 2020).

### **5.2.1.2 Cumulative disadvantage theory**

The Theory of Cumulative Disadvantage/Advantage (CDA) explains how disparities in a trait or resource like income or social status tend to widen over time within a group due to the compounding effects of social systems (Dannefer, 2003). It posits that even slight early-life differences can escalate, leading to a snowballing of advantages or disadvantages throughout an individual's life. Social determinants of health, such as access to nutritious food, healthcare, and basic amenities like clean water and housing, profoundly affect development from infancy to adulthood, influencing health outcomes across the lifespan (Gordon et al., 2020). These determinants can create a trajectory where initial disadvantages compound, resulting in significant disparities in health and well-being.

### **5.2.2 Life course theory**

Similar to the theory of Cumulative Disadvantage/Advantage, The life course perspective posits that multiple factors, including maternal malnutrition during foetal development, limited access to educational resources during childhood, and occupations involving physical hazards, among others, collectively contribute to and manifest the observed patterns of disease trends over a period of time. The socioeconomic approach seeks to integrate ecological, social, and biological aspects in the understanding of disease causation, recognising the dynamic process by which these factors become embodied (Dannefer, 2003). This suggests that individuals actively incorporate biological cues from both the material and social surroundings. Several biological pathways have been established in order to provide a clearer understanding of how the social environment influences an individual's health and becomes integrated throughout their body(Chandola et al., 2003).

### **5.3 Equity and (In)equality**

Health equity aims to ensure fair opportunities for all to reach their full health potential regardless of socio-demographic backgrounds, recognizing that socioeconomic status, race, ethnicity, gender, location, and disability impact health outcomes (WHO, Health Equity 2010). Achieving this requires targeted interventions to address social determinants and remove healthcare barriers (Culyer & Wagstaff, 1993), striving to eliminate disparities between different social strata (McIntyre et al., 2009; McIntyre & Mooney, 2007). Health inequality, reflecting the uneven distribution of health and healthcare across populations, is influenced by factors like income, education, occupation, and access to care (Williams & Cookson, 2000). Addressing these disparities, which can lead to poorer health metrics for marginalized groups, involves understanding their root causes and implementing strategic measures to reduce them (McIntyre et al., 2009).

## 6 Conceptual Framework

### 6.1 Intersectionality framework and social determinants of health

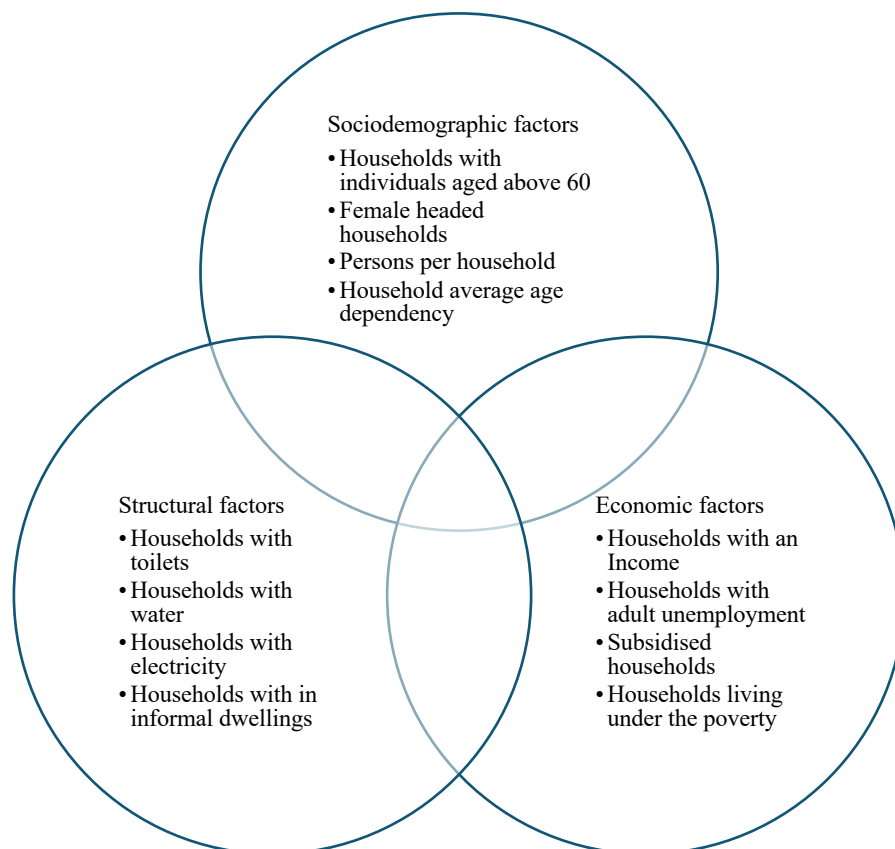
Intersectionality, a term coined by Kimberlé Crenshaw in 1989, emerged from Black feminist activism. It is a theoretical framework for understanding how aspects of a person's social and political identities combine to create different modes of discrimination and privilege. These identities include but are not limited to race, gender, class, and sexual identity, and are not isolated but interwoven in such a way that the intersections compound the experiences of oppression and privilege. This paradigm is particularly significant in recognizing that individuals navigate through life encountering varying degrees of advantage or marginalization. By examining the lived experiences of people belonging to multiple marginalized groups, intersectionality highlights the necessity of considering a multitude of overlapping factors—such as ethnicity, gender identity, socioeconomic status, language, skin color, neurodiversity, religion, (dis)ability, mental health, age, and others—that contribute to the complexity of these experiences. Recent studies continue to explore the nuances of intersectionality, reflecting its evolving nature and ongoing relevance in contemporary social research (Iyanda et al., 2021; Komanisi et al., 2022)

At an individual level, the framework might explore how each SES indicator influences an individual's risk of contracting COVID-19, experiencing severe symptoms, and potentially dying from the virus (Bambra et al., 2020). For example, individuals with lower income or education levels may be more likely to work in jobs that require them to interact with the public or may have limited access to healthcare, increasing their risk of exposure to the virus (Khambule, 2022). The framework would also explore how COVID-19 vulnerability and SES interact to impact outcomes. For example, individuals with lower SES may be less likely to have access to quality healthcare, making it more difficult to receive timely treatment for COVID-. Additionally, social determinants of health related to SES, such as stress and lack of access to healthy food options, may contribute to a weakened immune system, increasing vulnerability to COVID-19 (Gordon et al., 2020). Overall, the proposed framework would aim to identify the ways in which individual SES indicators and broader socio-economic factors interact to influence COVID-19 vulnerability and outcomes. This information could help inform interventions and policies aimed at reducing COVID-19 related inequalities in vulnerable populations.

In addition to individual SES indicators, the proposed framework could also consider contextual factors that may contribute to COVID-19 vulnerability and outcomes in South Africa. These factors could include geographic location, race, gender, and other social determinants of health that are relevant to the South African context (Fernandes, 2020). For example, individuals living in densely populated areas or informal settlements may be at higher risk of contracting COVID-19 due to difficulties with social distancing and limited access to basic amenities such as clean water and sanitation facilities. Additionally, systemic racism and historical inequalities in South Africa may contribute to differential access to

healthcare and other resources, further exacerbating COVID-19 related inequalities (Gordon et al., 2020). At the same time, the framework could also explore how individual and contextual factors may interact to influence COVID-19 outcomes (Chersich et al., 2020). For example, individuals from historically disadvantaged racial or ethnic groups may be more likely to work in essential jobs that put them at risk of exposure to the virus (Khambule, 2022). These individuals may also be more likely to experience co-morbidities such as diabetes or hypertension, which are known risk factors for severe COVID-19 outcomes. Overall, the proposed conceptual framework would aim to provide a comprehensive understanding of how individual and contextual factors interact to influence COVID-19 vulnerability and outcomes in South Africa. This understanding could help guide the development of targeted interventions and policies aimed at reducing COVID-19 related inequalities in the country.

*Figure 1: Intersectionality framework and social determinants of health*



## **6.2 Conceptualising the intersectionality framework in quantitative health inequality studies**

The use of the intersectionality framework, traditionally qualitative in nature, is central to understanding interactive and overlapping disadvantages within social studies (Crenshaw, 1989). In this context, this study aims to adapt and integrate this framework into a quantitative health inequality analysis. Although the framework is not inherently designed for quantification, it is employed here to conceptualize complex, interlocking social constructs that resist simple measurement. The study endeavours to go beyond theoretical exposition by using statistical analyses that are informed by both theoretical and empirical literature. This approach supports the framework and allows for an attempt to quantify the socioeconomic impacts on health—factors that are often considered intangible or difficult to measure (Bambra et al., 2020). By incorporating quantitative data into the intersectionality framework, the study bridges the qualitative-quantitative divide and advances the understanding of how socioeconomic status affects health outcomes in a multifaceted manner (Gkiouleka et al., 2018).

## **7 Empirical Review of COVID-19 Health Disparities**

### **7.1 Introduction**

In the wake of the COVID-19 pandemic, the world has witnessed not just a health crisis but a magnifier of existing socio-economic inequalities. This empirical literature review focuses on the complex socio-economic landscapes, to assess the application of various methodological approaches and results of studies analysing the health disparities in COVID-19 outcomes. The objective of this review to synthesize the findings of studies that looked at socioeconomic related covid-19 outcomes inequality

### **7.2 Literature Search Strategy:**

A comprehensive search was executed across several distinguished databases, including PubMed, Google Scholar, and ScienceDirect, chosen for their vast collections of medical and social science literature. The search utilized an array of keywords such as 'COVID-19,' 'socioeconomic health disparities,' 'income-related health outcomes,' as well as additional terms pertinent to social determinants of health and intersectionality. This expanded keyword strategy was crafted to encompass studies that discuss the multifaceted impact of the pandemic, capturing the nuances of health disparities across different populations.

### **7.3 Inclusion and Exclusion Criteria**

Studies selected for review met stringent inclusion criteria. We considered peer-reviewed articles published from 2019 to 2024 to ensure the data's relevancy and timeliness. Our global literature scope encompassed studies from various countries, providing a wide-ranging perspective. Exclusion criteria ruled out publications not in English and those published outside the defined time range, to maintain focus and clarity in data analysis. Data extraction from the chosen articles was meticulous, noting authors, publication year, research methods, and key findings. This diligent process ensured a thorough and robust synthesis of the data, allowing for comprehensive analysis and cross-study comparisons.

### **7.4 Preliminary findings**

#### **7.4.1 Aggravation of Existing Inequalities: A Global Perspective**

A critical examination of recent literature reveals a pronounced disparities in health outcomes as consequences socio-economic disparities amidst the COVID-19 pandemic. Research predominantly emanating from high income countries indicates that individuals with lower socio-economic status (SES) have encountered disproportionately greater risks of COVID-19 infection and mortality (Albani et al., 2022; Little et al., 2021; Marí-Dell'Olmo et al., 2021). An analysis was conducted on surveillance data that was submitted to the Swiss Federal Office. This analysis incorporated geocoded disease notifications and the associated Swiss neighbourhood index of socioeconomic position, which comprises socioeconomic status

variables such as household chief occupation, education, and crowding. The test positivity rate (aIRR = 0.75) was reduced among individuals who were tested in neighbourhoods with the highest SEP compared to those with the lowest SEP. Among those who have tested positive, the adjusted IRR was 0.68 for hospitalisation, 0.54 for ICU admission, and 0.86 for death. The associations between neighbourhood SEP and outcomes were also found to have heterogeneity between areas, highlighting the significance of neighbourhood clustering and the importance of looking at population level indicators (Riou et al.2021).

Similarly, COVID-19 incidence, stratified by age were high risk was associated with being over 65, sex where women were at a higher risk, geographical area and income categorised by quintiles were analysed. Results show that within the same urban areas in Spain, Barcelona, The risk ratio (RR) increased in the poorest groups compared to the richest ones with RR being 1.67 (Mari-Dell'Olmo et al.,2021). The pervasive nature of such disparities is not confined by geographic or cultural boundaries, illustrating a pattern of aggravated inequality that persists globally. The consistent manifestation of these issues across diverse socio-economic landscapes underpins the pandemic as a universally disruptive force, implicating the need for a cohesive response across all SES strata.

#### **7.4.2 Social determinates of health and COVID-19 outcomes**

The National Income Dynamics Study (NIDS) and its Coronavirus Rapid Mobile Survey (CRAM) in South Africa highlight the socioeconomic impacts of COVID-19. The studies reveal a chain reaction from job losses to reduced household income and increased hunger. The government's social grants and special COVID-19 relief have provided some relief (Turok & Visagie, 2021). Data from the NIDS-CRAM survey shows that the economic downturn has hit lower-income earners harder, exacerbating existing poverty and inequality cycles (Davillas & Jones, 2021). The informal economy's resilience to the pandemic has varied. Strict lockdown measures resulted in substantial job losses, especially in informal settlements and townships (Turok & Visagie, 2021). The unemployment rates across different residential areas widened significantly during the pandemic, with poorer neighbourhoods experiencing more severe impacts compared to suburbs. These findings emphasize the uneven economic landscape within South African cities and the increased vulnerability of lower-income communities during crises (Khambule, 2022). The pandemic has not only exposed existing disparities but has also intensified them, underscoring the need for targeted policies to support affected communities and promote equitable recovery.

#### **7.5 Assessment of Inequality Measures in COVID-19 Outcome Studies**

This segment examines research that has investigated inequality measures within the context of COVID-19 outcomes. Summarized in Table 1 are the synthesized findings from our literature review. Our analysis encompassed eight studies; seven of which applied the concentration index to assess disparities. One study conducted a comparative analysis using

the relative index of inequality alongside the simple slope index, while another study provided a comprehensive examination by evaluating all three indices.

### **7.5.1 Concentration index as a measure on socioeconomic inequality in health**

The Concentration Index (CI) has been widely extended beyond individual-level income inequality to assess disparities in health outcomes, serving as a critical measure in public health studies. In a notable application of this metric, a study in China used both the CI and the Corrected Concentration Index (CCI) to gauge income-related inequalities in mental health and self-reported health (SRH). Results indicated a CCI for SRH of  $-0.09$  ( $p < 0.01$ ), suggesting a disparity favouring the poor, and a CCI for mental health at  $0.04$  ( $p < 0.01$ ), indicating a bias toward the wealthy. A Wagstaff-type decomposition analysis pinpointed income as the primary driver of these inequalities, contributing to  $62.7\%$  ( $p < 0.01$ ) of the SRH disparities and  $39.0\%$  ( $p < 0.05$ ) of those in mental health. The study also identified significant factors associated with low income, such as inadequate food and medication supply, which explained  $1.7\%$  ( $p < 0.01$ ) and  $17.6\%$  ( $p < 0.01$ ) of the variations in self-reported health, respectively (Nie et al., 2021).

Little et al. (2021), on the other hand, examined the correlation between socioeconomic status (SES) and COVID-19-related clinical outcomes, such as hospitalisation and all-cause mortality, in relation to poverty level (defined as the proportion of residents in each ZIP code whose household income fell below the federal poverty threshold (FPT):  $0\%$  to  $20\%$  below FPT (low poverty); and  $>20\%$  below FPT (high poverty)). It was discovered that residing in a high-poverty area was associated with a reduced risk of in-hospital mortality but not an increased risk of hospitalisation related to COVID-19.

It is noteworthy that an analysis of the National Survey of Households—PNAD COVID-19/IBGE was conducted in Brazil amidst the initial phase of the COVID-19 pandemic. A positive concentration index is observed for the incidence rate, suggesting that higher income groups exhibit a larger density of diagnoses (measured by the number of tests). In addition to lying below the line of inequality, the concentration curve for per capita household income was dominant over the Lorenz curve, both of which indicated a distribution that favoured the wealthy. Nevertheless, the outcomes of the decomposition indicate that if the disparities were solely accounted for by race (non-white) and residential location (North and Northeast), a clustering of COVID-19 would occur among the most impoverished individuals. An additional clarification regarding the peculiarity of the results was that  $57.42\%$  of the sample was comprised of the two wealthiest regions in the country, South and Southeast. Considering the testing aspect of the research, the exorbitant cost of the tests hinders participation, thereby posing a challenge in diagnosing the disease among the most susceptible individuals. This perspective underscores the significance of socioeconomic status in the evaluation of disparities in COVID-19 outcomes (Franca et al., 2021).

Shahbazi and Khazaei (2020) conducted an analysis of the human development index (HDI), along with the incidence and mortality rates of COVID-19 on a global scale, utilising data obtained from the world bank. Linear regression was employed to examine the associations between incidence, mortality rates, and HDI parameters. The results indicated a statistically significant direct correlation between the incidence and mortality rates of COVID-19 and HDI on a global scale. Positive concentration indices were calculated by the authors for the incidence rate (0.62) and mortality rate (0.69) of COVID-19, indicating that groups with a high HDI had a greater concentration of the rates. The concomitant concentration curve was situated below the line of equality, indicating a pro-rich distribution. Irrespective of the results, the authors additionally assert that the elevated incidence rate in nations with a higher HDI may be ascribed to the efficient healthcare systems and extensive utilisation of screening programmes that aim to diagnose the disease in these countries. Such programmes are designed to identify asymptomatic and subclinical manifestations of the disease. In countries with a low HDI, inadequate access to diagnostic devices results in a low infection incidence value. Nevertheless, substandard disease registration and reporting systems prevail in low-income nations, resulting in inadequate disease reporting (Shahbazi & Khazaei, 2020).

In the context of South Africa, a study conducted by Shifa et al. (2022) focuses on Socio-Economic Status (SES) driven Covid-19 vulnerability in South Africa. The findings, marked by negative and highly significant concentration index estimates, reveal that the vulnerability to Covid-19 is more pronounced among the poorer sections of society. This study underscores the disproportionate impact of the pandemic on different economic strata within the country. The relationship between socio-economic status (SES) and the effectiveness of non-pharmaceutical interventions (NPIs) in controlling the spread of COVID-19 is a critical area of research. Studies show that lower SES is a barrier to implementing NPIs like social distancing, isolation, and handwashing, essential before vaccines were widely available. Shifa et al. (2022) point out that lack of basic amenities and inadequate housing significantly hinder these health measures. Papageorge et al. (2021) found that in the U.S., individuals with lower incomes and limited remote work opportunities were less likely to practice social distancing. This trend is also seen in South Africa, where preventive measures are more common among the wealthy and educated. Kollamparambil & Oyenubi (2021) explain this using the Health Belief Model, which suggests that personal beliefs and perceived efficacy of actions influence health-related behaviors. The model indicates that the affluent were more likely to adopt protective measures. This study by Kollamparambil & Oyenubi (2021), which utilizes data from the first and second waves of South Africa's National Income Dynamics Study (NIDS)—Coronavirus Rapid Mobile Survey (CRAM). This research highlights an evolving trend in preventive behaviours against Covid-19 and their relationship to socioeconomic status. There is increased risk perception with significant concentration among the higher income groups (concentration index of 0.23 in wave 1 and concentration index of 0.24 in wave 2,  $p > 0.01$ ), the educated (concentration index of 0.13 in wave 1 and concentration index of 0.15 in wave 2,  $p > 0.01$ ) and older respondents (concentration index of 0.07 in wave 1 and concentration index of 0.103 in wave 2,  $p > 0.01$ ). Further citing that behavioural practices and ultimately the prevention on negative outcomes was associated with

preventative practices such as social distancing, avoiding close contact, steering clear of large groups, and staying at home (Kollamparambil & Oyenubi, 2021).

Lastly, a study by Nwosu & Oyenubi (2021) delves into income-related health inequalities associated with the coronavirus pandemic in South Africa. By comparing data from the fifth wave of the NIDS dataset (2017) and the first wave of the NIDS-CRAM dataset (2020), the study estimates health inequalities before and during the pandemic. The use of household per capita income as a ranking variable reveals that poor health was more prevalent among the poorer populations in both the pre-COVID-19 and COVID-19 periods, as indicated by both the 2017 NIDS data (concentration index of -0.022) and the 2020 NIDS-CRAM data (concentration index of -0.123), as indicated by the concentration curves above the line of equality. A further decomposition analysis points out that worse health outcomes were concentrated among females, Africans, informal dwellers, those with chronic illnesses, and households experiencing hunger (Nwosu & Oyenubi, 2021).

### **7.5.2 The use of other measures of socioeconomic inequality**

Socioeconomic inequality in in-hospital mortality was evaluated using three methods in an Iranian study. The relative index of inequality (RII) is utilised to quantify relative inequality, while the slope index of inequality (SII) and the concentration index (CI) are employed to assess absolute inequality. According to Mehdi Zadeh et al. (2023), when education level was utilised as a ranking variable, the distribution of COVID-19-related fatalities was greater in the lower education levels, as indicated by all inequality indices. The findings of an additional Belgian study that employed both the SII (Slope Index of Inequality) and the RII (Relative Index of Inequality) revealed a substantial inverse relationship between income and excess mortality, with the highest incidence of fatalities occurring in the lowest income decile. These findings corroborate the notion that COVID-19 consequences are more prevalent in households with reduced socioeconomic status (Decoster et al., 2021). These observations underscore the inherent connection between socioeconomic status and health results, and the current pandemic has exacerbated this rift. There is an urgent need for strategies that address the underlying socioeconomic determinants that predispose certain populations to greater risk as well as the acute health needs, according to the evidence.

## **7.6 Synthesis**

The COVID-19 pandemic has highlighted significant disparities in health outcomes, largely influenced by socioeconomic factors and systemic inequalities. Several studies have employed different inequality measures to analyse the effects of socioeconomic status (SES) on health outcomes during the pandemic, but limitations persist in capturing the full scope of these disparities. For instance, concentration indices are frequently used to quantify SES-related health inequalities; however, they often fail to account for intersectional factors, such as race, gender, and geographic location, which compound health vulnerabilities (Shahbazi &

Khazaei, 2020; Nie et al., 2021). Studies conducted in South Africa demonstrated that conventional SES measures, while useful, might overlook specific community-level determinants that exacerbate COVID-19 vulnerability in low-income areas (Kollamparambil & Oyenubi, 2021; Shifa et al., 2022). A growing body of research suggests that multidimensional approaches incorporating both absolute and relative measures of inequality could offer a more nuanced understanding of these health disparities (Mehdizadeh et al., 2023; Decoster et al., 2021). This review identifies a critical gap in current SES measurements and emphasizes the need for frameworks that can adequately capture the intersectional dimensions of inequality exacerbated by the pandemic.

## **7.7 Research Gaps**

While the current body of literature on the socio-economic impacts of the COVID-19 pandemic is comprehensive, it has not sufficiently addressed the intersection of pandemic impacts with systemic inequalities on a macro-scale. This research specifically aims to fill that gap by employing a population-level analysis with a focus on systemic and structural inequities.

There is a distinct necessity for interdisciplinary approaches to unpack the complex and interwoven socio-economic effects of the pandemic. This research contributes to that need by integrating methods and insights from public health, economics, and sociology to offer a multi-dimensional view of COVID-19's repercussions. Such a vantage is indispensable for identifying overarching trends and formulating inclusive policy interventions.

A key gap in current studies is the dominance of household-level analysis over population-level scrutiny. Our research addresses this by analysing the broader systemic effects of the pandemic, such as shifts in employment, public health outcomes, socio-economic disparities, and national economic health. This macroscopic perspective is vital for policymakers, providing the aggregate data necessary for comprehensive strategy development and resource distribution (Khambule, 2022).

In addition to broadening the scale of analysis, this research focuses on unveiling the differential impacts of COVID-19 across various socio-economic groups. By highlighting how systemic issues and structural inequalities have been impacted by the pandemic, it aims to inform targeted interventions to support the most affected communities. Through comparative analysis, it also extends insights on a global scale, considering the pandemic's effects across different regions and nations.

This research thereby not only identifies but also begins to address these critical gaps, offering a foundation for future studies and policy considerations that prioritize equity and the well-being of all socio-economic strata during pandemic recovery efforts.

## **7.8 Conclusion**

In conclusion, a focus on specific areas like income inequality and health disparities, the incorporation of qualitative methodologies, and interdisciplinary approaches will significantly advance the understanding of the socio-economic impacts of the COVID-19 pandemic. This enhanced knowledge is essential for informing effective policy and intervention strategies to mitigate the long-term effects of the pandemic.

## **8 Methodological Review**

This methodological review encompasses 2 sections:

1. Methods Assessment of socioeconomic status using various deprivation indices
2. Methods in the assessment of inequality

### **8.1 Measurements of socioeconomic status**

In this section we analyse the different methods that researchers used to measure socioeconomic status in inequality studies. Our analysis included 15 studies. 5 studies used the deprivation index, 4 used the SES index, 4 used Wealth index/ asset index and 2 used the multidimensional poverty index as indicated in table XXX in the appendix. Methodologies employed included Principal component analysis (PCA), Confirmatory Factor Analysis (CFA) and Multiple Correspondence Analysis (MCA),

### **8.2 Transitioning from Income to Asset/Wealth Indexes and Multidimensional Socioeconomic Indicators**

Before we can quantify socioeconomic status, we must quantify health disparities associated with socioeconomic status. Social class (SES) is commonly assessed through various metrics including income, education, occupation, amenity ownership, and other measures of social welfare. Income is the most direct indicator of socioeconomic status; nevertheless, income data is not readily accessible. Furthermore, a recurring issue in health research and policy interventions is the apprehension that socioeconomic status (SES) may have a differential effect on health service utilisation or health outcomes (Deaton, 2003; Schellenberg et al., 2003). Thus, information regarding the degree to which households differ by socioeconomic status and how this relates to relevant variables is crucial for addressing issues such as how to target the impoverished. Standard economic indicators of socioeconomic status (SES) rely on monetary data, including income and consumption expenditure. Nevertheless, obtaining precise income data is a challenging undertaking (Montgomery et al. 2000), necessitating substantial resources for household surveys. For instance, household and individual income from multiple sources must be accounted for in the calculations of allowances. Furthermore, the application of income indicators can be challenging in certain circumstances (Cortinovis et al., 1993). For instance, income data fails to account for the possibility that individuals (particularly the impoverished) possess value-added income in the form of traded crops. Assessing income for the self-employed or those temporarily employed in occupations such as agriculture is challenging due to accounting complexities and seasonal variations (McKenzie, 2010).

In light of these concerns, scholars have begun to employ data on household assets and other attributes in order to develop alternative indicators of living standards or welfare, such as the

socioeconomic index (Bollen et al. 2001; Filmer and Pritchett 2001; Montgomery et al. 2000; Sahn and Stifel 2000).

### **8.3 Approach to Composite Socioeconomic measures**

A socioeconomic index is a comprehensive metric that combines multiple socioeconomic status (SES) indicators to provide a succinct evaluation of the social and economic standing of an individual or household.

There exist three fundamental methodologies for constructing composite utility and socioeconomic indices, each characterised by a distinct weighting of distinct household assets and characteristics within the overarching index.

#### **8.3.1 “Arbitrary” approach**

Some studies have used what may be referred to as “naive” indices to proxy or control for. Certain research studies have employed so-called "naive" indices to serve as controls or proxies for living standards. These indices are frequently constructed using the sum of indicator or dummy variables that represent the possession of specific assets by a household (Case et al., 2004; Montgomery et al., 2000; Morris et al., 2000). One instance of a "convenient proxy" utilised in the context of the new core welfare indicator questionnaire (CWIQ) surveys is a straightforward "asset score," which is derived by allocating equivalent weights to all ten assets.

#### **8.3.2 Multidimensional approach : PCA, CFA, MCA**

As an alternative to calculating the weights of the index using a basic sum of asset variables contained in the data, statistical techniques can be utilised. Primarily, this is achieved through the utilisation of principal component analysis and factor analysis. In essence, they serve as instruments to condense the variability present in a collection of variables (Vyas & Kumaranayake, 2006).

A burgeoning debate concerning the optimal methods for assessing socioeconomic status (SES) is underway, particularly relevant to health disparity research. Multifaceted statistical approaches such as Principal Components Analysis (PCA) used by 10 studies, Confirmatory Factor Analysis used by 2 studies, and Multiple Correspondence Analysis (MCA), used by 2 studies, are gaining traction over the traditional singular measure of income (Howe et al., 2008). In affluent nations, household income is a reliable SES proxy; conversely, in lower-income regions, income reporting is notoriously inaccurate, prompting the call for more robust SES indicators suitable for rural areas in low- and middle-income countries (LMICs) (Patel et al., 2020). PCA has emerged as a favoured method for asset-based household socioeconomic position (SEP) evaluation (Howe et al., 2008). Its advocates argue that PCA

provides a logical framework for condensing asset data into a single, more meaningful SEP measure pertinent to health-related studies, leveraging data that is either readily accessible or straightforward to collect.

The utility of PCA extends to formulating composite index measures, offering a more comprehensive SES snapshot that encompasses the dynamic nature of asset ownership and living conditions over time (Vyas & Kumaranayake, 2006). Unlike unidimensional income measures that inequitably equate diverse assets, PCA incorporates non-quantifiable wealth indicators like land and livestock—crucial in rural settings. By integrating global SES dimensions such as education, occupation, housing quality, and available amenities, PCA assigns a weighted significance to each, thus presenting a more accurate SES portrayal (Vyas & Kumaranayake, 2006). Particularly in LMICs, household assets are considered more indicative of sustained wealth than income or expenditure data, which are subject to fluctuations and reporting inaccuracies (Kabudula et al., 2016).

#### **8.4 Constructing a Population-Level Socioeconomic Deprivation Index: Bridging the Gap in Health Inequality Research**

While numerous studies have developed comprehensive SES indices at the household level, there remains a notable paucity of research constructing similar indices to measure deprivation on a population level. These household-based SES indices, as detailed in studies such as Ataguba et al. (2011) and Patel et al. (2020), effectively capture socioeconomic position by integrating income with various household attributes. However, they do not extend to the broader social and economic factors influencing population-level health inequalities.

This research diverges from the traditional household-level SES composite indices, which often focus on asset ownership and household characteristics. Instead, it endeavours to create a deprivation index that reflects the wider socioeconomic environment affecting population health. By moving beyond the microcosm of household assets and conditions, this index seeks to incorporate broader indicators such as employment rates, educational levels, access to healthcare, and urban-rural divides that are more reflective of population-wide socioeconomic status.

The gap in the literature for such a comprehensive, population-level SES index is significant, especially in light of the COVID-19 pandemic, which has highlighted and often exacerbated existing socioeconomic inequalities. Our research responds to this gap by developing an index that is sensitive to the nuances of population-level socioeconomic deprivation, providing a tool that can be instrumental in formulating public health policies and socio-economic interventions aimed at mitigating inequalities on a larger scale.

In our review, studies done on population variables use an index referred by many authors as the small area deprivation index or deprivation index one study that referred to a population SES index specified that it was a neighbourhood level SES index (De Silva et al., 2022). In most literature, a small-area deprivation index differs from a socioeconomic status (SES) index in several key ways, particularly in terms of the scale of analysis. Small Area Deprivation Index- SADI is specifically designed to capture socioeconomic conditions at a local or neighbourhood level. It aggregates data related to various deprivation factors for small geographic areas to highlight disparities within cities or regions. An SES index on the other hand typically measures the social and economic position of individuals or households. (Havard et al., 2008; Lamnisos et al., 2019; McIntyre, 2002; Strömberg et al., 2021)

The suite of studies provided in table 2 collectively underscores the utility of the deprivation index as an instrument for quantifying socioeconomic inequalities at a granular, small-area level, with implications for public health surveillance and policy. These studies share a common methodological thread in their use of Principal Component Analysis (PCA) (Havard et al., 2008; Lamnisos et al., 2019; McIntyre, 2002) and, in some instances, Confirmatory Factor Analysis (CFA) (Strömberg et al., 2021), to construct or validate their indices. The deprivation index is employed across various national contexts—from France (Havard et al., 2008) to South Africa (McIntyre, 2002)—to capture the multifaceted nature of deprivation, which encompasses dimensions such as income, employment, education, and living standards (Havard et al., 2008). In Cyprus, the linkage of the deprivation index with premature mortality explicitly acknowledges the critical influence of socioeconomic context on health outcomes, highlighting areas where policy interventions may be most needed (Lamnisos et al., 2019).

In the study creating small-area deprivation indices, the application of both PCA and CFA suggests a comprehensive approach to ensure the robustness of the index, by not only identifying the main components of deprivation but also confirming their validity (Lamnisos et al., 2019). Meanwhile, the Swedish study's comparative approach to deprivation indicators reflects an investigative rigor aimed at enhancing the precision of public health surveillance tools (Strömberg et al., 2021). The utility of a small-area deprivation index, as evidenced by these studies, lies in its ability to reflect the local variances in socioeconomic conditions that broader measures may obscure. This local specificity is what differentiates a small-area deprivation index from a general socioeconomic status (SES) index as used by Patel et al., 2020 and Vyas & Kumaranayake, 2006. While SES indices often assess individual or household-level attributes, small-area deprivation indices synthesize data at a community or neighbourhood level, providing insights into the collective socioeconomic environment. This distinction is crucial, as local area deprivation can exert distinct influences on health and well-being, independent of individual SES measures (Strömberg et al., 2021). Furthermore, the small-area approach allows for the identification of spatial patterns of inequality, enabling targeted interventions at the community level. It can reveal pockets of deprivation that may be hidden within broader regional analyses, thereby informing more

nanced and effective public health strategies and resource allocations(Strömberg et al., 2021).

### **8.5 Constructing socioeconomic index using principal component analysis**

Principal Component Analysis (PCA) is often used to make a Socioeconomic Status (SES) index because it can use statistics to find latent factors or dimensions that explain the differences seen in a set of socioeconomic indicators. The use of Principal Component Analysis (PCA) enables the derivation of weights for each indicator, which are determined by their respective contributions to the overall variability in socioeconomic status. In the case of principal component analysis, the asset index,  $A_i$ , for individual  $i$  is defined as follows:

$$A_i = \sum_k \left[ f_k \frac{(a_{ik} - \bar{a}_k)}{s_k} \right],$$

where  $a_{ik}$  is the value of asset  $k$  for household  $i$ ,  $\bar{a}_k$  is the sample mean,  $s_k$  is the sample standard deviation, and  $f_k$  are the weights associated with the first principal component (Vyas & Kumaranayake, 2006). In the same manner, a population level composite socioeconomic index can be computed.

## **8.6 Methodological approaches for assessing equality**

In the evaluation of health inequalities, particularly those linked to socio-economic status, methodological precision is paramount. Indices like the Slope Index of Inequality (SII) and the Relative Index of Inequality (RII), along with the Generalised Concentration Index (GCI), serve as fundamental tools in this analysis. These metrics do more than quantify disparities; they illuminate the gradient of health outcomes across social strata, offering insights into the magnitude and direction of inequalities (*World Health Organization 2013*). The application of these indices allows for a comprehensive assessment of health disparities, capturing both absolute and relative differences within populations. This introduction outlines the methodologies behind these indices and sets the stage for discussing their application in understanding the socio-economic disparities revealed in the wake of the COVID-19 pandemic.

### **8.6.1 The slope index (SII)**

Utilising a statistical measure known as the slope index of inequality, one can illustrate the variation in health outcomes between naturally ordered subgroups, such as those based on affluence or education. The slope index of inequality (SII) measures the discrepancy between individuals with the highest and lowest levels of education or affluence in predicted health indicator values. By utilising an appropriate regression model, this metric addresses the complete dispersion of wealth or education. To calculate the slope index of inequality, weights are assigned to a representative sample of the entire population and the sample is subsequently ranked; the least privileged subgroup is assigned the rank of zero, while the most privileged subgroup is assigned the rank of one. In order to account for the proportional distribution of the population within each subgroup, the ranking is weighted. Following this, an analysis is conducted on the population of each wealth or education category in relation to its position in the cumulative population distribution, with the range and midpoint of this distribution taken into consideration. The independent variable in regression analysis is the midpoint value for the subgroups of wealth or education, which is then applied to the health indicator of interest. To estimate the predicted values of the health indicator for the two extremes, rank 1 and rank 0, a suitable statistical model is implemented. The slope index of inequality values is calculated by examining the discrepancy between the predicted values at ranks and zero, a region that represents the distribution in its entirety. The slope index of inequality (SII), which takes into consideration the existence of other subgroups, measures the discrepancy between the lowest and highest categories in a regression model. In the case of a horizontal regression line slope, the slope index of inequality is zero. When ranking subgroups according to their level of advantage, it is noted that higher prevalence of the health indicator of interest is indicated by positive values in the most disadvantaged subgroup. On the contrary, negative values signify an increased occurrence of the indicator within the subgroup that is most disadvantaged. The significance of the slope index of inequality (SII) is unambiguous and readily comprehensible, and it operates using the

identical unit of measurement as the health indicator. Due to this attribute, it becomes exceedingly beneficial and applicable in a multitude of analytical contexts. Non-technical audiences can approximate the disparity in a particular health measure between the most disadvantaged and most advantaged population groups using the slope index. Nevertheless, these individuals might have a rudimentary understanding of the calculation methodology or the reasoning behind its superiority in comparison to a fundamental distinction (World Health Organisation, 2013).

### **8.6.2 Relative Index of Inequality (RII)**

For health outcome indicators, the relative index of inequality (RII) is a complex weighted measure of inequality that conveys the ratio of estimated values of a health indicator from the most privileged to the least privileged, or vice versa. Nevertheless, it incorporates all the remaining subgroups by employing an OLS regression model. The relative index of inequality exclusively accepts positive values; the absence of inequality is indicated by a RII value of 1. One such example that we focus on in this study is the generalised concentration index (World Health Organization 2013).

### **8.6.3 Generalised Concentration index**

The concentration index has emerged as the prevailing metric for assessing income-related disparities within the field of health economics (Wagstaff & van Doorslaer in 2000). The presence of a concentration index with a value of zero signifies the absence of socioeconomic inequalities. Conversely, a negative value indicates an uneven distribution of socioeconomic inequalities among individuals with lower socioeconomic status, while a positive value signifies the concentration of socioeconomic inequalities among individuals with higher socioeconomic status (World Health Organization, 2013).

The standardized concentration index ( $C_h$ ) is typically estimated using the following formula:

$$C_h = \frac{2Cov(h_i, R_i)}{\mu}$$

where  $h_i$  is health service use or outcome. In the context of this study, it refers to the COVID-19 related health outcomes, the term  $\mu$  is the mean of health outcomes and takes the value of 1 if the individual  $I$  had the outcome and 0 if they did not, and  $R_i$  is the individual's fractional socioeconomic rank.

## **8.7 Limitations**

The estimation of the concentration index can be conducted using either grouped or aggregated data, or alternatively, micro-data sets that encompass details pertaining to an individual's income and health status. When employing district-level data, as demonstrated in

this study, it is imperative to recognise several constraints in contrast to individual-level income data.

Aggregation bias may manifest itself when data on individual-level SES indicators are aggregated at the district level. In academic research, micro-datasets are typically preferred over grouped datasets due to their ability to yield more reliable estimates of the concentration index. This is because point estimates derived from grouped datasets fail to account for the valuable information regarding the relationship between income and health status within specific groups (Kakwani et al., 1997).

Additionally, ecological fallacy is a potential limitation in data analysis, where the analysis of data at the district level may lead to incorrect conclusions about individuals. This occurs when inferences are made based on aggregated data (Subramanian et al., 2009). The generalisations pertaining to relationships at the district level may not necessarily possess applicability to individual entities within said district. Therefore, it is crucial to acknowledge that drawing inferences about income inequality at the individual level solely from district-level data has the potential to result in inaccurate conclusions.

Limitations in the details of the data become apparent when contrasting district-level data with individual-level income data, as the former provides a more restricted level of granularity. The data provided may not offer a comprehensive representation of the complete range of income inequality within the district, nor does it account for the differences in socioeconomic characteristics across smaller geographic subdivisions within the district. The lack of precise specificity could impede the identification of noteworthy nuances in the distribution of income inequalities (Lanker et al., 2016).

Another problem becoming apparent is the issue of spatial heterogeneity, this is a term used to describe the existence of disparities in income distribution within districts. This phenomenon is characterised by the presence of distinct neighbourhoods or regions that exhibit varying levels of income and inequalities. The depiction of spatial heterogeneity in income inequality within a district may be oversimplified due to potential compromises in accuracy when relying solely on district-level data (Khan & Siddique, 2021).

Although the acquisition of income data at the individual level may pose certain challenges and raise concerns regarding the precision and dependability of reporting, it is crucial to recognise that the district-level income data may also possess certain limitations in terms of the availability and quality of the data. The inclusion of district-level data sources, such as surveys or administrative records, may lead to an incomplete representation of income, which can introduce biases and limitations in the evaluation of income inequality.

## 8.8 Summary from inequality studies

Health outcome inequality, sometimes called health disparity, pertains to the variations in health status and outcomes encountered by distinct individuals or groups within a given population (Braveman & Tarimo, 2002). The metric assesses the disparity in the distribution of health-related outcomes, encompassing factors such as morbidity, mortality, life expectancy, and overall quality of life. The observed disparities can be attributed to various factors, including socioeconomic status, educational attainment, availability of healthcare services, and environmental circumstances (Culyer & Wagstaff, 1993).

The measurement of disparities in health outcomes is a complex task that involves the examination of various indicators and the utilisation of diverse methodologies to gain a comprehensive understanding of inequality across different population groups. One key approach entails assessing disparities by examining variations in mortality rates and life expectancy across different demographic groups. This methodology involves the examination of mortality data and the computation of life expectancy within various demographic subgroups, including those delineated by socioeconomic status, race, ethnicity, and geographic regions. The analysis of these data allows for an examination of the variations in measures, which in turn provides insight into the disparities observed in health outcomes (Hosseinpoor, 2013). Another valuable approach is the investigation of disease prevalence or incidence. When conducting comparative analyses of disease rates or health conditions among different population segments, researchers are able to infer disparities in the prevalence of illnesses and the wider distribution of health outcomes (Hosseinpoor, 2013). This approach offers a comprehensive perspective on the distribution of health adversities within the population, allowing for the identification of groups that may experience disproportionate impacts. But this method does not look at how all the different types of inequality add up; demographic factors often overlap and have a bigger effect when added together, so they should not be looked at separately. Therefore, an intersectional approach is necessary.

In addition, health surveys and self-reported measures have established a distinct presence within this field. By assessing individuals' subjective assessments of their health status, these instruments provide a nuanced insight into the varying perceptions of health among different demographic groups (Lanker et al., 2016). This approach, which involves analysing self-assessments related to self-rated health, functional limitations, and quality of life, provides insights into disparities not only in objective health outcomes but also in subjective health perceptions. The incorporation of metrics such as the health disparity index serves to enhance and refine the aforementioned analysis. This statistical metric assesses inequalities by comparing the health outcomes of the most socioeconomically disadvantaged groups with those of the general population or the most privileged cohorts. This index, drawn from the theory behind the Gini coefficient, offers a concrete metric, enabling a quantifiable evaluation of the extent and magnitude of disparities in health outcomes (Hosseinpoor, 2013).

In cases where health outcome inequality is assessed using direct income measures, research has employed different approaches to consider the intersectionality of social determinants of health. For instance, Candio et al. (2023) employed the Corrected Concentration Index (CCI) to quantify absolute inequalities in a preferred health outcome across three facets of socioeconomic deprivation: educational attainment, occupational status, and neighborhood-level deprivation. All three dimensions of socioeconomic deprivation were discovered to be positively correlated with the health outcome, according to the study. This and other studies have determined the relationship between socioeconomic status and health outcomes using decomposition techniques such as the Wagstaff and Shapley decomposition methods. These methods exclusively utilise income as a metric for assessing socioeconomic status. While the concentration index decomposition considers the individual contributions of socioeconomic factors, it does not incorporate these factors in the determination of individuals' socioeconomic standing (Candio et al., 2023). Based on the theory of intersectionality, we argue in the present study that socioeconomic status should be analysed in the context of social and structural environments in addition to financial income.

In previous studies, SES indicators have been used as proxies where income data is not available. The existing literature cautions that it is crucial to take into account socioeconomic and demographic indicators as proxies within this discourse. Socioeconomic factors such as income, educational attainment, occupational status, and racial or ethnic background can play a crucial role in identifying disparities (Van Doorslaer et al., 1997). Through a thorough examination of disparities in health outcomes in relation to these contextual indicators, scholars have the ability to reveal discernible trends of inequality, emphasising the specific areas that necessitate immediate focus in the realms of public health planning and policy formulation.

## 9 References

- (2016) GBV prevention and response—a cornerstone of the RTAP tackling gender-based. Available at: <https://gbvresponders.org/wp-content/uploads/2017/05/RTAP-Baseline-Final-Overview-Dec2016.pdf> (Accessed: 17 June 2023).
- Ahinkorah, B.O., Budu, E., Seidu, A.A., Osei, D.B., Agbaglo, E., Adu, C., & Osei, M. (2020) ‘Socio-economic and demographic determinants of female genital mutilation in sub-Saharan Africa: Analysis of data from demographic and Health Surveys’, *Reproductive Health*, 17(1). doi:10.1186/s12978-020-01015-5.
- Amin, N. and Mahabeer, P. (2021) ‘Curriculum tinkering in situations of crises and inequalities: The case of South Africa’, *PROSPECTS*, 51(1–3), pp. 489–501. doi:10.1007/s11125-021-09564-8.
- Andersen, T.M. and Maibom, J. (2019) ‘The big trade-off between efficiency and equity—is it there?’, *Oxford Economic Papers* [Preprint]. doi:10.1093/oep/gpz040.
- Ataguba, J.E. and McIntyre, D. (2017) ‘The incidence of health financing in South Africa: Findings from a recent data set’, *Health Economics, Policy and Law*, 13(1), pp. 68–91. doi:10.1017/s1744133117000196.
- Ataguba, J.E., Akazili, J. and McIntyre, D. (2011) ‘Socioeconomic-related health inequality in South Africa: Evidence from general household surveys’, *International Journal for Equity in Health*, 10(1), p. 48. doi:10.1186/1475-9276-10-48.
- Baciú, A., Negussie, Y. and Geller, A. (2017) ‘The Root Causes of Health Inequity’, in *Communities in Action: Pathways to Health Equity*. Washington, DC: National Academies Press (US). Available at: <https://www.ncbi.nlm.nih.gov/books/NBK425845/> (Accessed: 17 August 2023).
- Betthäuser, B.A., Bach-Mortensen, A.M. and Engzell, P. (2023) ‘A systematic review and meta-analysis of the evidence on learning during the COVID-19 pandemic’, *Nature Human Behaviour*, 7(3), pp. 375–385. doi:10.1038/s41562-022-01506-4.
- Chandola, T. (2003) ‘Social Inequalities in health by individual and household measures of social position in a cohort of healthy people’, *Journal of Epidemiology & Community Health*, 57(1), pp. 56–62. doi:10.1136/jech.57.1.56.
- Consolazio, D. et al. (2022) ‘The impact of school closure intervention during the third wave of the COVID-19 pandemic in Italy: Evidence from the Milan Area’, *PLOS ONE*, 17(7). doi:10.1371/journal.pone.0271404.
- Cook, R. and Grimshaw, D. (2020) ‘A gendered lens on COVID-19 employment and Social Policies in Europe’, *European Societies*, 23(sup1). doi:10.1080/14616696.2020.1822538.
- Clarke, P. and Van Ourti, T. (2010) ‘Calculating the concentration index when income is grouped’, *Journal of Health Economics*, 29(1), pp. 151–157. doi:10.1016/j.jhealeco.2009.11.011.
- Williams, D., Yung, K.C. and Grépin, K.A. (2021) ‘The failure of private health services: COVID-19 induced crises in low- and middle-income country (LMIC) Health Systems’, *Global Public Health*, 16(8–9), pp. 1320–1333. doi:10.1080/17441692.2021.1874470.
- Deaton, A. (2003) ‘Health, inequality, and Economic Development’, *Journal of Economic Literature*, 41(1), pp. 113–158. doi:10.1257/jel.41.1.113.
- Diez-Roux, A.V. (2000) ‘Multilevel Analysis in public health research’, *Annual Review of Public Health*, 21(1), pp. 171–192. doi:10.1146/annurev.publhealth.21.1.171.

- Fisher, D.A. et al. (2022) 'Locked down: Economic and health effects of COVID-19 response on residents of a South African township', *Global Social Welfare* [Preprint]. doi:10.1007/s40609-022-00230-1.
- Francis, D. and Webster, E. (2019) 'Poverty and inequality in South Africa: Critical reflections', *Development Southern Africa*, 36(6), pp. 788–802. doi:10.1080/0376835x.2019.1666703.
- Giorgi, G.M. and Gigliarano, C. (2016) 'The Gini Concentration Index: A review of the inference literature', *Journal of Economic Surveys*, 31(4), pp. 1130–1148. doi:10.1111/joes.12185.
- Galama, T. and van Kippersluis, H. (2010) *A theory of socioeconomic disparities in health over the life cycle* [Preprint]. doi:10.7249/wr773.
- Glover, R.E. et al. (2020) 'A framework for identifying and mitigating the equity harms of COVID-19 policy interventions', *Journal of Clinical Epidemiology*, 128, pp. 35–48. doi:10.1016/j.jclinepi.2020.06.004.
- Goldman, N. (2006) 'Social Inequalities in health', *Annals of the New York Academy of Sciences*, 954(1), pp. 118–139. doi:10.1111/j.1749-6632.2001.tb02750.x.
- Gray, W.K. et al. (2021a) 'Variability in COVID-19 in-hospital mortality rates between National Health Service Trusts and regions in England: A national observational study for the getting it right first time programme', *EClinicalMedicine*, 35, p. 100859. doi:10.1016/j.eclinm.2021.100859.
- Gray, W.K. et al. (2021b) 'Variability in COVID-19 in-hospital mortality rates between National Health Service Trusts and regions in England: A national observational study for the getting it right first time programme', *EClinicalMedicine*, 35, p. 100859. doi:10.1016/j.eclinm.2021.100859.
- Grossman, M. (1972) 'On the concept of health capital and the demand for health', *Journal of Political Economy*, 80, pp. 223–255. Available at: <http://www.jstor.org/stable/10.2307/1830580>.
- Grossman, M. (2004) 'The demand for health, 30 years later: a very personal retrospective and prospective reflection', *Journal of Health Economics*, 23, pp. 629–636. doi:10.1016/j.jhealeco.2004.04.001.
- Hall, B.J. and Tucker, J.D. (2020) 'Surviving in place: The Coronavirus Domestic Violence Syndemic', *Asian Journal of Psychiatry*, 53, p. 102179. doi:10.1016/j.ajp.2020.102179.
- World Health Organization (2013) *Handbook on Health Inequality Monitoring with a special focus on low- and middle-income countries*. Geneva: World Health Organization. Available at: [https://apps.who.int/iris/bitstream/handle/10665/85345/9789241548632\\_eng.pdf](https://apps.who.int/iris/bitstream/handle/10665/85345/9789241548632_eng.pdf) (Accessed: 19 August 2023).
- World Health Organization (2010) *Health equity*. Available at: [https://www.who.int/health-topics/health-equity#tab=tab\\_1](https://www.who.int/health-topics/health-equity#tab=tab_1) (Accessed: 17 August 2023).
- Healthy People 2020 (2014) *Social determinants of health*. Available at: <https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health>.

- Hoffmann, R., Kröger, H. and Geyer, S. (2018) ‘Social causation versus health selection in the life course: Does their relative importance differ by dimension of SES?’, *Social Indicators Research*, 141(3), pp. 1341–1367. doi:10.1007/s11205-018-1871-x.
- Iyanda, A., Boakye, K. and Lu, Y. (2021) ‘COVID-19: Evidenced health disparity’, *Encyclopedia*, 1(3), pp. 744–763. doi:10.3390/encyclopedia1030057.
- Jayasinghe, S. (2015) ‘Social determinants of health inequalities: Towards a theoretical perspective using systems science’, *International Journal for Equity in Health*, 14(1). doi:10.1186/s12939-015-0205-8.
- Kakwani, N., Wagstaff, A. and van Doorslaer, E. (1997) ‘Socioeconomic inequalities in health: Measurement, computation, and statistical inference’, *Journal of Econometrics*, 77(1), pp. 87–103. doi:10.1016/s0304-4076(96)01807-6.
- Kawachi, I., Subramanian, S.V. and Almeida-Filho, N. (2002) ‘A glossary for health inequalities’, *Journal of Epidemiology & Community Health*, 56, pp. 647–652.
- Kawachi, I. and Berkman, L. (2000) ‘Social cohesion, social capital, and health’, in Berkman, L. and Kawachi, I. (eds.) *Social Epidemiology*. New York: Oxford University Press, pp. 174–190.
- Kawachi, I. and Kennedy, B.P. (1997) ‘Health and social cohesion: why care about income inequality?’, *BMJ*, 314, pp. 1037–1040.
- Kealeboga, K.M., Ntsayagae, E.I. and Tsima, O. (2022) ‘Psychological impact of COVID-19 on nurses caring for patients during COVID-19 pandemic in Gaborone’, *Nursing Open*, 10(5), pp. 3084–3093. doi:10.1002/nop2.1557.
- Khambule, I. (2021) ‘COVID-19 and the role of the state in Africa’, in Decent Work or Decent Income. pp. 243–260. doi:10.5771/97839571103895-243.
- Khan, M.S. and Siddique, A.B. (2021) ‘Spatial analysis of regional and income inequality in the United States’, *Economies*, 9(4), p. 159. doi:10.3390/economies9040159.
- Kim, S.J. and Bostwick, W. (2020) ‘Social vulnerability and racial inequality in COVID-19 deaths in Chicago’, *Health Education & Behavior*, 47(4), pp. 509–513. doi:10.1177/1090198120929677.
- Lakner, C. et al. (2016) ‘Measuring inequality isn’t easy or straightforward - here’s why’, *World Bank Blogs*. Available at: <https://blogs.worldbank.org/developmenttalk/measuring-inequality-isn-t-easy-or-straightforward-here-s-why> (Accessed: 19 August 2023).
- Levine, S. (2020) ‘View of Proxemics, COVID-19, and the ethics of care in South Africa’, *Cultural Anthropology*. Available at: <https://journal.culanth.org/index.php/ca/article/view/5134/640> (Accessed: 17 June 2023).
- Mackey, K. et al. (2021) ‘Racial and ethnic disparities in COVID-19–related infections, hospitalizations, and deaths’, *Annals of Internal Medicine*, 174(3), pp. 362–373. doi:10.7326/m20-6306.
- Manly, B.F.J. (2004) *Multivariate statistical methods* [Preprint]. doi:10.1201/b16974.

- McCartney, G. et al. (2019) ‘Defining health and health inequalities’, *Public Health*, 172, pp. 22–30. doi:10.1016/j.puhe.2019.03.023.
- McKeever, M. (2010) ‘Income inequality and economic development’, *Oxford Research Encyclopedia of International Studies* [Preprint]. doi:10.1093/acrefore/9780190846626.013.24.
- Melo, S., Guedes, J. and Mendes, S. (2019) ‘Theory of cumulative disadvantage/advantage’, *Encyclopedia of Gerontology and Population Aging*, pp. 1–8. doi:10.1007/978-3-319-69892-2\_751-1.
- Metsing, B. (2020) ‘Gender-Based Violence Cases Rose by 500% Since Start of Lockdown - Lifeline’, *IOL News*. Available at: <https://www.iol.co.za/the-star/news/gender-based-violence-cases-rose-by-500-since-start-of-lockdown-lifeline-48193496> (Accessed: 17 June 2023).
- Montgomery, M.R. et al. (2000) ‘Measuring living standards with proxy variables’, *Demography*, 37(2), pp. 155–174. doi:10.2307/2648118.
- OECD Economic Outlook, June 2020 (no date) *OECD*. Available at: <https://oecd.org/economic-outlook/june-2020/> (Accessed: 20 August 2023).
- Nwosu, C.O. and Oyenubi, A. (2020) ‘Income-related health inequalities associated with the coronavirus epidemic in South Africa: A decomposition analysis’ [Preprint]. doi:10.21203/rs.3.rs-77109/v1.
- Onyango, M.A. et al. (2019) ‘Gender-based violence among adolescent girls and young women: A neglected consequence of the West African Ebola outbreak’, in *Global Maternal and Child Health*. pp. 121–132. doi:10.1007/978-3-319-97637-2\_8.
- Orindi, B.O. et al. (2020) ‘Experiences of violence among adolescent girls and young women in Nairobi’s informal settlements prior to scale-up of the dreams partnership: Prevalence, severity and predictors’, *PLOS ONE*, 15(4). doi:10.1371/journal.pone.0231737.
- Phaswana-Mafuya, N. et al. (2021) ‘Understanding the differential impacts of COVID-19 among hospitalised patients in South Africa for equitable response’, *South African Medical Journal*, 111(11), p. 1084. doi:10.7196/samj.2021.v111i11.15812.
- Phelan, J.C. and Link, B.G. (2013) ‘Fundamental cause theory’, in *Medical Sociology on the Move*. pp. 105–125. doi:10.1007/978-94-007-6193-3\_6.
- Price-Haywood, E.G. et al. (2020) ‘Hospitalization and mortality among black patients and white patients with COVID-19’, *New England Journal of Medicine*, 382(26), pp. 2534–2543. doi:10.1056/nejmsa2011686.
- Rouse, C.M. (2021) ‘Necropolitics versus biopolitics: Spatialization, White Privilege, and visibility during a pandemic’, *Cultural Anthropology*, 36(3). doi:10.14506/ca36.3.03.
- Roy, C.M. et al. (2022) ‘Impact of COVID-19 on gender-based violence prevention and response services in Kenya, Uganda, Nigeria, and South Africa: A cross-sectional survey’, *Frontiers in Global Women’s Health*, 2. doi:10.3389/fgwh.2021.780771.
- Sahn, D. E. and Stifel, D. C. (2000) ‘Poverty Comparisons over Time and Across Countries in Africa’, *World Development*, 28(12), pp. 2123–2155.

- Schellenberg, J.A., Victora, C.G., Mushi, A., de Savigny, D., Schellenberg, D., Mshinda, H. and Bryce, J. (2003) 'Inequities among the very poor: Health care for children in rural southern Tanzania', *The Lancet*, 361(9357), pp. 561–566. doi:10.1016/s0140-6736(03)12515-9.
- UN Women (no date) *The shadow pandemic: Violence against women during COVID-19*, UN Women – Headquarters. Available at: <https://www.unwomen.org/en/news/in-focus/in-focus-gender-equality-in-covid-19-response/violence-against-women-during-covid-19> (Accessed: 17 June 2023).
- Shaw, M. (2005) 'Health inequality: An introduction to theories, concepts and methods. Mel Bartley. Cambridge: Polity Press, 2004, pp. 224, £16.99 (pb), ISBN: 0745627803', *International Journal of Epidemiology*, 34(2), pp. 500–502. doi:10.1093/ije/dyi053.
- Shumaker, S.A. and Brownell, A. (1984) 'Toward a theory of social support: closing conceptual gaps', *Journal of Social Issues*, 40, pp. 11–36.
- Subramanian, S.V., Jones, K. and Duncan, C. (2009) 'Revisiting Robinsom: The perils of individualistic and ecologic fallacy', *International Journal of Epidemiology*, 38(2), pp. 342–360. doi:10.1093/ije/dyn359.
- Statistics Solutions (2013) *Data analysis plan: Bivariate (Pearson) Correlation* [WWW Document]. Available at: <http://www.statisticssolutions.com/academic-solutions/member-resources/member-profile/data-analysis-plan-templates/data-analysis-plan-bivariate-pearson-correlation/>.
- World Population Review (no date) *South Africa Population 2022 (Demographics, Maps, Graphs)*. Available at: <https://worldpopulationreview.com/countries/south-africa-population> (Accessed: November 3, 2022).
- Vella, V. and Ndiku, J. (1993) 'Construction of a socio-economic index to facilitate analysis of health data in developing countries', *Social Science & Medicine*, 36(8), pp. 1087–1097. doi:10.1016/0277-9536(93)90127-p.
- Vindrola-Padros, C., Chisnall, G., Cooper, S., Dowrick, A., Djellouli, N., Symmons, S.M., Martin, S., Singleton, G., Vanderslott, S., Vera, N., Johnson, G., and Welch, V. (2020) 'Carrying out rapid qualitative research during a pandemic: Emerging lessons from COVID-19', *Qualitative Health Research*, 30(14), pp. 2192–2204. doi:10.1177/1049732320951526.
- Vyas, S. and Kumaranayake, L. (2006) 'Constructing socio-economic status indices: How to use Principal Components Analysis', *Health Policy and Planning*, 21(6), pp. 459–468. doi:10.1093/heapol/czl029.
- World Bank Group (2023) *Gender-based violence (violence against women and girls)*. Available at: <https://www.worldbank.org/en/topic/socialsustainability/brief/violence-against-women-and-girls> (Accessed: 17 June 2023).
- World Health Organization (2018) *Health inequities and their causes*. Available at: <https://www.who.int/news-room/facts-in-pictures/detail/health-inequities-and-their-causes> (Accessed: December 19, 2022).
- Zalla, L.C., Mulholland, G.E., Filiatreau, L.M. and Moghaddam, M. (2021) 'A geography of risk: Structural racism and coronavirus disease 2019 mortality in the United States', *American Journal of Epidemiology*, 190(8), pp. 1439–1446. doi:10.1093/aje/kwab059.
- Britannica (1998) *The National Party and apartheid*. Available at: <https://www.britannica.com/place/South-Africa/Postapartheid-South-Africa> (Accessed: 08 June 2023).

## 10 Annexures

Table 1: Summary of studies on inequalities in COVID-19 outcomes

Title	Author, year, country	Measure of covid outcome disparity	Level
Socio-economic inequality in global incidence and mortality rates from coronavirus disease 2019: an ecological study	Shahbazi & khazaei (2020) Global	Concentration index	Population level
Income-related health inequality among Chinese adults during the covid-19 pandemic: evidence based on an online survey	Nie et al.(2021) China	Concentration index	Household level
Behavioural response to the covid-19 pandemic in South Africa	Kollamparambil & oyenubi (2021) South africa	Concentration index	Household level
Socioeconomic-related inequalities in covid-19 vulnerability in south Africa	Shifa et al.(2022) South africa	Concentration index	Household level
Income-related health inequalities associated with the coronavirus pandemic in South Africa: a decomposition analysis	Nwosu & oyenubi (2021) South africa	Concentration index	Household level
A decomposition analysis for socioeconomic inequalities in health status associated with the covid-19 diagnosis and related symptoms during Brazil's first wave of infections	De frança et al.(2021) Brazil	Concentration index	Household level
Using relative and absolute measures for socioeconomic inequalities in health: experiences from a retrospective cohort study on covid-19	Mehdizadeh et al. (2023) Iran	Slope index of inequality Concentration index Relative index of inequality	Household level
The income gradient in mortality during the covid-19 crisis: evidence from Belgium	Decoster et al. (2021) Belgium	Slope index of inequality Relative index of inequality	Household level Population level

Table 2: Summary of Findings from studies on measurements of socioeconomic inequalities

Title	Author Year County	Name of socioeconomic status measure	Statistical technique	Study level
A small-area index of socioeconomic deprivation to capture health inequalities in France	Havard et al., (2008) France	Small Area Deprivation Index (SADI)	PCA	Population level
Small-area socioeconomic deprivation indices in Cyprus: development and association with premature mortality	Lamnisis et al., (2019) Cyprus	Small Area Deprivation Index (SADI)	PCA	Population level
A comparison of small-area deprivation indicators for public-health surveillance in Sweden	Strömberg et al., (2021) Sweden	Small Area Deprivation Index (SADI)	CFA	Population level
Geographic patterns of deprivation in South Africa: informing health equity analyses and public resource allocation strategies	McIntyre, (2002) South Africa	Small Area Deprivation Index (SADI)	PCA	Population level
A statistical procedure to create a neighbourhood socioeconomic index for health inequalities analysis	Lalloué et al., (2013) France	Socioeconomic index (SES index)	PCA	Population level
Comparing Global and Spatial Composite Measures of Neighbourhood Socioeconomic Status Across US Counties	De Silva et al., (2022) USA	Socioeconomic index (SES index)	PCA	Population level
Development of the Global Network for Women's and Children's Health Research's socioeconomic status index for use in the network's sites in low and lower middle-income countries	(Patel et al., 2020) Global	Socioeconomic index (SES index)	CFA	Household level
Constructing socio-economic status indices: how to use principal components analysis	Vyas & (Kumaranayake, 2006)	Socioeconomic index (SES index)	PCA	Household level
Spatial inequality through the prism of a pandemic: Covid-19 in South Africa	Shifa et al., (2021) South Africa	Wealth index/ asset index	PCA	Household level
Socioeconomic-related health inequality in South Africa: evidence from General Household Surveys	Ataguba et al., (2011) South Africa	Wealth index/ asset index	PCA	Household level

Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries	Howe et al., (2008)	Wealth index/ asset index	PCA, MCA,	Household level
Assessing Changes in Household Socioeconomic Status in Rural South Africa, 2001–2013: A Distributional Analysis Using Household Asset Indicators	Kabudula et al., (2016) South Africa	Wealth index/ asset index	PCA, MCA	Household level
Re-examining the Multidimensional Poverty Index of South Africa	Jackson & Yu, (2023) South africa	Multidimensional poverty index	MCA	Household level
A multiple correspondence analysis approach to the measurement of multidimensional poverty in Morocco, 2001–2007	Ezzrari & Verme, (2012) Morocco	Multidimensional poverty index	MCA	Household level

## 11 Section B: Journal Manuscript

### Title: Socioeconomic related Covid-19 outcome disparities in South African districts

#### 1 Abstract

**Introduction:** The COVID-19 pandemic exposed and intensified pre-existing socioeconomic disparities across the globe, with South Africa experiencing severe consequences. This body of research addresses these socioeconomic disparities in COVID-19 outcomes at South Africa's district level, recognizing the multifaceted nature of socioeconomic status (SES).

#### **Background literature review:**

The background literature highlights how socioeconomic inequalities, such as income levels, housing conditions and sociodemographic characteristics, influenced COVID-19 outcomes in the country (Cloete et al., 2021; Khambule, 2021). The literature further underscores the importance of intersectional analyses, demonstrating how overlapping disadvantages amplified the impact on marginalized communities.

**Methods:** The study utilised data amalgamated by the National Policy Data Observatory (NPDO), which synthesizes information from the National COVID-19 outcomes surveillance spanning from November 2019 to July 2022 and socioeconomic indicator data from the 2021 General Household Survey (GHS) . The study analysed 12 socioeconomic indicators across 53 districts to create four analytically determined domains of socioeconomic standing namely: sociodemographic index, economic index, infrastructural index and a multidimensional socioeconomic index using the Principal Component Analysis technique. The relationship between these indices with COVID-19 cases, recoveries, and fatalities were further investigated using the Wagstaff concentration index of inequality and concentration curves.

**Results:** The analysis revealed that low sociodemographic, and economic indices, as well as the overall socioeconomic status index had negative concentration indices and concentration curves above the line of equality indicating a pro poor distribution. A high infrastructural index was associated with high cases, recoveries and mortalities, the concentration index was positive and the concentration curve below the line of equality indicating a pro-rich distribution, suggesting that urbanisation subsequent overcrowding in well developed areas such as metropolitans increased the risk of spreading infection and worsening covid-19 outcomes.

**Conclusion:** The research provides compelling evidence of a 'social gradient' in health at the district level in South Africa. These disparities are driven mainly by sociodemographic characteristics and economic deprivation indicating potential pressure points for policy makers to focus on.

## **2 Introduction**

The COVID-19 pandemic, which emerged in late 2019, placed immense strain on healthcare systems worldwide, with South Africa bearing a particularly heavy burden (Khambule, 2021). As one of the African countries most affected by the virus, South Africa's experience highlighted deep-seated socioeconomic inequalities that shaped the trajectory of the pandemic (Cloete et al., 2021). This study aims to investigate the role of socioeconomic disparities in influencing COVID-19 outcomes across the nation. By incorporating relevant theoretical and conceptual frameworks, this review provides an in-depth analysis of how factors such as income inequality, socio-demographic factors, and living conditions contributed to varied health outcomes. The study also employs an intersectional perspective to capture the complex interplay of these factors, emphasizing how multiple dimensions of disadvantage combined to exacerbate the impact of COVID-19 on vulnerable communities. Although other factors, such as endemic diseases like HIV and TB, as well as non-communicable diseases, contribute to the burden of disease, this study acknowledges their significance but focuses specifically on examining socioeconomic factors.

## **3 Background**

The coronavirus outbreak in 2019, commonly referred to as COVID-19, precipitated substantial adverse repercussions on the global economy, which, in turn, exerted significantly deleterious effects on individuals and families (Consolazio et al., 2021). While the pandemic universally affected the population, its detrimental consequences were not uniformly distributed among different groups. Disparities in the impact were evident, with certain demographics enduring more severe repercussions than others (Mishra et al., 2021). Populations already at a disadvantage, such as the unemployed, individuals in precarious employment situations, inhabitants of low-income neighbourhoods, and the homeless, experienced a disproportionately higher level of hardship due to the pandemic compared to their more affluent counterparts (Amin and Mahabeer, 2021). The covid-19 pandemic as we have witnessed it has shed a light to numerous social injustices, calling for new public health policies that cater not only for health outcomes but for the associated social determinants of health at the neighborhood context. Even though, Social Determinants at neighborhood context are structural drivers of health inequalities, emphasis has been on Social Determinants of Health at individual level (Kollamparambil & Oyenubi, 2021; Nie et al., 2021; Nwosu & Oyenubi, 2021; Shahbazi & Khazaei, 2020; Shifa et al., 2022) Thus, this study measures district level or otherwise termed the neighborhood socio-economic index by constructing a composite index from key socio-economic status indicators of South African districts and further examine the socioeconomic inequality associated with COVID-19 outcomes based on the district SES composite index.

## **4 Theoretical Framework**

### **4.1 Theory of social determinants of health**

The backbone of this study is the theory of social determinants of health. According to Ataguba and McIntyre (2011), it is crucial to have a comprehensive understanding of the social determinants of health, which requires taking into consideration both the material and psychological elements. They contend that despite the fact that material factors such as wealth and education have a direct influence on health outcomes, psychological factors such as social networks and social support also play a key role in determining health outcomes.

### **4.2 Social causation**

The concept of "social causation" further posits that a multitude of factors, including material, psycho-social, and behavioural aspects, collectively influence the disparities in health outcomes found among different populations (Hoffmann et al., 2018). Material considerations encompass a broad spectrum of economic levels and investments in infrastructure that provide advantages to the community. Psychosocial difficulties refer to the long-lasting stresses that result from an individual's perceptions and interactions with their social position in a society characterised by inequalities (Chandola et al., 2003). This viewpoint further illustrates how social determinants of health can cause disease outcomes.

An important social causation theory in the present discussion is the theory of Cumulative Disadvantage/Advantage (CDA). This theory explains how disparities in a trait or resource like income or social status tend to widen over time within a group due to the compounding effects of social systems (Dannefer, 2003). It posits that even slight early-life differences can escalate, leading to a snowballing of advantages or disadvantages throughout an individual's life. Cumulative disadvantage, when discussed in the context of COVID-19, refers to how the pandemic has exacerbated existing inequalities and vulnerabilities among certain populations, leading to disproportionately negative impacts on those groups. This concept is shown in studies such as that conducted by Shifa et al. (2022), where socioeconomic variables were used to illustrate SES driven Covid-19 vulnerability in South Africa. The findings were marked by negative and highly significant concentration index estimates, revealing that the vulnerability to Covid-19 was more pronounced among the poorer sections of society.

Socioeconomic status has shown to affect disease process by determining groups' predisposition, vulnerability, disease transmission, prevention and access to treatment. For example, the relationship of SES and the effectiveness of non-pharmaceutical interventions (NPIs) in controlling the spread of COVID-19 was a critical area of research. Studies show that lower SES is a barrier to implementing preventative NPIs like social distancing, isolation, and handwashing (Shifa et al., 2022). These circumstances were facilitated by the lack of basic amenities and inadequate housing in lower SES neighbourhoods. To illustrate, Papageorge et al. (2021) found that in the United States of America, individuals with lower incomes and limited remote work opportunities were less likely to practice social distancing.

This trend is also seen in South Africa, where preventive measures are more common among the wealthy and educated. Kollamparambil & Oyenubi (2021) explained this using the Health Belief Model, which suggests that personal beliefs and perceived efficacy of actions influence health-related behaviours. The model indicates that the affluent were more likely to adopt protective measures.

## **5 Conceptual framework**

Intersectionality theory is indispensable when considering the complex layers of discrimination and privilege that shape health outcomes. It is particularly relevant in a society as stratified as South Africa, where the legacies of apartheid continue to cast long shadows over contemporary socio-economic structures (Francis et al., 2020). This theory allows us to understand how intersecting identities such as race, gender, class, and more, do not act independently but compound to affect individuals' experiences with the healthcare system and their susceptibility to diseases like COVID-19 (Crenshaw, 1989; Maestripieri, 2021).

### **5.1 Sociodemographic factors**

The intersectionality paradigm recognises that throughout their existence, individuals encounter varying degrees of privilege and discrimination (Komanisi et al., 2022). Race, ethnicity, gender identity, social class, language, skin colour, neurodiversity, religion, ability or disability, sexual orientation, mental health, age, ecological systems (including neighbourhoods, schools, offices, rural-urban areas, and local and federal policies), education, citizenship and immigration status, housing, and body size are sociodemographic elements that contribute to the formation of an individual's or community's intersectional identity. This list is not exhaustive. Research concerning the COVID-19 pandemic has provided evidence that individuals aged 60 and above have an increased risk of mortality or contracting a severe COVID-19 infection. Elderly individuals are more susceptible to contracting the disease in households containing younger members; thus, the secondary attack rate among senior individuals is higher within the household. Additionally, household members headed by women were more susceptible to harm than those from households headed by men. In South Africa, there was also a consistent correlation between advanced age, households headed by women, and poverty (Nwosu & Oyenubi, 2021). Thus emphasising the correlation between socioeconomic status, age, and gender in determining the susceptibility of groups to adverse consequences.

### **5.2 Economic Factors**

With regards to economic factors, low-income individuals, often working in essential but low-paid jobs, have faced higher exposure to COVID-19 due to their inability to work from home, coupled with less access to protective measures (Turok & Visagie, 2021). This vulnerability is further compounded for racial and ethnic minorities who are overrepresented

in essential sectors. To cite an example, in the USA, COVID-19 positive patients who resided in low-income areas were significantly younger, and were more likely to be of female gender or a racial minority when compared to individuals living in high income areas (Little et al., 2021). This argument evidence supports the intersection of income, race, gender and even social clustering.

### **5.3 Infrastructural factors**

SES also intersects with race by way of influencing infrastructure and living conditions, with low-income and minority populations more likely to live in crowded housing conditions, facilitating the spread of the virus. Homelessness or inadequate housing further exacerbates exposure risks. Specifically in the context of south Africa, low-SES districts are formed upon the legacy of the apartheid government's Group Areas Act of 1950 which displaced people of color to settle in rural areas and townships that are often characterized by limited access to quality healthcare, inadequate housing conditions, and higher levels of environmental pollution (Joseph, 2021). Moreover withing these poorly developed areas, there is a marked limitation to accessing basic amenities such as water, electricity and toilets, all culminating to worse outcomes (shifa et.al, 2022).

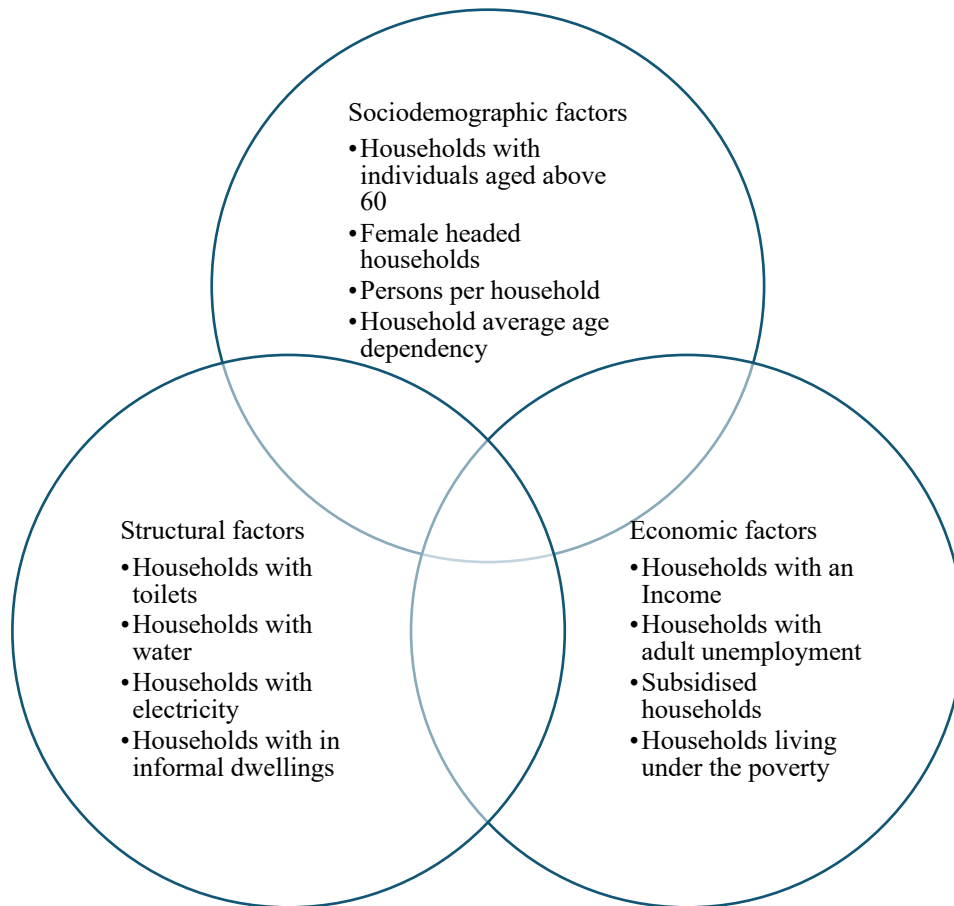


Figure 1: Intersectionality of socioeconomic factors

Meanwhile, social causation models direct our attention to the societal structures and factors that significantly influence health outcomes. Highlighting themes such as residential poverty and neighbourhood level socioeconomic deprivation. These models posit that social conditions are not mere backdrops to the spread of disease but are intrinsic determinants of health (Bierman et al., 2021).

## Method

### Setting

The study was conducted on South African data. The country is a low-middle-income country located at the top of the African Country. South Africa has 9 provinces and 53 districts which were analysed in this study. The country of south Africa, is nearly 30 years into liberation but the remnants of the apartheid as still being felt. South Africa is one of the countries with a high Gini coefficient, highlighting a context of neighbourhood poverty and inequality all of which played a role in spreading as well as curbing the spread of the virus.

### Data

An observational study was conducted, leveraging data amalgamated by the **National Policy Data Observatory (NPDO)**, which synthesizes information from the National COVID-19 outcomes surveillance spanning from November 2019 to July 2022 at the district level as well as the 2021 General Household Survey (GHS). In South Africa there are 53 districts.

### Outcome variables

The outcome variables of interest were number of COVID-19 cases, recoveries and deaths. All the data was captured at a district level, totalling 53 districts. Missing variables were imputed as averages.

### Independent Variables

The main independent variable is the district socioeconomic composite index computed from the 12 measures socioeconomic status from the NCPD dataset.

Statistical analysis was completed using STATA 15.1. Statistical techniques were presents used to compute a socioeconomic index from the independent variable representing various indicators of socioeconomic status. Based on empirical review justified in table, the indicators were grouped into 3 categories including sociodemographic factors (those that speaks to age, gender, household social complexities such as age dependency and female headed household households), the economic factors included variables related to income and employment, additionally the infrastructure factors were variables that spoke about spatial development in terms of access to amenities and adequate housing. Lastly all the variables were used to construct an overall district level SES index. The variable selection for the analysis is justified in table 1. Further analysis following the composite indices as ranking variables for equity analysis using Wagstaff concentration indices and concentration curves.

### Choice of Socio-Economic Indicators for Ranking the Districts

A total of 12 variables were selected for the analysis based on relevant literature review and is captured in table 1. These variables were classified to three domains

Table 1: Description of infrastructural factors

Domain	Variable	Explanation	Justification
Infrastructural factors	electricity	Proportion of household that have electricity in the district. Having electricity was measured as having connection to the national power grid	overcrowding, a lack of access to adequate water and sanitation, a lack of medical resources, and pre-existing risk factors (i.e., poor health) plague a large proportion of households and individuals in developing countries (shifa et.al, 2021).
	Water	Proportion of household that have water in the district. Having water was measured as having a tap or access to running water withing the household	Inability to wash hands regularly with soap or detergent increases the risk of contracting COVID-19 and collecting water from a public supply increases the risk of catching COVID-19 from infected people in other households due to close contact while queuing to collect water or touching contaminated water supply equipment, e.g., stand-pipe taps, pump handles, well buckets, etc. (shifa et.al, 2021).
	toilet	Proportion of household that have a toilet in the district, this is including pit toilets and flushing toilets but not bucket sanitation services	Sharing a toilet increases the risk of catching COVID-19 from infected people in neighbours' households either by faecal/oral transmission or from close contact in or near the shared toilet, e.g., while waiting or

			queuing (shifa et.al, 2021).
	Informal dwellings	Proportion of households in the district that live in informal dwellings	COVID-19 has severely impacted the whole country, townships and informal settlements have proved more vulnerable than suburbs (Turok & Visagie, 2021).

Table 2: Description of economic factors

Domain	Variable	Explanation	Justification
Economic factors	Income	Proportion of households in the district that receive an income. The variable reflects regular income received by the household on a monthly basis, net of taxes, as well as imputed rental income from owner-occupied housing.	Residents of areas with the lowest median incomes had a higher incidence of needing invasive mechanical ventilation (IMV) (25.4% for the bottom income quartile compared to 16.0% for the top quartile, $p < 0.001$ ) and were more frequently admitted to the ICU (35.2% versus 19.9% for the highest income quartile, $p < 0.001$ ) (Quan et al., 2021).
	Adult unemployment	Proportion of households in the district that have unemployed adults, including a primary job, secondary job, self-employment, paid casual work, or personal agricultural work, or if they assist others in business activities.	Wave 1 of the NIDS-CRAM analysis shows a decline in the labour market (Turok & Visagie, 2021)

	poverty	Proportion of households in the district that are living under the poverty line ( According to Statistics South Africa, the lower bound of the poverty line is R43 per person per month)	Wave 1 of the NIDS-CRAM analysis shows a causal link between the labour market, household income and ultimately poverty and food insecurity (Turok & Visagie, 2021)
	subsidized	Proportion of households in the district that receive government subsidy. Government subsidized are defined as any form of government grand including child grant, disability grant, pension, and other social relief grants	Poor communities have been much bigger beneficiaries of government grants than have wealthier residents. Provision of COVID-19 relief grants showed economic benefit to these individual as they were less likely to have formal employment or had been affected my the shutting down of the informal sector. (Turok & Visagie, 2021). By mid-year 2020, 17% of such adults had applied and received the COVID-19 Social Relief of Distress (SRD) Grant.

Table 3: Description of sociodemographic factors

Domain	Variable	Explanation	Justification
Sociodemographic factors	Age above 60	Proportion of household that have individual above the age of 60 in the district	People aged 60 and over are more likely to die or suffer from a severe COVID-19 infection. Older people are more likely to be infected within households with younger members, i.e., older people have a higher secondary attack

			rate within the household (Nwosu & Oyenubi, 2021)
	Persons per household	District Average of persons per household	An ill person is more likely to infect their household members than friends, neighbours, or the wider community. The larger the household, the more members are likely to be infected
	Female headed households	Proportion of households in the district that are headed by females	Members of female-headed households were more vulnerable than those of male-headed households (shifa et.al, 2021).
	Age dependency ratio	The average age dependency of households in each district . Age dependency is defined by the world bank as the percentage of working-age population. This variable was not used as an economic variable because it is a measure of the proportion of adults, a sociodemographic factor but does not speak to the whether or not they are actually employed.	COVID-19 positive patients who resided in high poverty areas were significantly younger, adding this variable in allows us to include the younger demographic who are not included in the Age above 60 variable. (Little et al., 2021)

## 6 Analytical method

### 6.1 Data normalisation

Z-Score was used for data normalisation before to limiting PCA. A popular statistical method for standardising a broad variety of data and illustrating meaningful changes in the data is the Z-score, which ensures that distributions have mean = 0 and std = 1 (Sarkar & Chouhan, 2021). The following formula has been used to normalise the data:

$$Z_i = \frac{X_i - \bar{X}}{\sigma}$$

Where  $Z_i$  is the Z-score,  $X_i$  is the variable  $\bar{X}$  is the mean and  $\sigma$  is the standard deviation

### 6.2 Principal Component Analysis (PCA) notation

Step 1: Defining the matrix

In PCA, the original data can also be put into a matrix A, where each column is one of your original variables :

*Data matrix A:*  $[x_1 \quad x_2 \quad \dots \quad x_n]$

Step 2 : Calculating the eigenvector matrix

The eigenvector represents a pattern in the way the different SES factors relate to one another. Putting the eigenvectors as the columns of a matrix gives:

$$\text{Eigenvector Matrix A: } \begin{bmatrix} a_{11} & a_{21} & a_{m1} \\ a_{12} & \dots & \dots \\ a_{1n} & a_{2n} & a_{mn} \end{bmatrix}$$

Where  $a_{mn}$  is the value of eigenvector. This vector is used to calculate the scores for PC1 using the original variables  $X_1, X_2, \dots, X_n$ . (Darin-Mattsson et al., 2017; Vyas & Kumaranayake, 2006).

Step 4: Calculating the principal component scores

The value of the first principal component is calculated as :

$$PC1 \text{ score} = x_1 \text{loadings}_1 + \dots + x_n \text{loadings}_n$$

Where :

$x_1$  is the value of the first variable and  $\text{loadings}_1$  is the loading of the variable  $x_1$ , the factor loading is a coefficient that provides the correlation between the observed variable and the latent factor or principal component. It indicates how much of the variation in an observed variable is explained by the factor (Vyas & Kumaranayake, 2006).

### Step 5: SES index estimation

In constructing the Socioeconomic Status (SES) index, our approach was meticulous and iterative, ensuring that we captured the multifaceted nature of SES. Initially, we divided SES into distinct domains guided by our variables — including sociodemographic, economic and infrastructural domains —each a significant dimension of socioeconomic standing. For each domain, we calculated individual indices that captured the nuances within that specific sphere and followed with a comprehensive SES indices capturing all three domains.

There exists a paucity of agreement on how to use PCA in contracting an index. However, empirically, score of the first principal component is used to predict SES index (Vyas& Kumaranayake, 2006).

The SES index is then calculated as

$$SES\ index = PC_1\ score$$

In this paper, a low index value is interpreted as lower SES and a high index value as high SES.

### 6.3 Derivation of Socioeconomic Status (SES) Indices Using Principal Component Analysis in Stata

In the process of quantifying SES indices through Stata, the procedure is initiated by standardizing variables to a common scale and then applying Principal Component Analysis (PCA).

The steps are as follows:

#### Step 1: Conduct PCA

To commence, PCA is performed on the normalised variables:

```
pca norm_var1 norm_var2 norm_var3 ... norm_varn
```

Where, norm\_var1 to norm\_varn denote the standardized variables. PCA results will present principal components along with their respective eigenvalues. Utilizing the Kaiser criterion, components with eigenvalues greater than 1 are selected for inclusion in the index calculation.

#### Step 2: Compute Principal Component Scores

The **predict** command is used here to generate scores (**PC1** to **PCn**). As drawn from empirical literature the value of the score of the PC is equal to the index.

Therefore the values of an index is computed using the function:

predict PC1, score

step 3: Including more than one principal component in the composite index

gen comp\_index = PC1\*weight1 + ... + PCnWeightn

## 6.4 Understanding the Variable-Specific Nature of Concentration Index Calculations

The concentration index has emerged as the prevailing metric for assessing income-related disparities within the field of health economics (Wagstaff and van Doorslaer in 2000). The presence of a concentration index with a value of zero signifies the absence of socioeconomic inequalities. Conversely, a negative value indicates an uneven distribution of socioeconomic inequalities among individuals with lower socioeconomic status, while a positive value signifies the concentration of socioeconomic inequalities among individuals with higher socioeconomic status (World Health Organization, 2013). Based on the nature of the ranking variable, the index value in our case, the relative inequality can be measure by either the standardised concentration index or the modified concentration index. We discuss the difference below

### 6.4.1 The standardised Concentration index

The standardized concentration index ( $C_h$ ) is twice the area between the concentration curve and the 45° line indicating no relationship between the two variables.

And it is typically estimated using the following formula:

$$C_h = \frac{2Cov(h_i, R_i)}{\mu}$$

where  $h_i$  is health service use or outcome. In the context of this study, it refers to the COVID-19 related health outcomes, the term  $\mu$  is the mean of health outcomes and takes the value of 1 if the individual  $i$  had the outcome and 0 if they did not, and  $R_i$  is the individual's fractional socioeconomic rank.

### 6.4.2 Modified concentration index

When assessing inequality in a trait using a variable that has been inconsistently assigned numerical values across various populations, such as the computed SES indices, or when examining disparities in various variables with cardinal scales within the same population,

the adjusted concentration index is recommended for use. This can be addressed by using the modified concentration index (Erreygers and Van Ourti, 2011).

$$MC_{(h|y)} = \frac{1}{n} \sum_{i=1}^n \left[ \frac{h_i}{\bar{h} - h^{min}} (2R_i - 1) \right]$$

Where:

where  $h^{min}$  is the lower limit of  $h_i$  and the index ranges between (maximal pro-poor)  $h_{[(1-n)/n]}$  and (maximal pro-rich)  $h_{[(n-1)/n]}$ . Under ratio or fixed measurement scales ( $h^{min} = 0$ ), MC simplifies to the standard concentration (O'Donnell et al., 2016).

## 6.5 Computing Concentration Indices in Stata

The computation of concentration indices can be achieved on STATA 15.1 by installing the “conindex” package . The **conindex** function calculates a spectrum of inequality indices that are dependent on ranking, encompassing measures like the Gini coefficient, the concentration index, the generalized concentration index, the modified concentration index, and the Wagstaff and Erreygers normalized concentration indices O'Donnell et al., 2016).

Using the “conindex” function to calculate the concentration index, the following command was run:

```
conindex health_variable, by(socioeconomic_rank_variable)
```

The default behaviour of the 'conindex' command produces the standardised concentration index. However, for cardinal ranking variables like our SES index which is invariably distributed and without a true zero, the standard concentration index may not remain consistent across computational transformations and can yield inconsistencies in the output. In such scenario, the modified concentration index (MC) is useful. Specification of the index calculation for the modified concentration index

To specify a the modified concentration index using the 'conindex' command, a theoretical lower limit must be specified as minimum value of the ranking variable.

The command is therefore written as:

```
conindex health_variable, by(socioeconomic_rank_variable) if rank_var >=
#theoretical_limit
```

## 7 Results

This section presents the findings of our study, systematically addressing the research questions outlined earlier. Through rigorous analysis, we have distilled key insights and

trends from the data, which are detailed below. Our results are organized to reflect the study's methodological sequence, ensuring clarity and coherence in the narrative of our discoveries. Table 4 and 5 delineates the descriptive statistics of the independent variables, the SES indicators from our data set and the outcome variables which are the cases, recoveries and mortalities related to COVID-19 at district level. The analysis was conducted in 2 phases, firstly analysing the level of deprivation by socioeconomic domains, sociodemographic, economic and infrastructural and secondly by looking at the holistic SES encompassing all SES variables. The results have yielded 4 deprivation indices namely, the sociodemographic index, the economic index, the infrastructural index and finally the overall SES index. The results of the PCA are shown, delving into how each deprivation index was calculated. Furthermore inequality in COVID-19 outcomes (cases, recoveries and mortalities) were computed using concentration indices and concentration curves to determine how each domain affected outcomes.

Table 4: Descriptive statistics of independent variables

Variable	Observations	Mean	Std. Dev.	Min	Max
Proportion of households that receive an income	53	0.2715	0.0553	0.16	0.38
Proportion of households that have Electricity	53	0.8941	0.0774	0.54	0.98
Proportion of households that have Water	53	0.8715	0.1407	0.39	1.00
Proportion of households that have Toilets	53	0.6213	0.2682	0.09	0.97
Proportion of households that have individuals Aged above 60	53	0.0834	0.0157	0.06	0.14
Proportion of households that experience Adult unemployment	53	0.2245	0.0588	0.09	0.39
Proportion of households that live in Poverty	53	0.0819	0.0489	0.02	0.22
Household Average Age dependency	53	57.44	11.7946	39.4	83.8
Proportion of households that live in Informal dwellings	53	0.1047	0.0653	0.01	0.27
Proportion of households that are Subsidised by Government grants	53	0.2472	0.0993	0.06	0.46
Average Persons per household	53	3.4868	0.5502	2.5	4.6
Proportion of households that are Female headed household	53	0.4296	0.0720	0.3	0.59

Table 5: Descriptive statistics of dependent variables

Variable	Observations	Mean	Std. Dev.	Min	Max
cases	53	31906.67	41816.39	2556	213684
recoveries	53	28480.51	37466.58	2335	188173

mortalities	53	1014.776	1169.006	67	6843
-------------	----	----------	----------	----	------

### 7.1 Validation of conceptual framework

Before we analyse the outcomes in each SES determinate category, we need to study the relationship of the individual facts to show their relation and why specific factors are grouped together. We used PCA for this

Table 5: Factor Loadings district level socioeconomic status index

Variable	Comp1	Comp2
income	0,30	-0,19
Electricity	-0,21	0,14
Water	-0,32	-0,01
Toilet	-0,32	0,16
Age above 60	-0,21	0,48
Adult unemployment	0,29	0,03
Poverty	0,33	-0,09
Age dependency	0,31	0,21
Informal dwellings	-0,24	-0,59
Subsidised	-0,27	0,40
Persons per household	0,29	0,29
Female headed household	0,32	0,23

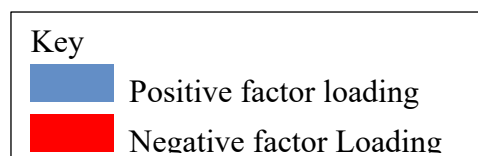
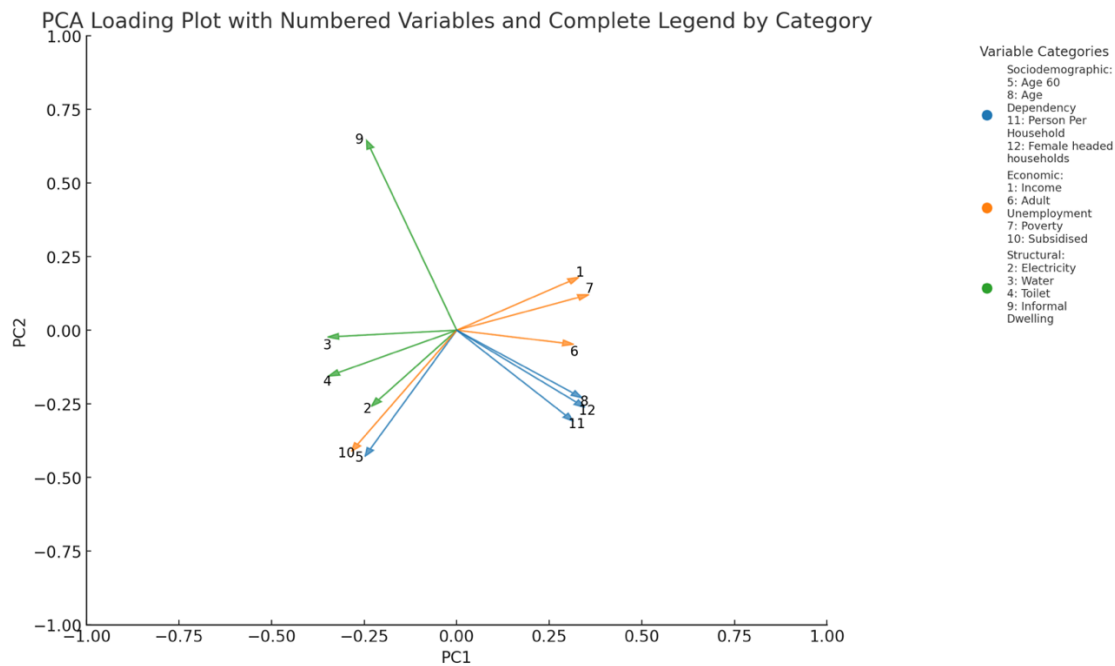


Figure 4 :PCA Loading Plot for PC1 and PC2 with Numbered Variables



The PCA results provide meaningful insights that support the initial conceptual framework by validating the grouping of variables into Economic, Sociodemographic, and Structural factors. Economic variables, such as Income (0.27), Adult Unemployment (0.25), and Poverty (0.28), show high loadings on PC1, which captures the largest share of the variance (50.84%). Subsidised households also loads positively on PC1 (0.18), indicating a correlation with these economic variables. This alignment affirms their classification as Economic factors, as they collectively represent household economic conditions. Sociodemographic variables, including Age Dependency (0.29), Persons per Household (0.27), and Age 60 (0.24), show moderate loadings on PC2, suggesting that this component captures demographic characteristics and explains 23.7% of the variance. Female-headed households, though weakly aligned with PC2 (0.07), also fits within the Sociodemographic group, indicating its relevance to population structure and dependency dynamics within households. Structural factors, such as Water (-0.22), Toilet (-0.23), and Electricity (-0.21), display negative loadings on PC1, positioning them as distinct from Economic factors, while Informal Dwelling shows a high loading on PC2 (0.51), indicating it as a key structural characteristic. The distinct positioning of these infrastructure-related variables from economic and demographic indicators validates their classification as Structural factors, representing access to essential infrastructure and housing quality within the framework.

This analysis supports the conceptual framework by showing distinct groupings of variables along the principal components that align with the hypothesized categories. The clear separation and clustering of these variables along the components confirm the validity of grouping them into Economic, Sociodemographic, and Structural categories, supporting the conceptual framework's accuracy in capturing the underlying structure of the data.

## 7.2 Sociodemographic index

In this subsection, we detail the results pertaining to the Sociodemographic Index. Our analysis quantifies the variations in COVID-19 outcomes as they relate to sociodemographic factors across districts. The index's composition from individual variables and their statistical weightings provides insight into the impact of demographic variables on pandemic-related health disparities. This index was computed from sociodemographic factors namely, Age above 60, Age dependency, female headed households, persons per household.

Table 6: Outcomes of the Principal Component Analysis on Sociodemographic Factors

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.03809	2.36982	0.7595	0.7595
Comp2	0.668275	0.500283	0.1671	0.9266
Comp3	0.167993	0.042353	0.0420	0.9686
Comp4	0.12564	-	0.0314	1.0000

Table 7: Table of Factor Loadings of each factor from Principal Component Analysis

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Age above 60	-0,37	0,93	0,02	0,01	0,00
Age dependency	0,54	0,23	-0,06	-0,81	0,00
Persons per household	0,53	0,20	0,74	0,36	0,00
Female headed household	0,53	0,22	-0,67	0,47	0,00

### Key

- Positive factor loading
- Negative factor Loading

The results of the PCA are shown in tables 6 and 7. The first principal component with an eigenvalue of 3.03 is retained based on the Kaiser criterion which stipulates that the principal components with an eigenvalue greater than 1 are the most significant (Vyas & Kumaranayake, 2006). The proportion of the variance explained by PC1 is 75.95% meaning that 75.95% of variation is explained by PC1. Table 7 of the factor loadings the magnitude and direction of each variable contribution to the principal component. From the results of the PCA, the Sociodemographic index for each district is calculated as the value of the score first principal component.

$$\text{Sociodemographic index} = PC_1 \text{ score}$$

The following visual and tabular analyses connect the sociodemographic characteristics of districts to the distribution of COVID-19 outcomes. Figure 2 depicts the stratified distribution of COVID-19 outcomes by quintiles within the sociodemographic index, illustrating potential disparities in incidence, recovery, and mortality rates. Table 8 enumerates the concentration index values for these outcomes, offering a quantified perspective of sociodemographic inequities. Figure 3 presents the concentration curve, together offering a multifaceted view of the pandemic's impact across different social strata.

Figure 2: Distribution of COVID-19 outcomes by sociodemographic index quintile

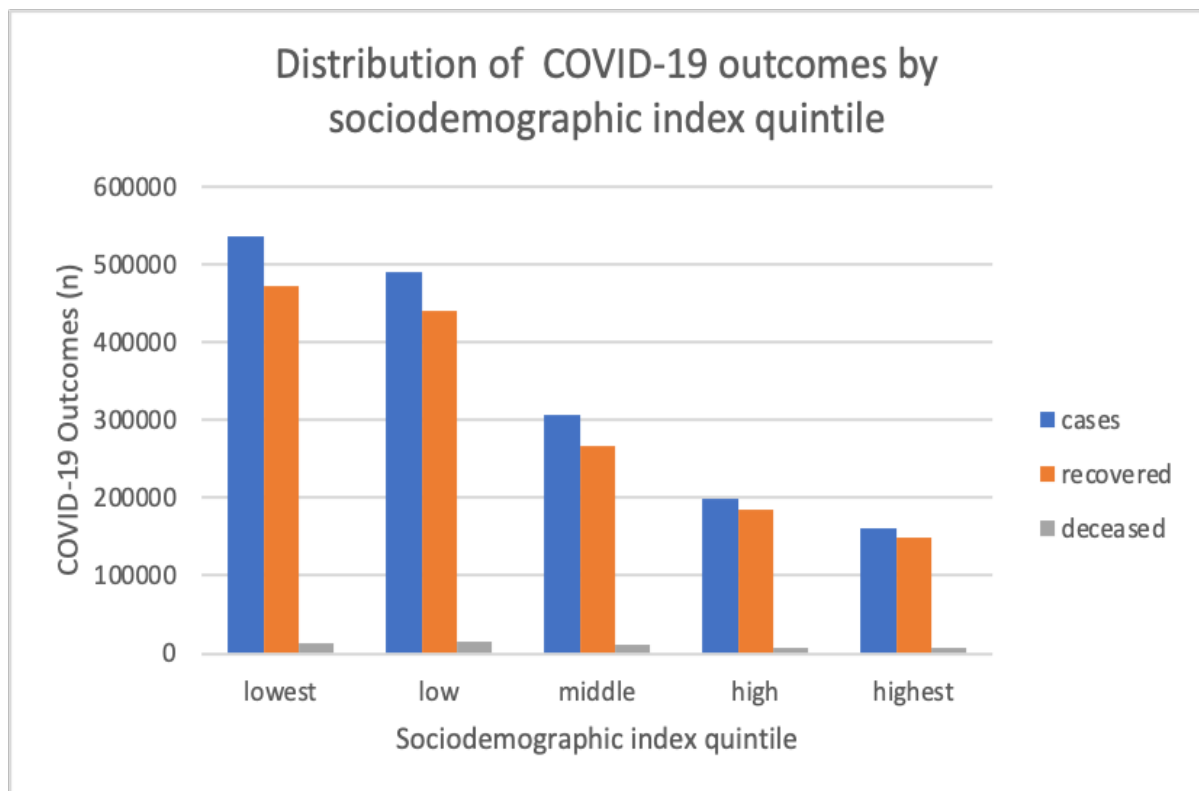
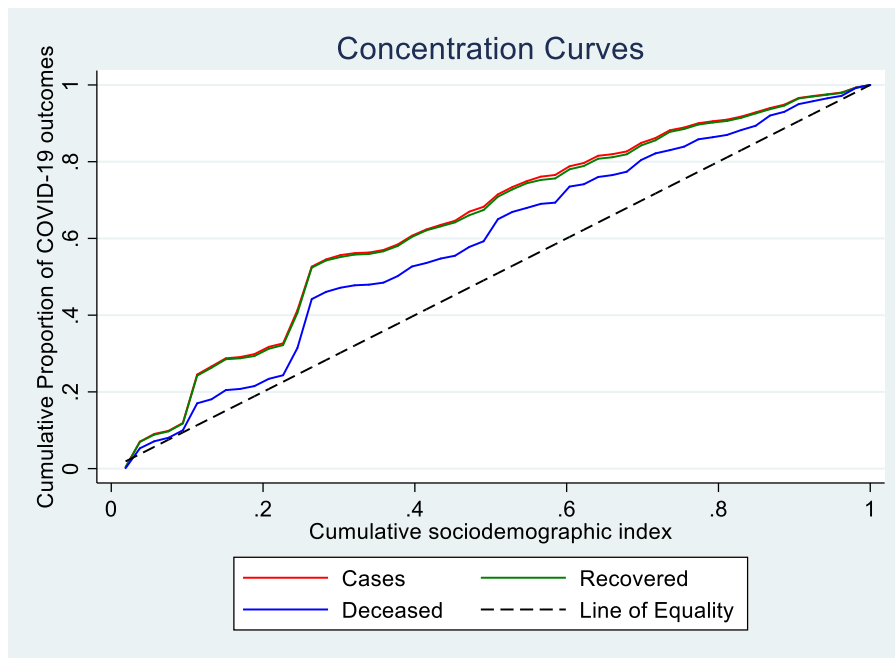


Table 8: concentration index values sociodemographic index ranking

Outcome	No. of obs.	Con Index value	Std. error	p-value
Cases	53	-0.27125905	0.09781079	0.0077
Recovered	53	-0.26303149	0.09867199	0.0103
Deceased	53	-0.1599468	0.08946872	0.0798

Figure 3: Concentration curve sociodemographic index ranking



The Sociodemographic index used as a ranking variable. In Table 3, the resulting negative concentration indices. For case CI was 0.21( $p < 0.05$ ), for recoveries the CI was 0.26( $p < 0.05$ ) which is statistically significant but for mortality the CI was 0.16( $p > 0.05$ ) which was not statistically significant. The concentration curve in figure 2 lying above the 45 degree line of inequality suggest a pro-poor distribution. This means that the lowest sociodemographic index quintile has the highest number of cases, recoveries, mortalities. This may indicate that districts with higher numbers of persons per household, a higher likelihood of female-headed households, and a higher age dependency ratio tend to high numbers of cases, recoveries, mortalities. The negative factor loading for the proportion of households with people over 60 could mean that these household tend to have fewer cases. However due to the other variables computed in PC1, which depict household sizes and complexity. This negative finding can indicate that people over the age of 60 are usually found in less complex and smaller-sized households but does not imply that individuals over 60 are at a lesser risk.

### 7.3 Economic index

In this section, we delve into economic deprivation and its quantification through principal component analysis (PCA) applied to key economic variables. Tables 6 and 7 display the outcomes of PCA on variables such as average income levels per district household, adult unemployment rates, poverty incidence, and the prevalence of government subsidies. The first principal component (PC1) emerged with an eigenvalue of 3.17, accounting for 79.27% of the variance, thus capturing the most significant proportion of economic disparities

Table 9: Outcomes of the Principal Component Analysis on Economic Factors

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	3.17089	2.63839	0.7927	0.7927

Comp2	0.532507	0.343092	0.1331	0.9259
Comp3	0.189416	0.0822315	0.0474	0.9732
Comp4	0.107184	-	0.0268	1.0000

Table 10: Table of Factor Loadings of each factor from Principal Component Analysis

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Income	0,53	0,21	-0,55	0,61	0,00
Poverty	0,52	-0,07	0,80	0,29	0,00
Adult unemployment	0,50	0,57	-0,03	-0,65	0,00
subsidised	-0,45	0,79	0,24	0,34	0,00

**Key**

Positive factor loading

Negative factor Loading

As shown in table 10, PC1 is characterized by positive factor loadings for poverty, and adult unemployment—indicators that exacerbate economic hardship. Conversely, the component bears a negative loading for government subsidies, indicating its role in alleviating economic deprivation. Of note, it is counterintuitive to have a positive factor loading for income introducing the idea of relative deprivation. When an index is constructed to compare relative deprivation within a specific context. For example, in areas where income disparities are vast, like the south African context, even moderate incomes might be considered low compared to the high-income benchmarks of the dataset, and thus could still represent a form of economic deprivation (Townsend, 1979). This disparity will not occur for variable like poverty because it is associated with a poverty line, a defined standard reference.

The economic index for each was the predicted as:

$$\text{Economic index} = PC_1 \text{ score}$$

Figure 4 shows the distribution of outcomes by economic index quintiles, although there are fewer cases at the lowest index quintile, there is a trend of decreasing outcomes with low to highest index quintile. This could be due to the fact districts with the lowest economic index are more likely to be in remote rural areas where the incidence of COVID-19 was low due to the less dense population and spatial isolation from the disease epicentre.

Figure 4: Distribution of COVID-19 outcomes by Economic Index quintiles

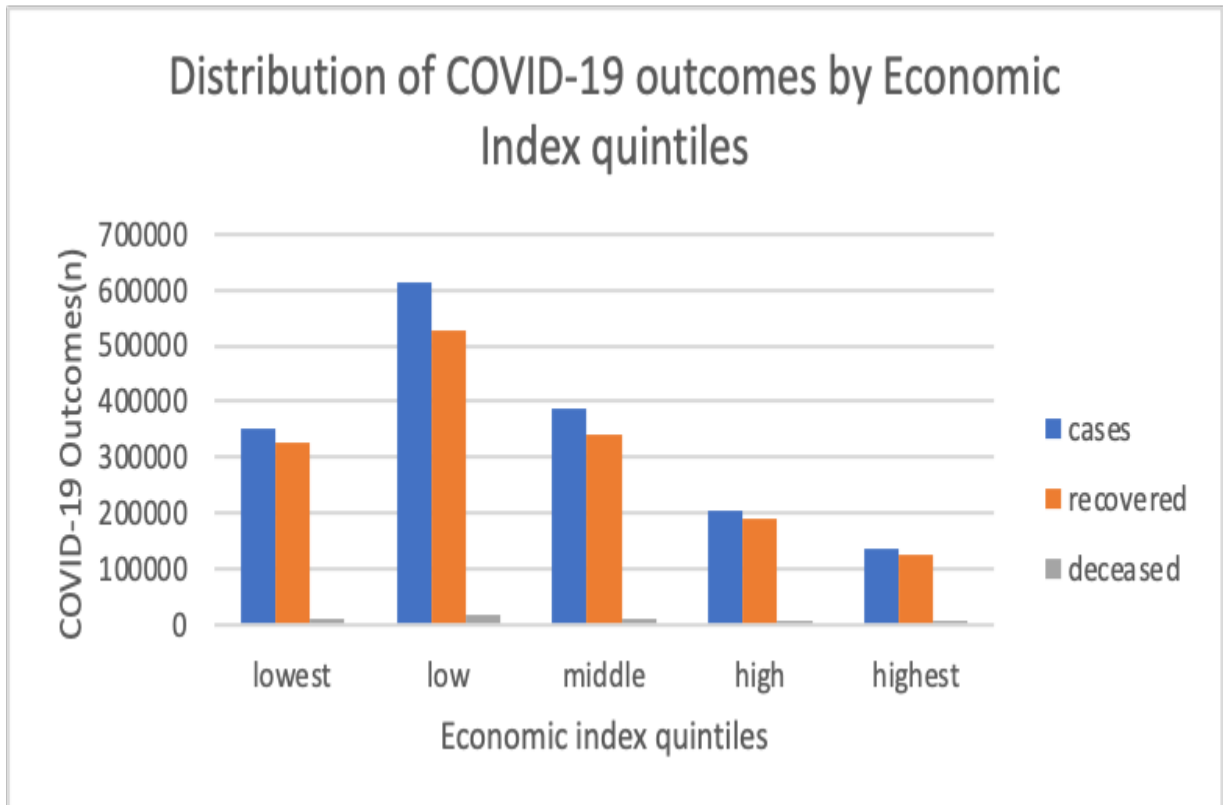
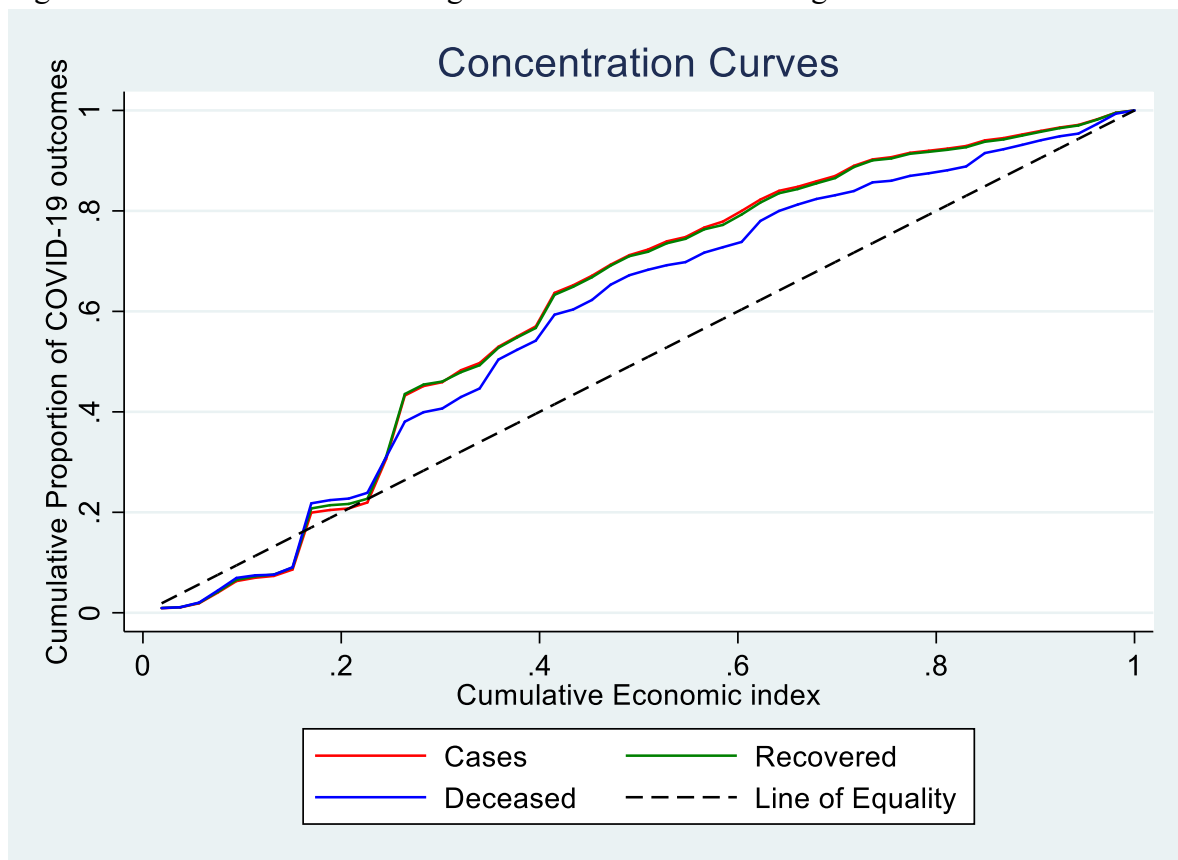


Table 11: concentration index using economic index ranking

Outcome	No. of obs.	Index value	Std. error	p-value
Cases	53	-0.21628082	0.10046154	0.0361
Recovered	53	-0.21434288	0.10095495	0.0386
Deceased	53	-0.16354318	0.08934114	0.0730

Figure 5: concentration curve using the economic index ranking



The economic index used as a ranking variable. In Table 12, the resulting negative concentration indices which were statistically significant, for cases CI was 0.22 ( $P < 0.05$ ), for recoveries CI was 0.21 ( $p < 0.05$ ), however the CI for mortalities was 0.16 ( $p > 0.05$ ) was not statistically significant. The concentration curves for all outcomes are initially below the line of equality and show a pro-rich distribution in the lowest economic index quintile but further quintiles have a curve predominately above the 45 degree line of inequality suggest a pro-poor distribution.

## 7.4 Infrastructural index

Table 13 and 14 show the results of a PCA on the variables that represent infrastructural development in the district including proportion of households with electricity, water, toilets and based informal dwellings. The first principal component explains 66.63% of the difference. With positive factor loadings for all 4 variables.

Table 12: Outcomes of the Principal Component Analysis on Infrastructural Factors

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.66516	1.85048	0.6663	0.6663
Comp2	0.814679	0.424231	0.2037	0.8700
Comp3	0.390448	0.260734	0.0976	0.9676
Comp4	0.129714	-	0.0324	1.0000

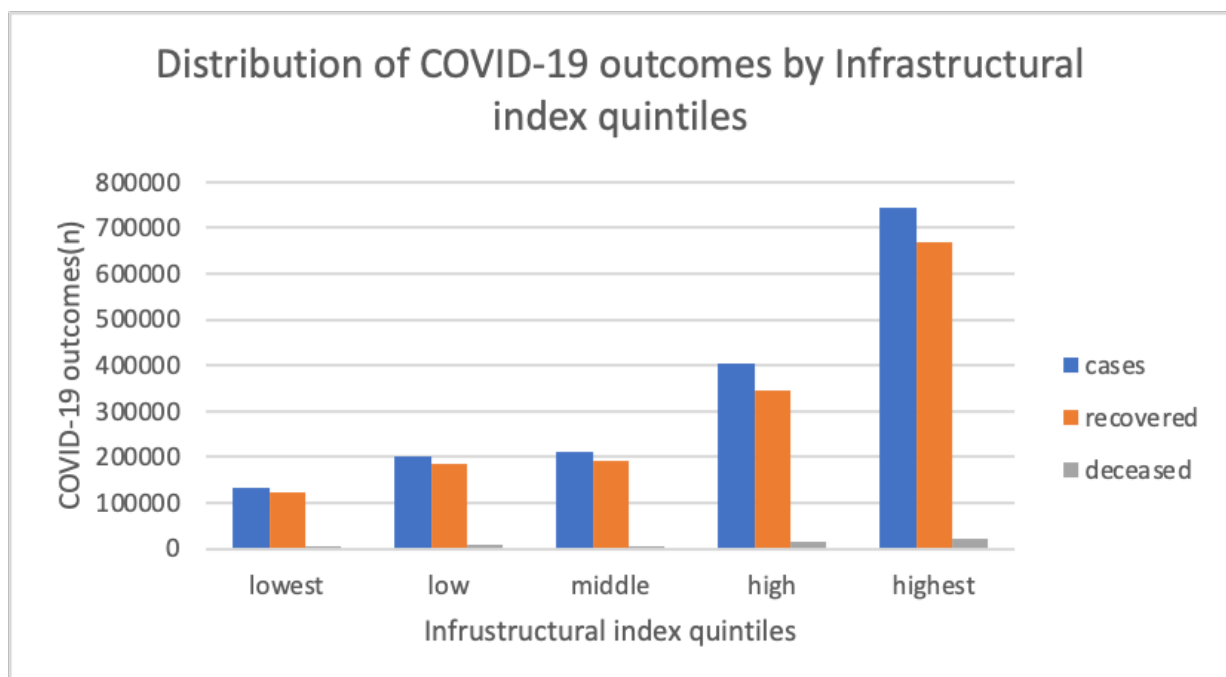
Table 13: Table of Factor Loadings of each factor from Principal Component Analysis

Variable	Comp1	Comp2	Comp3	Comp4	Unexplained
Electricity	0,44	-0,71	0,41	0,37	0,00
Water	0,58	-0,10	-0,07	-0,80	0,00
Toilet	0,53	0,14	-0,71	0,43	0,00
Informal dwelling	0,43	0,68	0,56	0,18	0,00

### Key

- Positive factor loading
- Negative factor Loading

Figure 6: Distribution of COVID-19 outcomes by Infrastructural index quintiles



The Infrastructural index for each was the predicted as:

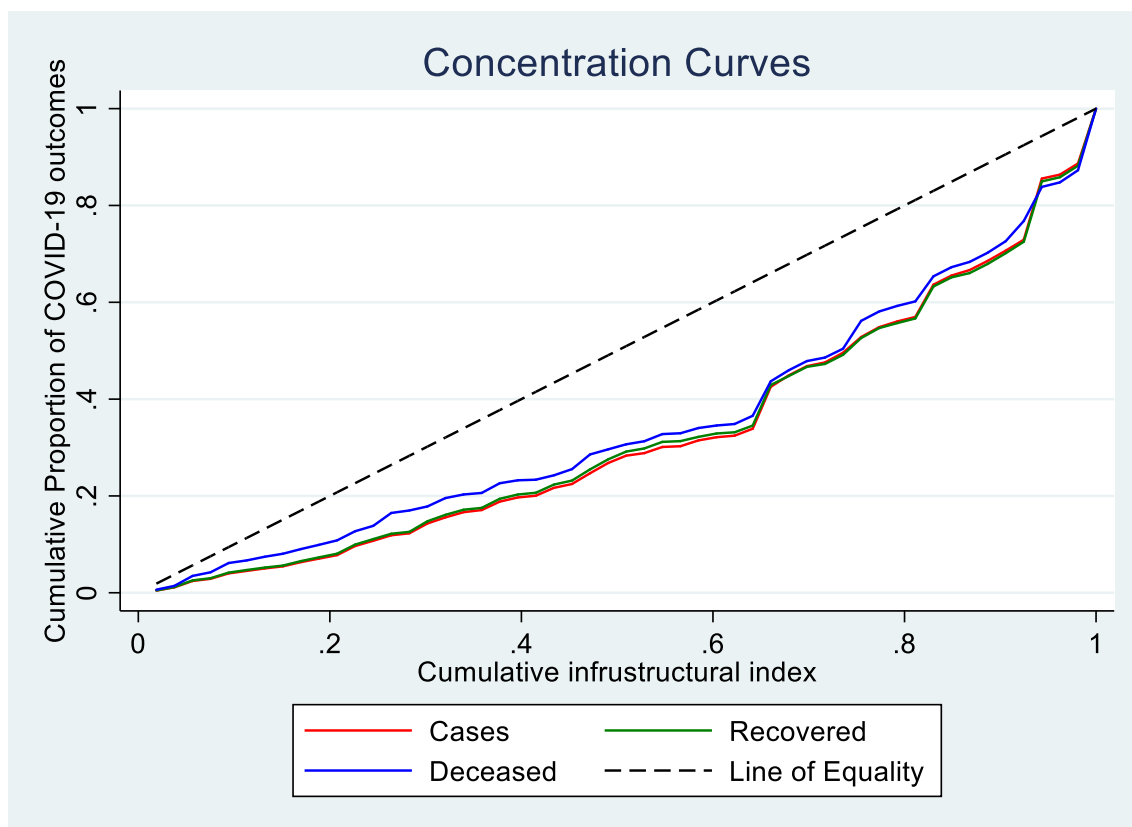
$$\text{Infrastructural index} = PC_1 \text{ score}$$

Figure 4 shows the distribution of outcomes by Infrastructural index quintiles, the results show that with an increasing Infrastructural index, the number of cases, recoveries and deaths increased. This is because majority of the cases were concentrated within big cities and metros. These cities, city of Johannesburg, city of cape town and eThekweni along with other well-developed municipalities have good infrastructure but tend to be densely populated, priming them for faster spread of COVID-19.

Table 14: concentration index using infrastructural index ranking

Cases	53	0.34812931	0.09291594	0.0005
Recovered	53	0.34426755	0.09364196	0.0006
Deceased	53	0.30275947	0.08190823	0.0005

Figure 7: Concentration curve using infrastructural index ranking



The concentration indices for each outcome was positive and the concentration curves below the line of equality as shown in table 13 and figure 7. The findings show a pro-rich distribution, implying that districts with better infrastructure were more at risk for negative covid-19 outcomes.

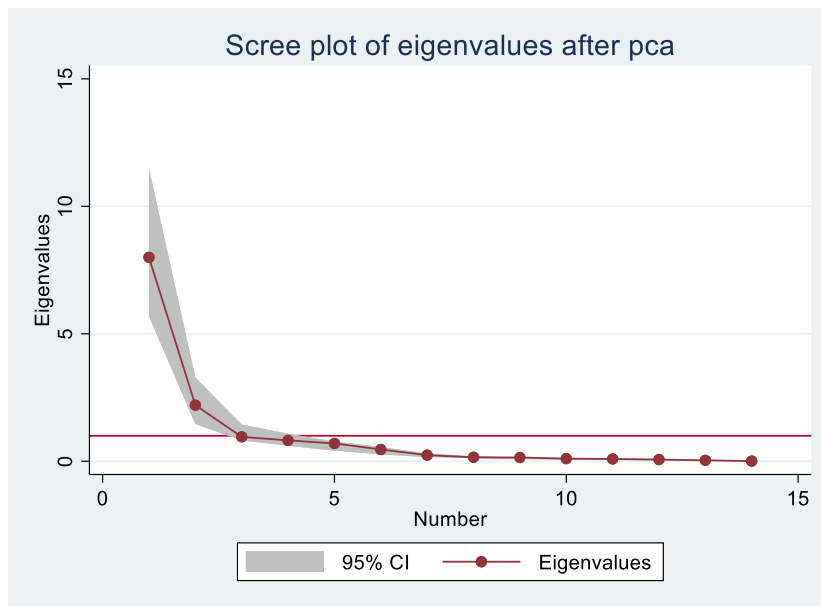
### 7.5 Multidimensional District level socioeconomic index

The interplay between various SES domains of socioeconomic standing as shown in figure 7 is critical to understand. All SES indicators were amalgamated using PCA as shown in table 16. Using the Kaiser criterion cut-off of 1, any PC variable with eigenvalue less than 1 should be discarded significant (Vyas & Kumaranayake, 2006). The eigenvalues signify the importance of each principal component, with PC1 (eigenvalue of 7.90) capturing most of the variance, followed by PC2 with an eigenvalue of 1.16, indicating a significant but lesser degree of variance explained. Components PC3 to PC14, with eigenvalues below 1, explain less variance than individual original variables and are disregarded in further analysis, focusing the interpretation on the more substantial components that embody the crucial variation in the data, thus only principle component 1 and 2 were retained as visualised in the scree plot in figure 8.

Table 15: PCA results for all domains of socioeconomic standing

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	7.90959	6.74826	0.6591	0.6591
Comp2	1.16132	0.297277	0.0968	0.7559
Comp3	0.864045	0.155681	0.0720	0.8279
Comp4	0.708364	0.235728	0.0590	0.8869
Comp5	0.472637	0.229248	0.0394	0.9263
Comp6	0.243389	0.0783126	0.0203	0.9466
Comp7	0.165076	0.0145372	0.0138	0.9604
Comp8	0.150539	0.0285323	0.0125	0.9729
Comp9	0.122007	0.0247787	0.0102	0.9831
Comp10	0.0972279	0.0290381	0.0081	0.9912
Comp11	0.0681899	0.0305719	0.0057	0.9969
Comp12	0.037618	-	0.0031	1.0000

Figure 8: Scree Plot from Principal Component Analysis of ALL SES Variables



The specific loadings of each principal component retained are shown in table 5. PC1 highlights an inverse relationship between income and access to basic utilities, suggesting resource distribution disparities among socioeconomic groups. PC2 reflects demographic influences and household size, with larger households potentially experiencing less poverty, possibly due to shared incomes or economies of scale.

The SES index is then calculated as weighted average of the first 2 principal components

$$SES \text{ index} = PC_1 * weight_1 + PC_2 * weight_2$$

Where  $PC_1$  is the score of the first principal component and  $weight_1$  is the proportion of variance explained by  $PC_1$ .

Figure 9: Distribution of COVID-19 outcomes by multidimensional SES index quintiles

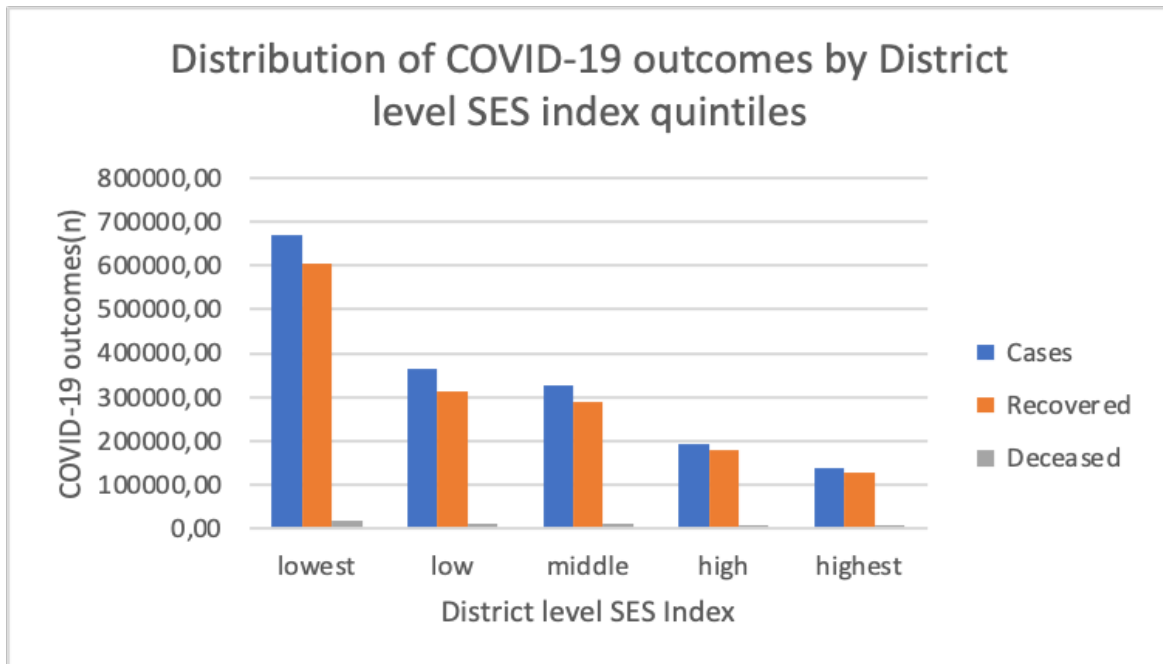
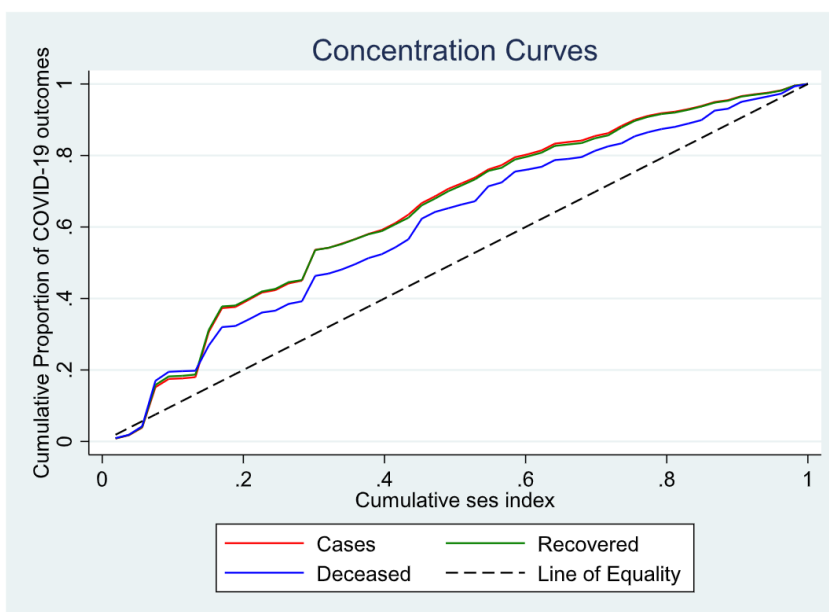


Table 16: concentration index using district level socioeconomic status index ranking

Outcome	No. of obs.	Index value	Std. error	p-value
Cases	53	-0.28070209	0.09728695	0.0057
Recovered	53	-0.27776023	0.09787738	0.0065
Deceased	53	-0.20444314	0.08767399	0.0237

Figure 10: concentration curve using district level socioeconomic status index ranking



Using the district level socioeconomic status index ranking as a ranking variable in which case all the domains have been combined. The concentration indices using the district level SES index, all three outcomes were negative ( -0.281 for cases, -0.278 for recoveries and -0.204 for deaths), and the concentration curves above the line of equality, indicating a pro poor distribution. The results show that districts with an overall low SES index were more likely to experience a greater burden of negative covid outcomes.

## **8 Discussion**

Our study aimed to explore the relationship between socioeconomic status (SES) and COVID-19 outcomes at the district level, leveraging the theoretical frameworks of social determinants of health, intersectionality, and cumulative advantage/disadvantage theory. By conducting a Principal Component Analysis (PCA) we computed various indices of socioeconomic condition (sociodemographic, economic, infrastructural indices) at the district level, further employing concentration indices and curves to study inequality in of COVID-19 cases, recoveries, and mortality related to these domains of socioeconomic standing. The use of district level data sought to bring understanding to the spatial distribution of COVID-19 cases, recoveries, and mortality, considering the disease's natural process of spreading within clustered communities.

### **8.1 Sociodemographic Index**

Sociodemographic Index findings indicated that districts with lower socioeconomic status, characterized by larger household sizes, higher age dependency ratios, presence of individuals aged above 60 and more female-headed households, experienced higher numbers of COVID-19 cases, recoveries, and mortalities. This suggests that these areas, likely due to their socio-structural composition, are more vulnerable to the spread and impact of the virus.

These demographic characteristics increase vulnerability to covid-19 in various ways. For example, literature shows that older adults are demonstrably more susceptible to severe outcomes. Age is a critical risk factor for COVID-19, with older individuals facing increased risks of severe illness and mortality. This vulnerability is largely attributed to physiological changes associated with aging, such as diminished immune function and a higher prevalence of underlying health conditions like hypertension, diabetes, and heart disease, which exacerbate the severity of COVID-19. Phaswana-Mafuya et al. (2021) highlight the use of an intersectionality framework to understand how the confluence of age and these health conditions amplifies susceptibility. Another critical demographic group are those closer to 60 who also have the critical comorbid risk factors as listed earlier. The average age dependency in all districts is 57 years, indicating that when poor covid-19 outcomes occur, households are at risk of losing chief breadwinners and thus worsening their socioeconomic circumstance. This point clearly conjoins age, economic deprivation and negative outcomes as we attempt to illustrate in our conceptual framework.

The mean percentage of female-headed households in South African districts is an estimated 43% and women were found to be at a greater risk than men in empiric literature. Women are worthy to highlight as they often face intersecting disadvantages in terms of access to healthcare, economic opportunities, and social support systems. Within the covid-19 context, our empirical literature review tears the veil to expose other forms of oppression including the named "pink recession" where women lost more jobs compared to men, and the increased burden of unpaid care-giving responsibilities during lockdowns (Collins et al., 2020).

The intersecting identity of a woman, with informal employment and a family to care for places them at great risk of forfeiting employment and ultimately their financial freedom (Cook and Grimshaw, 2020). This intersectional lens , helps to understand how gender and other socioeconomic factors intersect to create additional barriers and disadvantages for women in terms of access to healthcare, and economic opportunities. Alongside economic and financial freedom follows the surge in gender-based violence cases we saw particularly in the lockdown. This “shadow pandemic” of violence against women not only had direct physical and mental health impacts but also may have limited women's ability to seek treatment for COVID-19 or exacerbated the stress and trauma that can weaken immune responses (UN Women, 2020).

## **8.2 Economic Index**

Economic Index results further supported the notion that lower economic status, marked by higher unemployment, poverty rates, and fewer government subsidies, correlates with an increased burden of disease outcomes. This indicates that economic deprivation directly impacts the capacity of communities to respond to and recover from the pandemic.

The variability in employment rates across districts indicates how geographic location intersects with employment opportunities. Areas with lower employment rates might be experiencing compounded socio-economic challenges, including limited access to job markets and educational disparities.

In the context of South Africa, the intersection of geographic location and employment becomes even more pronounced when considering the impact on vulnerable populations such as the elderly, women, and marginalized communities with people of color (Ranchhod & Daniels, 2020). The disparities in employment and income inequalities contribute to shaping the health outcomes, particularly during the COVID-19 pandemic. The district-level analysis revealed a general trend of adult unemployment in the country, with the highest district employment rate at only 39%, a mean of 22%, and a staggering standard deviation of 6%. This variation in employment rates emphasizes the differing economic conditions and opportunities across districts. The presence of compounding socio-economic challenges in districts with lower employment rates further reinforces the need to address geographic disparities in employment opportunities.

Unemployment in certain geographic locations might lead to reduced access to healthcare, inability to afford private health insurance, lower health literacy, increased exposure to risky environments, and reduced ability to adhere to public health measures such as social distancing, especially if they are essential workers who must continue working in high-risk (Alaba et al., 2022; Alechenu, 2021). The pathways resulting from the intersection of geographic location and employment can cumulatively increase the risk of contracting COVID-19 and experiencing worse outcomes for individuals living in these areas. In South Africa, the legacy of apartheid has left a lasting imprint on the geographic distribution of jobs, often segregating employment opportunities from predominantly black residential areas. This spatial mismatch creates barriers to employment due to long commuting times and transportation costs, limiting access to job opportunities for many in historically disadvantaged communities. This leads to 27% of households without any sort of income and 8% living under the poverty line with a standard deviation of 6% and 8% respectively indicating a huge disparity across the country. This socioeconomic circumstance means that 25% of the households require government subsidies, including child, elderly, disability and relief grants, further putting financial strain on the government. Therefore, it is crucial for policymakers and stakeholders to address the socio-economic disparities in these regions and develop targeted interventions to improve access to healthcare services and create sustainable employment opportunities. By understanding the impact of employment and income inequalities in specific geographic locations, efforts can be directed towards mitigating the compounding challenges faced by vulnerable populations, such as the elderly, women, and marginalized communities. Through targeted interventions informed by these findings, significant strides can be made in addressing the disparities and improving the overall health outcomes in these areas.

### **8.3 Infrastructural Index**

Infrastructural Index analysis showed that districts with better infrastructure had higher numbers of COVID-19 outcomes. This finding underscores the complex role that infrastructure plays in disease spread, where better facilities can paradoxically facilitate faster transmission. This observation challenges simplistic interpretations of SES impacts. It suggests that while infrastructure is generally beneficial, in the context of a highly infectious pandemic, it can also facilitate disease spread. This finding invites a nuanced understanding of how different SES components interact to influence health outcomes.

Due to the settlement history of South Africa, there is a tendency of inequality in terms of housing conditions (Grangxabe et al., 2023), this analysis shows that 10% of housing is informal dwellings. South African metros, the City of Cape Town, City of Tshwane, City of Johannesburg, and eThekweni have an average informal dwelling rate of, 15%, 16%, 18% and 13% respectively. In analyzing the high person per household values, it is evident that there is high potential for overcrowding that plays a big role in the spread of COVID-19. The average household has 4 people, with a standard deviation of 0.55 which could indicate that most of the overcrowding is disproportionately in low-income residential areas particularly the

informal dwellings. The connection between dense living conditions in South Africa's informal settlements and the heightened risk of spreading infectious diseases like COVID-19 is further supported by research. Reports identify a significant number of homes in the Johannesburg metropolitan areas as densely populated beyond UN-HABITAT's recommended levels, with a correlated increase in acute respiratory symptoms among inhabitants. These findings imply that the tight living quarters typical of these settlements could amplify the transmission of airborne illnesses such as COVID-19 ( Nkosi et al., 2019; UN HABITAT, 2020).

Another contributor is the heavy concentration of economic activity in major urban centers that has led to several challenges associated with urbanization. The principal concern pertains to an extensive urban encroachment, denoting the unregulated proliferation of urban regions into adjacent rural territories. This phenomenon has resulted in the depletion of natural resources, increased pollution, and a strain on existing infrastructure. This shift has implications for spatial distribution, as newer sectors tend to be urban-centric. The rapid influx of people into urban areas has given rise to informal settlements, characterized by makeshift dwellings and a lack of basic services such as clean water, sanitation, and electricity. These settlements often face significant health and safety risks, further exacerbating the challenges faced by individuals seeking better employment prospects in urban areas (Grangxabe et al., 2023; UN HABITAT, 2020).

Furthermore, the increased demand for urban infrastructure and services, such as transportation, housing, and healthcare, has placed a considerable burden on local authorities and municipal governments (Mthiyane et al., 2022). Looking at the analysis of access to utilities, which is also a vital indicator of living standards, results show high mean values close to 1 for electricity (0,89), water (0.87), and toilet facilities (0.62), indicating that a majority of the sample population has access to these basic amenities. The high standard deviations in these variables suggest that access to these utilities is however not consistently distributed across the population. The need to accommodate and support the growing urban population while addressing issues of poverty, inequality, and access to opportunities presents a complex set of challenges for policymakers and stakeholders. Considering these challenges, it is crucial for South Africa to develop comprehensive urban planning strategies that prioritize sustainable development, equitable resource allocation, and the provision of essential services to both urban and peri-urban areas (UN HABITAT, 2020). By addressing the multifaceted impacts of urbanization, the country can work towards creating inclusive and resilient urban environments that support the well-being and economic advancement of all its residents (Mthiyane et al., 2022).

#### **8.4 Multidimensional District-level Socioeconomic Status Index**

The Overall District-level Socioeconomic Status Index combined these dimensions, demonstrating a comprehensive view of SES as a determinant of COVID-19 outcomes. The negative concentration indices for cases, recoveries, and deaths in lower SES districts confirm that these areas bear a disproportionate burden of the pandemic. Our findings align with the broader literature on the social determinants of health, highlighting how socioeconomic factors such as income, employment, and living conditions significantly influence health outcomes (Nwosu & oyenubi ,2021; Shifa et al., 2022). The disproportionate impact of COVID-19 on lower SES districts underscores the pre-existing inequities that exacerbate the pandemic's effects. This aligns with the theory of intersectionality, where the intersection of various socioeconomic disadvantages leads to cumulative impacts on health.

#### **9 Limitations and Future Research**

This study, while comprehensive, is not without limitations. The use of district-level data, rather than household-level data, provides a broad overview but may mask intra-district variations. Additionally, the PCA approach, though effective in reducing dimensionality, depends on the initial selection of variables, which may not capture all relevant aspects of SES. Future research should aim to disaggregate data to the household or individual level where possible, to capture the micro-level dynamics of COVID-19 spread and impact. Longitudinal studies could also provide insights into the temporal aspects of SES and COVID-19, examining how the relationship evolves over different stages of the pandemic. Further exploration of the interplay between infrastructure and disease spread in different contexts would also enhance our understanding of these complex dynamics. Another limitation in this study was the exclusion of important clinical factors such as non-communicable disease which played an important role in the morbidity and mortality of COVID-19, future bodies of research may explore how clinical and non clinical factors intertwined.

#### **10 Policy Implications**

This study underscores the need for policy measures that address socioeconomic disparities in health outcomes, particularly in times of crisis. Key recommendations include expanding social protection programs to support low-income households and implementing targeted healthcare interventions in underserved areas, such as mobile clinics and affordable medications (Amin and Mahabeer, 2021; Kim and Bostwick, 2020). Additionally, improving infrastructure in informal settlements, reducing overcrowding through affordable housing initiatives, and promoting employment opportunities in vulnerable communities can enhance economic resilience (Chitiga et al., 2021; Khambule, 2022). Public health education campaigns, tailored to address language and cultural barriers, are essential to improve health literacy and promote preventive behaviors (Cloete et al., 2021). Policies should also adopt an intersectional approach to recognize and address the compounded vulnerabilities of groups

affected by poverty, location, and other social factors (Bambra et al., 2020; Khambule, 2021). Lastly, building real-time data systems for monitoring health disparities and incorporating health equity considerations in emergency preparedness plans will enable more effective, targeted responses to future health crises, fostering resilience and reducing inequality (Glover et al., 2020; Turok & Visagie, 2021).

## **11 Declaration of conflict of interest**

We affirm that there are no financial, personal, or professional relationships or affiliations that could be perceived as influencing the content of this article. Additionally, there are no competing interests, such as employment, consultancies, honoraria, or ownership of stock, that could potentially bias our interpretation or presentation of the research findings.

## **12 Conclusion**

Our study contributes to the growing body of evidence on the socioeconomic determinants of health, specifically in the context of the COVID-19 pandemic. It highlights the importance of addressing socioeconomic disparities as part of public health responses to pandemics. The findings underscore the need for targeted interventions in lower SES districts, which are disproportionately affected by COVID-19. Policymakers must consider the multifaceted nature of SES and infrastructure in planning and implementing public health measures, to mitigate the impact of current and future pandemics on the most vulnerable populations.

## 13 Annexures 1

Table 17: Index values by district

Provinces	District	Cases	Recovered	Deceased	Sociodemographic index	Economic index	Infrastructural index	SES index
Kwazulu-Natal	Umzinyathi	7671,00	6959,00	408,00	-2,12	-2,68	1,80	-3,83
Limpopo	Mopani	12227,00	11606,00	472,00	-1,48	-3,09	1,38	-3,48
Eastern Cape	Chris Hani	19096,00	16590,00	1432,00	-1,78	-2,49	1,58	-3,40
Kwazulu-Natal	King Centshwayo	29471,00	28256,00	1076,00	-1,34	-1,97	2,15	-3,13
North West	Ngaka Modiri Molema	18040,00	15872,00	395,00	-0,94	-2,48	1,88	-3,10
Limpopo	Capricon	21449,00	20058,00	934,00	-1,04	-2,99	0,71	-2,79
Eastern Cape	Alfred Nzo	7780,00	7111,00	347,00	-2,57	-2,03	0,04	-2,73
Eastern Cape	Amathole	18961,00	17370,00	1031,00	-1,85	-1,13	1,59	-2,64
Eastern Cape	OR Tambo	22109,00	20625,00	1104,00	-2,53	-0,54	1,40	-2,60
Kwazulu-Natal	Uthukela	14861,00	14002,00	522,00	-1,77	-1,59	1,12	-2,59
Kwazulu-Natal	UmkhayaKude	11224,00	10760,00	419,00	-2,51	-0,55	1,22	-2,51
Kwazulu-Natal	Harry Gwala	8640,00	7669,00	409,00	-1,98	-0,74	1,31	-2,33
Northern Cape	John Taolo Gaetsewe	7451,00	5807,00	170,00	-1,00	-2,13	0,82	-2,32
Limpopo	Vhembe	12123,00	11445,00	494,00	-1,61	-1,10	1,22	-2,27
Eastern Cape	Joe Gqabi	7171,00	6158,00	328,00	-1,61	-1,10	1,22	-2,27
Kwazulu-Natal	Ugu	18416,00	17121,00	601,00	-1,42	-1,24	1,15	-2,20
North West	Dr Ruth Segomotsi	6898,00	5845,00	274,00	-1,08	-1,73	0,64	-2,03
Kwazulu-Natal	Umgungundlovu	37492,00	34850,00	1635,00	-0,79	-1,34	1,32	-1,99
Mpumalanga	Nkangala	27404,00	25518,00	487,00	-0,62	-1,99	0,65	-1,92
Kwazulu-Natal	iLembe	31906,67	28480,51	1014,78	-0,99	-0,99	1,14	-1,82
Mpumalanga	Enhlazeni	34271,00	33128,00	449,00	-1,20	-0,42	1,50	-1,78
Kwazulu-Natal	Amajuba	13567,00	12557,00	683,00	-1,20	-0,42	1,50	-1,78
Eastern Cape	Buffalo City	38190,00	35740,00	2246,00	-0,69	-1,08	1,18	-1,67
Mpumalanga	Gert Sibande	25780,00	24350,00	559,00	-0,56	-0,98	1,25	-1,62
North West	Bojanala	35720,00	31220,00	564,00	-0,55	-0,49	1,42	-1,40
Limpopo	Sekhukhune	8656,00	8108,00	287,00	-1,79	0,30	0,46	-1,09
Kwazulu-Natal	eThekweni	31906,67	28480,51	1014,78	-0,31	-0,50	0,50	-0,77
Limpopo	Waterberg	14520,00	13355,00	330,00	-0,83	-0,22	0,10	-0,68
Free State	Lejweleputswa	18981,00	13321,00	584,00	0,20	0,38	1,59	-0,56
Eastern Cape	Nelson Mandela Bay	54820,00	52359,00	3094,00	-0,14	0,03	0,77	-0,47
Northern Cape	Pixley ka Seme	8738,00	9678,00	342,00	0,83	-0,47	0,18	0,11
Eastern Cape	Lejweleputswa	31906,67	28480,51	1014,78	0,31	-0,15	-0,38	0,31
Free State	Thabo Mofutsanyane	20319,00	13242,00	581,00	-0,70	1,01	-0,63	0,58
North West	Dr Kenneth Kaunda	24240,00	20940,00	915,00	0,41	-0,05	-1,03	0,80
Free State	Mangaung	40322,00	28090,00	1232,00	0,11	1,23	-0,57	1,14
Eastern Cape	Sarah Baartman	21545,00	20541,00	797,00	0,42	1,45	-0,76	1,55
Gauteng	City of Tswane	146406,00	126507,00	3828,00	0,89	1,05	-0,64	1,55
Free State	Xhariep	5321,00	3754,00	165,00	2,23	0,77	0,13	1,64
Eastern Cape	Fezile Dabi	31906,67	28480,51	1014,78	1,15	1,02	-0,71	1,71
Western Cape	Central Karoo	2556,00	2335,00	91,00	2,84	0,42	-0,52	2,19
Gauteng	City of Johannesburg	213684,00	188173,00	3787,00	2,38	0,98	-0,95	2,50
Northern Cape	Frances Baard	20052,00	15627,00	620,00	0,64	2,14	-1,49	2,54
Gauteng	West rand	33893,00	28506,00	981,00	1,43	1,67	-1,71	2,77
Free State	Fezile Dabi	12946,00	9033,00	396,00	1,32	2,18	-1,19	2,79
Northern Cape	Namakwa	6137,00	5459,00	67,00	2,55	1,30	-1,52	3,08
Gauteng	Ekurhuleni	112819,00	99641,00	2782,00	2,38	2,01	-0,94	3,14
Gauteng	Sedibeng	34485,00	30980,00	1042,00	1,34	3,11	-2,02	3,79
Northern Cape	Z F Mgcawu	11224,00	10567,00	280,00	1,33	3,22	-2,07	3,87
Western Cape	Cape Winelands	38858,00	35878,00	1352,00	2,96	1,87	-1,94	3,90
Western Cape	City of Cape Town	191624,00	178116,00	6843,00	3,19	2,03	-2,99	4,69
Western Cape	Overberg	13804,00	12907,00	497,00	3,54	2,56	-4,66	6,05
Western Cape	West Coast	15564,00	14383,00	504,00	3,33	3,75	-3,49	6,12
Western Cape	Garden Route	35901,00	33428,00	1288,00	3,21	4,20	-4,69	6,94

Key:

- ■ Green: Higher values
- ■ Yellow to Orange: Intermediate values
- ■ Red: Lower value

## 14 References

- Achoki, T., Sartorius, B., Watkins, D., Glenn, S. D., Kengne, A. P., Oni, T., ... Naghavi, M. (2022). Health trends, inequalities and opportunities in South Africa's provinces, 1990–2019: Findings from the global burden of disease 2019 study. *Journal of Epidemiology and Community Health*, 76(5), 471–481. doi:10.1136/jech-2021-217480
- Alaba, O. A., Hongoro, C., Thulare, A., & Lukwa, A. T. (2022). Drivers of socioeconomic inequalities of child hunger during COVID-19 in South Africa: Evidence from Nids-Cram Waves 1–5. *BMC Public Health*, 22(1). doi:10.1186/s12889-022-14482-1
- Albani, V., Welsh, C. E., Brown, H., Matthews, F. E., & Bamba, C. (2022). Explaining the deprivation gap in covid-19 mortality rates: A decomposition analysis of geographical inequalities in England. *Social Science & Medicine*, 311, 115319. doi:10.1016/j.socscimed.2022.115319
- Alechenu, B. E. (2021). Forensic analysis of the impact of covid-19 pandemic on the South African economy. *London Journal of Social Sciences*, 26–31. doi:10.31039/ljss.2021.1.8
- Amin, N., & Mahabeer, P. (2021). Curriculum tinkering in situations of crises and inequalities: The case of south africa. *PROSPECTS*, 51(1–3), 489–501. doi:10.1007/s11125-021-09564-8
- Arcaya, M. C., Arcaya, A. L., & Subramanian, S. V. (2015). Inequalities in health: Definitions, concepts, and theories. *Global Health Action*, 8(1), 27106. doi:10.3402/gha.v8.27106
- Ashraf, B. N. (2020). Stock markets' reaction to COVID-19: Cases or fatalities? *Research in International Business and Finance*, 54, 101249. doi:10.1016/j.ribaf.2020.101249
- Ataguba, J. E., Akazili, J., & McIntyre, D. (2011). Socioeconomic-related health inequality in South Africa: Evidence from general household surveys. *International Journal for Equity in Health*, 10(1), 48. doi:10.1186/1475-9276-10-48
- Ataguba, J. E.-O., Day, C., & McIntyre, D. (2015). Explaining the role of the social determinants of health on health inequality in South Africa. *Global Health Action*, 8(1), 28865. doi:10.3402/gha.v8.28865
- Bamba, C., Riordan, R., Ford, J., & Matthews, F. (2020). The COVID-19 pandemic and Health Inequalities. *Journal of Epidemiology and Community Health*. doi:10.1136/jech-2020-214401

Bruce, C., Gearing, M. E., DeMatteis, J., Levin, K., Mulcahy, T., Newsome, J., & Wivagg, J. (2022). Financial vulnerability and the impact of covid-19 on American households. *PLOS ONE*, *17*(1). doi:10.1371/journal.pone.0262301

Chandola, T., Bartley, M., Sacker, A., Jenkinson, C., & Marmot, M. (2003). Health selection in the Whitehall II Study, UK. *Social Science & Medicine*, *56*(10), 2059–2072. doi:10.1016/s0277-9536(02)00201-0

Chitiga, M., Henseler, M., Mabugu, R. E., & Maisonnave, H. (2021). How covid-19 pandemic worsens the economic situation of women in South Africa. *The European Journal of Development Research*, *34*(3), 1627–1644. doi:10.1057/s41287-021-00441-w

Cloete, A., North, A., Ramlagan, S., Schmidt, T., Makola, L., Chikovore, J., ... Reddy, S. P. (2021). "... it is like it has come up and stole our lives from us" the first 21 days: A rapid qualitative assessment of how different sectors of society experienced the COVID-19 lockdown in South Africa. *Social Sciences & Humanities Open*, *4*(1), 100167. doi:10.1016/j.ssaho.2021.100167

Cooper, S., & Kramers-Olen, A. L. (2021). Covid-19, inequality, and the intersection between wealth, race, and gender. *South African Journal of Psychology*, *51*(2), 195–198. doi:10.1177/00812463211015517

Crenshaw, K. (2018). Demarginalizing the intersection of race and sex: A black feminist critique of antidiscrimination doctrine, feminist theory, and antiracist politics [1989]. *Feminist Legal Theory*, 57–80. doi:10.4324/9780429500480-5

Culyer, A. J., & Wagstaff, A. (1993). Equity and equality in Health and Health Care. *Journal of Health Economics*, *12*(4), 431–457. doi:10.1016/0167-6296(93)90004-x

Dannefer, D. (2003). Cumulative advantage/disadvantage and the life course: Cross-fertilizing age and Social Science theory. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *58*(6). doi:10.1093/geronb/58.6.s327

Davillas, A., & Jones, A. M. (2021). The first wave of the COVID-19 pandemic and its impact on socioeconomic inequality in psychological distress in the UK. *Health Economics*, *30*(7), 1668–1683. doi:10.1002/hec.4275

de França, N. C., Campêlo, G. L., de França, J. M., Vale, E. G., & Badagnan, T. F. (2021). A decomposition analysis for socioeconomic inequalities in health status associated with the COVID-19 diagnosis and related symptoms during Brazil's first wave of infections. *Economia*, *22*(3), 251–264. doi:10.1016/j.econ.2021.09.002

De Silva, S. S., Meeker, M. A., Ryan, V., Algur, Y., Long, D. L., Carson, April. P., ... McClure, L. A. (2022a). Comparing global and spatial composite measures of neighborhood

socioeconomic status across US counties. *Journal of Urban Health*, 99(3), 457–468.  
doi:10.1007/s11524-022-00632-8

De Silva, S. S., Meeker, M. A., Ryan, V., Algur, Y., Long, D. L., Carson, April. P., ... McClure, L. A. (2022b). Comparing global and spatial composite measures of neighborhood socioeconomic status across US counties. *Journal of Urban Health*, 99(3), 457–468.  
doi:10.1007/s11524-022-00632-8

Decoster, A., Minten, T., & Spinnewijn, J. (2021). The income gradient in mortality during the COVID-19 crisis: Evidence from Belgium. *The Journal of Economic Inequality*, 19(3), 551–570. doi:10.1007/s10888-021-09505-7

Ezzrari, A., & Verme, P. (2012). A multiple correspondence analysis approach to the measurement of multidimensional poverty in Morocco, 2001–2007. *Policy Research Working Papers*. doi:10.1596/1813-9450-6087

Fernandes, N. (2020). Economic effects of coronavirus outbreak (covid-19) on the World Economy. *SSRN Electronic Journal*. doi:10.2139/ssrn.3557504

Galama, T. J., & van Kippersluis, H. (2018). A theory of socio-economic disparities in health over the life cycle. *The Economic Journal*, 129(617), 338–374. doi:10.1111/eoj.12577

Glover, R. E., van Schalkwyk, M. C. I., Akl, E. A., Kristjansson, E., Lotfi, T., Petkovic, J., ... Welch, V. (2020). A framework for identifying and mitigating the equity harms of covid-19 policy interventions. *Journal of Clinical Epidemiology*, 128, 35–48.  
doi:10.1016/j.jclinepi.2020.06.004

Goldman, N. (1994). Social Factors and Health: The causation-selection issue revisited. *Proceedings of the National Academy of Sciences*, 91(4), 1251–1255.  
doi:10.1073/pnas.91.4.1251

Gordon, T., Booyesen, F., & Mbonigaba, J. (2020). Socio-economic inequalities in the multiple dimensions of access to healthcare: The case of South Africa. *BMC Public Health*, 20(1). doi:10.1186/s12889-020-8368-7

Grangxabe, X.S. *et al.* (2023) ‘The escalation of informal settlement and the high levels of illegal dumping post-apartheid: Systematic review’, *Challenges*, 14(3), p. 38.  
doi:10.3390/challe14030038.

Greyling, T., Rossouw, S., & Adhikari, T. (2021). The good, the bad and the ugly of lockdowns during covid-19. *PLOS ONE*, 16(1). doi:10.1371/journal.pone.0245546

Havard, S., Deguen, S., Bodin, J., Louis, K., Laurent, O., & Bard, D. (2008). A small-area index of socioeconomic deprivation to capture health inequalities in France. *Social Science & Medicine*, 67(12), 2007–2016. doi:10.1016/j.socscimed.2008.09.031

Hoffmann, R., Kröger, H., & Geyer, S. (2018). Social causation versus health selection in the life course: Does their relative importance differ by dimension of SES? *Social Indicators Research, 141*(3), 1341–1367. doi:10.1007/s11205-018-1871-x

Howe, L. D., Hargreaves, J. R., & Huttly, S. R. (2008). Issues in the construction of wealth indices for the measurement of socio-economic position in low-income countries. *Emerging Themes in Epidemiology, 5*(1). doi:10.1186/1742-7622-5-3

Iyanda, A., Boakye, K., & Lu, Y. (2021). Covid-19: Evidenced health disparity. *Encyclopedia, 1*(3), 744–763. doi:10.3390/encyclopedia1030057

Jackson, S., & Yu, D. (2023). Re-examining the multidimensional poverty index of South Africa. *Social Indicators Research, 166*(1), 1–25. doi:10.1007/s11205-023-03062-4

Joseph, J. E. (2021). Post-apartheid South Africa's exacerbated inequality and the COVID-19 pandemic: Intersectionality and the politics of power. *EUREKA: Social and Humanities, 6*(6), 68–78. doi:10.21303/2504-5571.2021.002099

Kabudula, C. W., Houle, B., Collinson, M. A., Kahn, K., Tollman, S., & Clark, S. (2016). Assessing changes in household socioeconomic status in rural South Africa, 2001–2013: A distributional analysis using household asset indicators. *Social Indicators Research, 133*(3), 1047–1073. doi:10.1007/s11205-016-1397-z

Khambule, I. (2021). Covid-19 and the counter-cyclical role of the state in South Africa. *Progress in Development Studies, 21*(4), 380–396. doi:10.1177/14649934211030457

Khambule, I. (2022). Covid-19 and the informal economy in a small-town in South Africa: Governance implications in the post-COVID ERA. *Cogent Social Sciences, 8*(1). doi:10.1080/23311886.2022.2078528

Howa, T., Cimi, A., & Mukasi, T. (2022). Socio-economic impact of covid-19 on rural livelihoods in Mbashe Municipality. *Jamba: Journal of Disaster Risk Studies, 14*(1). doi:10.4102/jamba.v14i1.1361

Kim, S. J., & Bostwick, W. (2020). Social vulnerability and racial inequality in covid-19 deaths in Chicago. *Health Education & Behavior, 47*(4), 509–513. doi:10.1177/1090198120929677

Kollamparambil, U., & Oyenubi, A. (2021). Behavioural response to the COVID-19 pandemic in South Africa. *PLOS ONE, 16*(4). doi:10.1371/journal.pone.0250269

Kröger, H., Pakpahan, E., & Hoffmann, R. (2015). What causes health inequality? A systematic review on the relative importance of social causation and Health Selection. *The European Journal of Public Health, 25*(6), 951–960. doi:10.1093/eurpub/ckv111

Lalloué, B., Monnez, J.-M., Padilla, C., Kihal, W., Le Meur, N., Zmirou-Navier, D., & Deguen, S. (2013). A statistical procedure to create a neighborhood socioeconomic index for Health Inequalities Analysis. *International Journal for Equity in Health*, 12(1), 21. doi:10.1186/1475-9276-12-21

Lamnissos, D., Lambrianidou, G., & Middleton, N. (2019). Small-area socioeconomic deprivation indices in cyprus: Development and association with premature mortality. *BMC Public Health*, 19(1). doi:10.1186/s12889-019-6973-0

Little, C., Alsen, M., Barlow, J., Naymagon, L., Tremblay, D., Genden, E., ... van Gerwen, M. (2021). The impact of socioeconomic status on the clinical outcomes of COVID-19; a retrospective cohort study. *Journal of Community Health*, 46(4), 794–802. doi:10.1007/s10900-020-00944-3

Mackenbach, J. P., Stirbu, I., Roskam, A.-J. R., Schaap, M. M., Menvielle, G., Leinsalu, M., & Kunst, A. E. (2008). Socioeconomic inequalities in health in 22 European countries. *New England Journal of Medicine*, 358(23), 2468–2481. doi:10.1056/nejmsa0707519

Mamelund, S.-E., & Dimka, J. (2021). Not the great equalizers: Covid-19, 1918–20 influenza, and the need for a paradigm shift in pandemic preparedness. *Population Studies*, 75(sup1), 179–199. doi:10.1080/00324728.2021.1959630

Mari-Dell’Olmo, M., Gotsens, M., Pasarín, M. I., Rodríguez-Sanz, M., Artazcoz, L., Garcia de Olalla, P., ... Borrell, C. (2021). Socioeconomic inequalities in COVID-19 in a European urban area: Two waves, two patterns. *International Journal of Environmental Research and Public Health*, 18(3), 1256. doi:10.3390/ijerph18031256

McIntyre, D. (2002). Geographic patterns of deprivation in South Africa: Informing health equity analyses and Public Resource Allocation Strategies. *Health Policy and Planning*, 17(90001), 30–39. doi:10.1093/heapol/17.suppl\_1.30

McIntyre, Di, & Mooney, G. (2007). Where now with equity? *The Economics of Health Equity*, 249–268. doi:10.1017/cbo9780511544460.013

McIntyre, Di, Mooney, G., & Jan, S. (2009). 12.1 need: What is it and how do we measure it? *Oxford Textbook of Public Health*. doi:10.1093/med/9780199218707.003.0091

Mehdizadeh, P., Baygi, V., & Teymourzadeh, E. (2023). Using relative and absolute measures for socioeconomic inequalities in health: Experiences from a retrospective cohort study on COVID-19. *Iranian Journal of Public Health*. doi:10.18502/ijph.v52i6.12993

Mosiane, M., & Shabala, N. (2020). (rep.). *Results from Wave 2 survey on the impact of the COVID-19 pandemic on employment and income in South Africa*. department of statistics .

Retrieved from <https://www.statssa.gov.za/publications/Report-00-80-03/Report-00-80-03May2020.pdf>

Mthiyane, D.B., Wissink, H. and Chiwawa, N. (2022) 'The impact of rural–urban migration in South Africa: A case of kwadukuza municipality', *Journal of Local Government Research and Innovation*, 3. doi:10.4102/jolgr.v3i0.56.

Mulyanto, J., Kringos, D. S., & Kunst, A. E. (2019). Socioeconomic inequalities in healthcare utilisation in Indonesia: A comprehensive survey-based overview. *BMJ Open*, 9(7). doi:10.1136/bmjopen-2018-026164

Nie, P., Ding, L., Chen, Z., Liu, S., Zhang, Q., Shi, Z., ... Wang, Y. (2021a). Income-related health inequality among Chinese adults during the covid-19 pandemic: Evidence based on an online survey. *International Journal for Equity in Health*, 20(1). doi:10.1186/s12939-021-01448-9

Nie, P., Ding, L., Chen, Z., Liu, S., Zhang, Q., Shi, Z., ... Wang, Y. (2021b). Income-related health inequality among Chinese adults during the covid-19 pandemic: Evidence based on an online survey. *International Journal for Equity in Health*, 20(1). doi:10.1186/s12939-021-01448-9

Nkosi, V. *et al.* (2019) 'Overcrowding and health in two impoverished suburbs of Johannesburg, South Africa', *BMC Public Health*, 19(1). doi:10.1186/s12889-019-7665-5.

Nwosu, C. O., & Oyenubi, A. (2021). Income-related health inequalities associated with the coronavirus pandemic in South Africa: A decomposition analysis. *International Journal for Equity in Health*, 20(1). doi:10.1186/s12939-020-01361-7

Omotoso, K. O., & Koch, S. F. (2018). Assessing changes in social determinants of Health Inequalities in South Africa : A decomposition analysis. *International Journal for Equity in Health*, 17(1). doi:10.1186/s12939-018-0885-y

Ostadtaghizadeh, A., Hamdanieh, L., & Nasser, S. (2022). Effects of covid-19 on the availability of clean water and Sanitation. *COVID-19 and the Sustainable Development Goals*, 31–52. doi:10.1016/b978-0-323-91307-2.00001-8

Papageorge, N. W., Zahn, M. V., Belot, M., van den Broek-Altenburg, E., Choi, S., Jamison, J. C., & Tripodi, E. (2021). Socio-demographic factors associated with self-protecting behavior during the COVID-19 pandemic. *Journal of Population Economics*, 34(2), 691–738. doi:10.1007/s00148-020-00818-x

Patel, A. B., Bann, C. M., Garces, A. L., Krebs, N. F., Lokangaka, A., Tshetu, A., ... Hibberd, P. L. (2020). Development of the global network for women's and Children's

Health Research's socioeconomic status index for use in the network's sites in low and lower middle-income countries. *Reproductive Health*, 17(S3). doi:10.1186/s12978-020-01034-2

Phaswana-Mafuya, N., Shisana, O., Jassat, W., Baral, S. D., Makofane, K., Phalane, E., ... Chadyiwa, M. (2021). Understanding the differential impacts of COVID-19 among hospitalised patients in South Africa for equitable response. *South African Medical Journal*, 111(11), 1084. doi:10.7196/samj.2021.v111i11.15812

Phelan, J. C., Link, B. G., & Tehranifar, P. (2010). Social Conditions as fundamental causes of health inequalities: Theory, evidence, and policy implications. *Journal of Health and Social Behavior*, 51(1\_suppl). doi:10.1177/0022146510383498

Quan, D., Luna Wong, L., Shallal, A., Madan, R., Hamdan, A., Ahdi, H., ... Zervos, M. (2021). Impact of race and socioeconomic status on outcomes in patients hospitalized with COVID-19. *Journal of General Internal Medicine*, 36(5), 1302–1309. doi:10.1007/s11606-020-06527-1

Ranchhod, v, & Daniels, R. (2020). Labour market dynamics in South Africa in the time of COVID-19: Evidence from wave 1 of the NIDS-CRAM survey. *South African Labour and Development Research Unit*. Retrieved from <http://hdl.handle.net/11090/981>

Riley, A. R. (2020). Advancing the study of Health Inequality: Fundamental causes as systems of exposure. *SSM - Population Health*, 10, 100555. doi:10.1016/j.ssmph.2020.100555

Riou, J., Panczak, R., Althaus, C. L., Junker, C., Perisa, D., Schneider, K., ... Egger, M. (2021). Socioeconomic position and the COVID-19 care cascade from testing to mortality in Switzerland: A population-based analysis. *The Lancet Public Health*, 6(9). doi:10.1016/s2468-2667(21)00160-2

Rocha, R., Atun, R., Massuda, A., Rache, B., Spinola, P., Nunes, L., ... Castro, M. C. (2021). Effect of socioeconomic inequalities and vulnerabilities on health-system preparedness and response to covid-19 in Brazil: A comprehensive analysis. *The Lancet Global Health*, 9(6). doi:10.1016/s2214-109x(21)00081-4

Sarkar, A., & Chouhan, P. (2021). Covid-19: District level vulnerability assessment in India. *Clinical Epidemiology and Global Health*, 9, 204–215. doi:10.1016/j.cegh.2020.08.017

Settersten, R. A., Bernardi, L., Härkönen, J., Antonucci, T. C., Dykstra, P. A., Heckhausen, J., ... Thomson, E. (2020). Understanding the effects of covid-19 through a life course lens. *Advances in Life Course Research*, 45, 100360. doi:10.1016/j.alcr.2020.100360

Shahbazi, F., & Khazaei, S. (2020). Socio-economic inequality in global incidence and mortality rates from coronavirus disease 2019: An ecological study. *New Microbes and New Infections*, 38, 100762. doi:10.1016/j.nmni.2020.100762

Shifa, M., David, A., & Leibbrandt, M. (2021). Spatial inequality through the prism of a pandemic: Covid-19 in South Africa. *Scientific African*, 13. doi:10.1016/j.sciaf.2021.e00949

Shifa, M., Gordon, D., Leibbrandt, M., & Zhang, M. (2022). Socioeconomic-related inequalities in COVID-19 vulnerability in South Africa. *International Journal of Environmental Research and Public Health*, 19(17), 10480. doi:10.3390/ijerph191710480

Singh, G. K., & Siahpush, M. (2006). Widening socioeconomic inequalities in US life expectancy, 1980–2000. *International Journal of Epidemiology*, 35(4), 969–979. doi:10.1093/ije/dyl083

Stein, H. (2020). Africa and the economic pathologies of the COVID-19 pandemic. *COVID-19 in the Global South*, 85–94. doi:10.2307/j.ctv18gfz7c.15

Strömberg, U., Baigi, A., Holmén, A., Parkes, B. L., Bonander, C., & Piel, F. B. (2021). A comparison of small-area deprivation indicators for public-health surveillance in Sweden. *Scandinavian Journal of Public Health*, 51(4), 520–526. doi:10.1177/14034948211030353

Turok, I., & Visagie, J. (2021). Covid-19 amplifies urban inequalities. *South African Journal of Science*, 117(3/4). doi:10.17159/sajs.2021/8939

Vyas, S., & Kumaranayake, L. (2006). Constructing socio-economic status indices: How to use Principal Components Analysis. *Health Policy and Planning*, 21(6), 459–468. doi:10.1093/heapol/czl029

Warren, J. R. (2009). Socioeconomic status and health across the life course: A test of the social causation and health selection hypotheses. *Social Forces*, 87(4), 2125–2153. doi:10.1353/sof.0.0219

Williams, A., & Cookson, R. (2000). Chapter 35 equity in Health. *Handbook of Health Economics*, 1863–1910. doi:10.1016/s1574-0064(00)80048-7

## 15 Section C: Policy brief



### Policy Brief

**Towards Equity in Pandemic Response: Strengthening Socioeconomic Structures to Improve COVID-19 Outcomes**

By Dr Anza Tshiketane, MBCHB University of Cape Town

## Introduction



### Policy Context

The outbreak of the coronavirus in 2019, widely known as COVID-19, unleashed profound adverse effects on the global economy, leading to significantly deleterious impacts on individuals and families across the globe. The empirical research highlighted the extensive economic repercussions of the pandemic, underlining the widespread strain it has placed on societies<sup>1</sup>. However, the detrimental effects of the pandemic were not evenly distributed among all populations. Studies also have identified stark disparities in the impact of COVID-19, revealing that certain demographics bore the brunt of the pandemic's consequences far more severely than others<sup>2</sup>. Particularly affected were those already facing socioeconomic challenges, including the unemployed, individuals in precarious employment situations, residents of low-income neighbourhoods, and the homeless. These groups encountered a disproportionately higher level of hardship due to the pandemic compared to their more affluent counterparts.<sup>1</sup>



### Stakeholders

The stakeholders in addressing the issues outlined are multifaceted, involving but not limited to:

- National and provincial department of health
- Other relevant ministries such the department of social development, Department of employment and labour and the department of human settlement.
- healthcare providers
- community leaders and civil society leaders
- Healthcare based organisations e.g. the World health organisation.
- Health care donor organisations e.g Bill and Melinda gates foundations, USAID etc.

These entities must collaborate to ensure that the policies and interventions developed in response to pandemics are equitable and address the broader social determinants of health at a neighbourhood level.



### Theoretical Framework

Underpinning this policy brief is the intersectionality theory, which elucidates the complex layers of discrimination that shape health outcomes. In the South African context, with its unique socio-economic landscape shaped by the legacies of apartheid, understanding the interplay of race, gender, class, and other social determinants is crucial for developing effective health policies<sup>1</sup>. Additionally, The social causation hypothesis illustrates how a combination of material, psychosocial, and behavioural factors can lead to health disparities<sup>3</sup>. Furthermore, the Cumulative Disadvantage/Advantage theory emphasizes the magnifying effect of societal structures on these inequalities, a trend clearly evidenced in COVID-19's impact.<sup>1,3</sup>

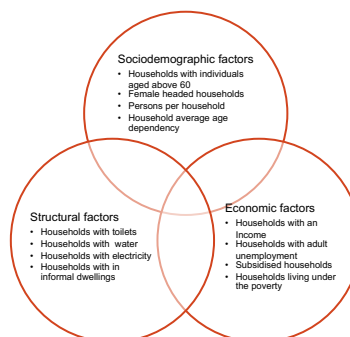
1. Shifa, M. et al. (2022) 'Socioeconomic-related inequalities in COVID-19 vulnerability in South Africa', *International Journal of Environmental Research and Public Health*, 19(17), p. 10480. doi:10.3390/ijerph191710480.  
2. Nwosu, C. O., & Oyenubi, A. (2021). Income-related health inequalities associated with the coronavirus pandemic in South Africa: A decomposition analysis. *International Journal for Equity in Health*, 20(1). doi:10.1186/s12938-020-01361-7  
3. Hoffmann, R., Kröger, H., & Geyer, S. (2018). Social causation versus health selection in the life course: Does their relative importance differ by dimension of SES? *Social Indicators Research*, 141(3), 1341–1367. doi:10.1007/s11205-018-1871-x

# Evidence from the COVID-19 pandemic

## Background of study

The research investigated socioeconomic inequalities in COVID-19 outcomes at the district level in South Africa, employing the intersectionality framework to analyse how different socioeconomic indicators affect COVID-19 cases, recoveries, and fatalities. Data from the National Policy Data Observatory (NPDO) and the 2021 General Household Survey (GHS) were merged to create a dataset.

Socioeconomic variables were categorized into three main domains of deprivation, and a deprivation index was computed for each dimension using principal component analysis (PCA). Additionally, a multidimensional socioeconomic index was computed by combining all variables through PCA. Districts were then grouped into three quintiles based on their deprivation index, with the lowest quintile representing the highest level of deprivation.



**Figure 1: Intersectionality framework**

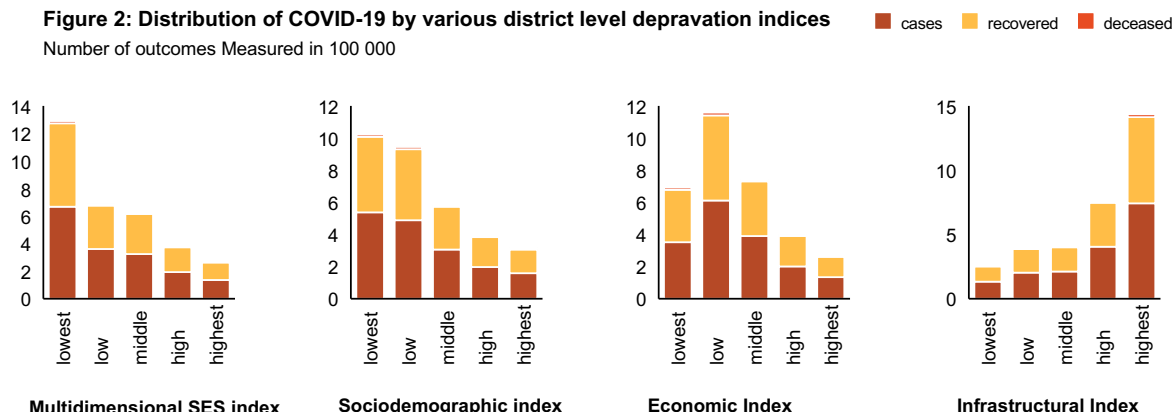
Variables included in the study and their respective SES domain  
Variables were measure as proportion of households per districts

## Results

The charts below show the distribution of outcomes across SES strata, providing a compelling evidence of a 'social gradient' in health at the district level in South Africa.

**Figure 2: Distribution of COVID-19 by various district level deprivation indices**

Number of outcomes Measured in 100 000



### Results of relative inequality measurement

COVID-19 outcome distributions across quintiles were examined, and a concentration index was employed to assess relative inequality<sup>1</sup>, indicating whether outcomes were skewed towards areas of high or low socioeconomic deprivation. Analysing Sociodemographic, economic and multidimensional SES domains, outcomes were concentrated where pro poor and dominated in areas of great deprivation. However, looking at infrastructural development, the outcomes were pro-rich, indicating that areas with adequate infrastructure had worse outcomes.

Socioeconomic Dimension	Distribution
Sociodemographic	Pro-poor
Economic	Pro-poor
Infrastructure	Pro-rich
Multi-dimensional SES	Pro-poor

1. Kakwani, N., Wagstaff, A. and van Doorslaer, E. (1997) 'Socioeconomic inequalities in health: Measurement, computation, and statistical inference', *Journal of Econometrics*, 77(1), pp. 87-103. doi:10.1016/s0304-4076(96)01807-6.

## Recommendations

Based on the evidence and comprehensive analysis presented, the study recommends a combined approach that integrates strengthening public health infrastructure with targeted economic support programs and social policy reforms



### Housing Reforms

Implementing land redesign and redistribution initiatives alongside the development of essential infrastructure in rural areas, aiming to mitigate urbanization pressures and alleviate overcrowding in city centres, thereby reducing the risk of airborne disease transmission.

#### Strategies

- Implement zoning policies for sustainable land use.
- Invest in rural infrastructure: roads, water, electricity.
- Promote economic growth: agriculture, tourism, local industries.

These strategies will boost the economic landscape and habitability of rural areas, further reducing the rate of rural-urban migration.<sup>2</sup>

#### Potential threats to implementation

Due to ongoing socioeconomic deprivation, there are competing priorities such as education that can limit resource allocation into these changes

There may be resistance from certain stakeholders, such as landowners or urban-focused businesses, who may perceive these initiatives as a threat to their interests.

Implementing zoning policies and infrastructure projects can be complex and time-consuming, requiring coordination among various government agencies and stakeholders.

Redistribution of land and development of infrastructure may lead to displacement of existing communities or conflicts over land ownership and use.



### Strengthening Healthcare Infrastructure

Directly impacts the ability to manage public health crises, ensuring long-term sustainability and readiness for future health challenges. Public health systems are built on an infrastructure of (i) service delivery, (ii) health workforce, (iii) health information systems, (iv) access to essential medicines, (v) financing, and (vi) leadership/governance, according to the WHO building blocks<sup>3</sup>.

#### Strategies

- Implementation of the NHI Bill
- Partner with international organizations for funding and expertise.
- Prioritize upgrades in high-density areas to manage caseloads effectively.
- Implement training programs for healthcare workers in rural and underserved areas.

#### Potential threats to implementation

Reliance on international organizations for funding and expertise may lead to challenges in maintaining sustainability if external support diminishes over time.

Implementing the NHI may face political resistance especially if deemed a threat to the private healthcare system, it may also face logistical and administrative hurdles, potentially delaying implementation.



### Economic Support Programs

Offers immediate relief to the most affected, mitigating the direct impact of the pandemic and promotes adherence to public health measures by reducing economic pressures.

#### Strategies

- Roll out of Social Relief of Distress Grant
- Award grants to small and medium sized enterprises to prevent closure during pandemics.
- Implementation of cash incentives programmes for vaccinations, this facilitates good health behaviour whilst providing financial relief.
- Offer educational and vocational training programs, especially focused on technological skills, to ensure alignment with job market demands and facilitate the potential for remote employment opportunities amid pandemics.<sup>4</sup>

#### Potential threats to implementation

The implementation of relief grants and incentive programs requires significant financial resources, which may strain government budgets, particularly during times of economic downturn.

Ensuring fair distribution of grants and incentives to eligible individuals and businesses can be challenging, potentially leaving out vulnerable populations or those in remote areas with limited access to resources.

The long-term sustainability of relief programs and incentives depends on ongoing funding and support, which may be uncertain or subject to changes in government priorities.

The effectiveness of cash incentives for vaccinations in promoting vaccination uptake may vary depending on factors such as public perception, cultural beliefs, and access to healthcare services.

1. Image Source: <https://www.spotlightmap.co.za/2020/09/19/covid-19-what-life-is-like-in-khavelithe-after-the-sunrise/>

2. Yu, D., Li, X., Yu, J., Shi, X., Liu, P., & Tian, P. (2021). Whether urbanization has intensified the spread of infectious diseases—renewed question by the COVID-19 pandemic. *Frontiers in Public Health*, 9. doi:10.3389/fpubh.2021.699710

3. Manyasewale, T. (2017). Using the World Health Organization Health System Building Blocks through survey of healthcare professionals to determine the performance of Public Healthcare Facilities. *Archives of Public Health*, 75(1). doi:10.1186/s13690-017-0221-9

4. Khambule, I. (2022). Covid-19 and the informal economy in a small-town in South Africa: Governance implications in the post-COVID ERA. *Cogent Social Sciences*, 8(1). doi:10.1080/23311886.2022.2078528

## **16 Section D: Research Proposal**

**Research Topic: Socioeconomic inequalities in COVID-19 outcomes in south Africa**

**Student name : Dr Anza Tshipetane**

**Student Number: TSHANZ006**

**Supervisor: Dr Olufunke Alaba**

**Division/Dept: Public Health and family medicine**

### ***Section D: Research Proposal* 93**

#### ***1 Background* 94**

#### ***2 Problem Statement and Rationale for Research* 94**

#### ***3 Literature review* 95**

##### ***3.1 Theoretical literature review* 95**

3.1.1 Theory of the Social Determinants of Health (SDH) 95

3.1.2 Causal Theories of Health Inequality 95

##### ***3.2 Conceptual framework – Intersectionality* 96**

##### ***3.3 Empirical Literature Review* 98**

#### ***4 Aims and Objectives* 99**

#### ***5 Methodology* 100**

##### ***5.1 Data source* 100**

##### ***5.2 Study population* 100**

##### ***5.3 Study variables* 100**

5.3.1 Exposure variables 100

5.3.2 Outcome Variables 101

##### ***5.4 Data analysis plan* 101**

5.4.1 Principal component analysis 102

5.4.2 Generalised Concentration index 103

5.4.3 Concentration curves 103

#### ***6 Limitations* 103**

#### ***7 Ethical consideration* 103**

#### ***8 Conclusion* 104**

#### ***9 Time frame* 104**

#### ***10 References* 104**

## **1 Background**

The World Health Organization (WHO) declared COVID-19 a public health emergency in January 2020 and subsequently a pandemic in March 2020 (WHO, 2020a). In response, the South African government and healthcare system introduced stringent policies to counteract the potential devastation of the virus. These measures encompassed widespread testing, a nationwide lockdown, a prohibition on large public gatherings (including concerts, sporting events, religious festivals, and other social engagements), and the propagation of educational content highlighting the significance of maintaining safe distances and adhering to proper hygiene practices. Despite these efforts, South Africa witnessed a mortality rate of 7%, accounting for 90% of the deaths within the Southern African Development Community (SADC), which represents 91% of the region's confirmed deaths (Aregbeshola & Folayan, 2021).

Moreover, research has identified age, gender, and comorbidities as key determinants of adverse health outcomes and severe COVID-19 manifestations. Specifically, the elderly, males, and individuals with comorbidities (such as chronic kidney diseases, hypertension, cardiovascular diseases, and diabetes) were reported to be at heightened risk (Fathi et al., 2021). However, there's a dearth of literature focusing specifically on South African risk factors contributing to COVID-19-related mortality (Jassat et al., 2021a; Boulle et al., 2020). Existing studies have predominantly targeted patients within public sector hospitals. Few have addressed the situation in private sector hospitals, and those that do often use private sector data as predictor variables for public sector outcomes rather than examining both sectors independently (Jassat et al., 2021b).

## **2 Problem Statement and Rationale for Research**

While recent research has diligently examined the private health-insured population in terms of hospitalization, mortality, length of hospital stay, treatment costs, and the influence of comorbidities on hospitalization and mortality outcomes (Solanki et al., 2022), there remains a paucity of investigation into the socio-economic determinants affecting COVID-19 outcomes. A notable study in Kenya has delved into the manner in which COVID-19 has upset the socio-economic equilibrium, probing deeper into disparities in these disruptions across different Socio-Economic Status (SES) strata. Nonetheless, a definitive connection between the socio-economic statuses of communities and their respective COVID-19 outcomes remains elusive (Oyando et al., 2021).

In light of this, the proposed research seeks to elucidate, through epidemiological theories, how socio-economic status can culminate in disparate health outcomes during outbreaks and pandemics. Insights gleaned from this study hold potential to shape the development and deployment of more effective management and risk mitigation strategies, thereby fostering greater equality during public health crises.

### **3 Literature review**

#### **3.1 Theoretical literature review**

##### **3.1.1 Theory of the Social Determinants of Health (SDH)**

Theories are used in epidemiology to understand the relationships between exposure to socio-economic disadvantage and diseases. In publication of the Black Report in 1982, several categorical theories have been recommended to explain the links between social inequalities and health. Ataguba and McIntyre (2017) highlight the importance of considering both material and psychosocial factors in understanding the social determinants of health. They argue that material factors, such as income and education, have a direct impact on health outcomes, but that psychosocial factors, such as social networks and social support, also play a crucial role. Which bring us to the underlying theory, the theory of the social determinates of health(SDH). These determines directly infer to an individuals socioeconomic status.

Socioeconomic status is a combined economic and sociological measure of an individual's work experience and an individual's or family's economic access. The social determinants of health are the conditions under which people are born, grow up, live, work and age. These include factors such as socioeconomic status parameters including education, neighborhood and physical environment, employment and social support networks, and access to health care. Through the epidemiological theories explored in the literature review, a relationship can be established so show how social determinates of health can affect health outcomes and as such lead to health-related inequality. This is to add on to the work done by McIntyre et al. (2009) which argue that poverty and inequality create a social gradient in health outcomes, with the poorest and most marginalized populations experiencing the worst health outcomes. Covid-19 was a disease that had outcomes being heavily influenced by social factors such overcrowding, employment, access to health care, age and pre-existing medical comorbidities. There were also visible disparities that were seen across south African provinces with varying socio-economic circumstances. This research aims to probe at how there's clustering effects were influenced by socioeconomic circumstances. Making use of theory of social determinants to further explain the context of what happed to cause the varying covid 19 outcomes.

##### **3.1.2 Causal Theories of Health Inequality**

Causal theories of health inequality aim to elucidate the underlying mechanisms that drive disparities in health outcomes across different populations. These theories assert that health inequalities are not merely the product of random events or individual choices but result from a complex interplay of systemic factors. For instance, the "social causation" theory posits that socioeconomic status influences health, with poverty or low social status leading to adverse

health outcomes due to factors like limited access to quality healthcare, poor living conditions, and chronic stress. Conversely, the "health selection" theory suggests that poor health can lead to downward social mobility, thereby reinforcing health disparities. Meanwhile, the "life course" perspective emphasizes the cumulative impact of different social determinants experienced throughout an individual's life, from prenatal stages to old age, in shaping health trajectories. Collectively, these causal theories underscore the multifaceted nature of health disparities and the need for comprehensive interventions addressing the root causes.

### **3.2 Conceptual framework – Intersectionality**

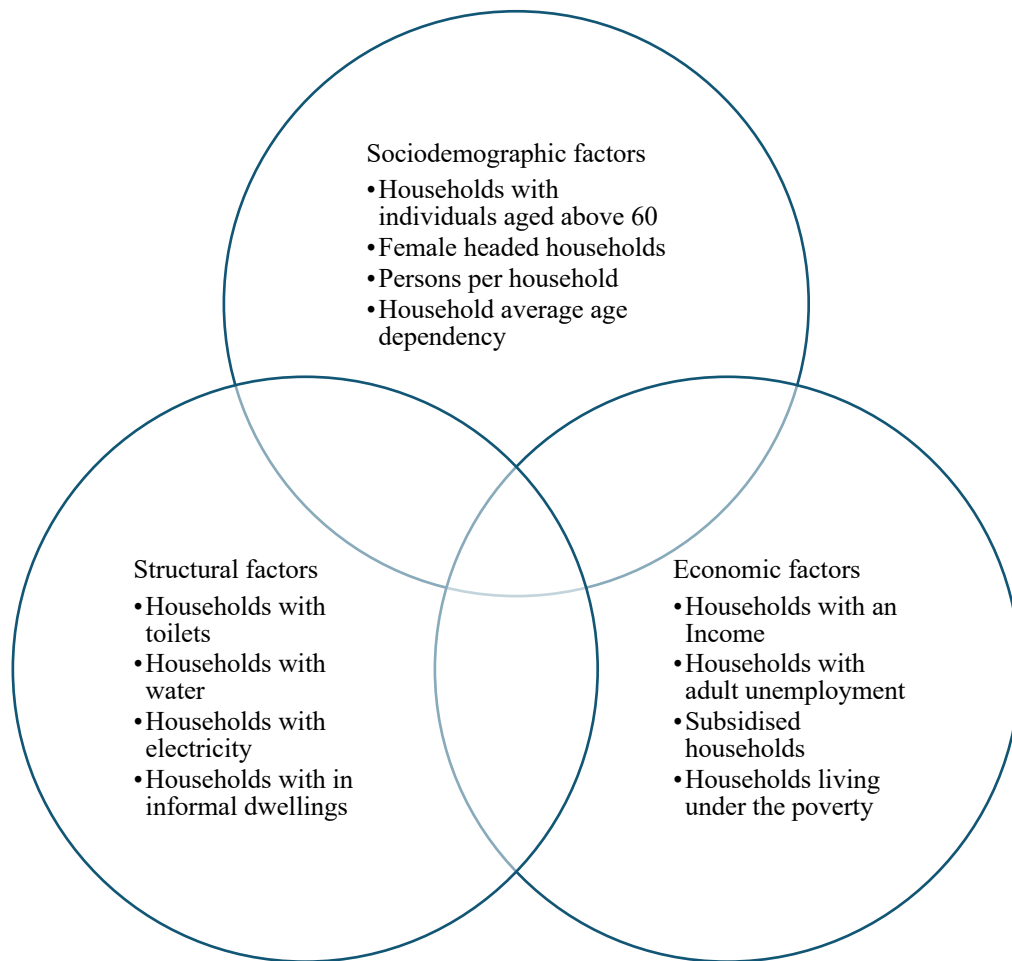
Intersectionality, a term coined by Kimberlé Crenshaw in 1989, emerged from Black feminist activism. It is a theoretical framework for understanding how aspects of a person's social and political identities combine to create different modes of discrimination and privilege. These identities include but are not limited to race, gender, class, and sexual identity, and are not isolated but interwoven in such a way that the intersections compound the experiences of oppression and privilege. This paradigm is particularly significant in recognizing that individuals navigate through life encountering varying degrees of advantage or marginalization. By examining the lived experiences of people belonging to multiple marginalized groups, intersectionality highlights the necessity of considering a multitude of overlapping factors—such as ethnicity, gender identity, socioeconomic status, language, skin color, neurodiversity, religion, (dis)ability, mental health, age, and others—that contribute to the complexity of these experiences. Recent studies continue to explore the nuances of intersectionality, reflecting its evolving nature and ongoing relevance in contemporary social research (Komanisi et al., 2022; Iyanda et al., 2021).

At an individual level, the framework might explore how each SES indicator influences an individual's risk of contracting COVID-19, experiencing severe symptoms, and potentially dying from the virus (Bambra et al., 2020). For example, individuals with lower income or education levels may be more likely to work in jobs that require them to interact with the public or may have limited access to healthcare, increasing their risk of exposure to the virus (Khambule, 2022). The framework would also explore how COVID-19 vulnerability and SES interact to impact outcomes. For example, individuals with lower SES may be less likely to have access to quality healthcare, making it more difficult to receive timely treatment for COVID-. Additionally, social determinants of health related to SES, such as stress and lack of access to healthy food options, may contribute to a weakened immune system, increasing vulnerability to COVID-19 (Gordon et al., 2020). Overall, the proposed framework would aim to identify the ways in which individual SES indicators and broader socio-economic factors interact to influence COVID-19 vulnerability and outcomes. This information could help inform interventions and policies aimed at reducing COVID-19 related inequalities in vulnerable populations.

In addition to individual SES indicators, the proposed framework could also consider contextual factors that may contribute to COVID-19 vulnerability and outcomes in South

Africa. These factors could include geographic location, race, gender, and other social determinants of health that are relevant to the South African context (Fernandes, 2020). For example, individuals living in densely populated areas or informal settlements may be at higher risk of contracting COVID-19 due to difficulties with social distancing and limited access to basic amenities such as clean water and sanitation facilities. Additionally, systemic racism and historical inequalities in South Africa may contribute to differential access to healthcare and other resources, further exacerbating COVID-19 related inequalities (Gordon et al., 2020). At the same time, the framework could also explore how individual and contextual factors may interact to influence COVID-19 outcomes (Chersich et al., 2020). For example, individuals from historically disadvantaged racial or ethnic groups may be more likely to work in essential jobs that put them at risk of exposure to the virus (Khambule, 2022). These individuals may also be more likely to experience co-morbidities such as diabetes or hypertension, which are known risk factors for severe COVID-19 outcomes. Overall, the proposed conceptual framework would aim to provide a comprehensive understanding of how individual and contextual factors interact to influence COVID-19 vulnerability and outcomes in South Africa. This understanding could help guide the development of targeted interventions and policies aimed at reducing COVID-19 related inequalities in the country.

*Figure 2: Intersectionality framework and social determinants of health*



### 3.3 Empirical Literature Review

The empirical literature review form the backbone of research by scrutinizing and synthesizing existing empirical studies related to the topic of interest. This systematic examination provides critical insights into the depth and breadth of previous investigations, establishes a context for the current study, and helps identify gaps in the current body of knowledge.

In the context of health inequalities and the COVID-19 pandemic, the empirical literature documents real-world evidence on how various societal factors, such as political violence, structural racism, and gender disparities, have influenced health outcomes. For instance, studies have reported on the militarization of the COVID-19 response in certain regions of the country, exploring the implications for vulnerable populations(Levine & Manderson, 2020). There's also substantial empirical evidence on the challenges faced by residents of informal settlements, where racial segregation often exacerbates limited access to healthcare, making them disproportionately susceptible to the virus (Salo, 2018; Levine, 2020). Lower SES groups had higher rates of exposure to the virus. Racial/ethnic disparities in risk were found across age groups, Among adults under 65 years old, 33% of Black individuals

(PR=1.22, 95% CI=1.18, 1.26) and 42% of American Indian individuals (PR=1.53, 95% CI=1.41, 1.66) faced a higher risk compared to 27% of White individuals, highlighting the racial disparities further (Raifman & Raifman, 2020).

The association between socio economic status and health outcomes ranging from cardiovascular disease and breast cancer was measured across 22 European counties using regression-based inequality indexes signaling that inequalities might be reduced by improving educational opportunities, income distribution, health-related behavior, or access to health care (Mackenbach et al., 2008). This pattern is consistent in covid-19 findings that showed that lower levels of education and employment, was associated with higher rates of COVID-19 morbidity and mortality. Moreover lower SES was associated with limited access to health care, resulting in delayed or inadequate treatment (Guan et al., 2020).

When using the National Income Dynamics Study (NIDS) dataset conducted in 2017 and the first wave of the NIDS-Coronavirus Rapid Mobile Survey (NIDS-CRAM) dataset conducted in May/June 2020, Concentration curves and indices were used to depict the income-related health inequalities, both indicated a pro poor effect. A decomposition study further showed that, being of African origin (compared to white), individual household income, and instances of hunger in the household notably influenced income-related health disparities, accounting for 130%, 46%, and 9% of these inequalities respectively. On the other hand, having paid employment made a 13% difference to health inequality, but this difference was not statistically significant (Nwosu & Oyenubi, 2021).

Further, the empirical literature paints a comprehensive picture of the pandemic's indirect consequences. Gender inequalities have been magnified during the crisis, with empirical findings indicating significant shifts in women's employment patterns and a spike in gender-based violence due to lockdowns and associated stresses (Musoni, 2022). Moreover, economic repercussions, as evidenced by numerous empirical studies, depict a bleak landscape of market failures, government interventions, and their varied effectiveness. Business closures, bankruptcies, and subsequent unemployment have further accentuated health disparities, creating a vicious cycle where poor economic outcomes can lead to deteriorated health and vice versa (Anderson & Maibom, 2019).

#### 4 Aims and Objectives

##### Aim

- To explore the relationship between socioeconomic status and SES related inequality in Covid-19 outcomes (cases, mortalities, and recoveries).

##### Objectives

- To measure income SES index from socioeconomic indicators of wealth using **principal component analysis**
- To examine the **relationship** between the measured SES and COVID-19 outcomes.

- To use **concentration indices and concentration curves** to quantify SES related inequality in COVID-19 related health outcomes

## 5 Methodology

This section describes the dataset to be used to answer the proposed research question, the variables of interest and proposed statistical analysis

### 5.1 Data source

This study will make use of open-source longitudinal data provided by the National Policy Data Observatory (NPDO). **The National Policy Data Observatory (NPDO) is a government-led, national policy data observatory.** The Council for Scientific and Industrial Research (CSIR) is currently developing the National Policy Data Observatory (NPDO), which is a government-led organisation. The CSIR's Data and Decision Support Centre offers data gathering and storage services, analytics, trends, and dashboards on various socio-economic variables and to the Department of Health.

Information on COVID-19 provided by the NPDO reflects provincial, district, and national-level COVID-19 statistics, encompassing trends, analytics, models, and strategies, rolling averages, mortality, hospitalization surveillance, including pandemic monitoring of waves, variants, and vaccinations (Invitado, 2020). The data is downloaded from the National Policy Data Observatory portal and compiled in a locally accessible spreadsheet. The spreadsheet is backed up on Google Drive under the researcher's account to prevent any loss of information. The NPDO platform collates different open sources data as a repository and has combined sources from national COVID-19 surveillance and the 2021 GHS(General Household Survey).

### 5.2 Study population

The study population is South Africa; each province in South Africa will be taken as a sampling frame and individual districts as sampling units.. With districts as sampling units, this data will take the form of grouped data. The data provided is assigned to the sampling units; however, there are some identified cases where COVID-19 cases cannot be assigned to a district; these will be excluded from the study.

The data captured by the NPDO data with the specified duration of **March 2020 and September 2022**, which is shown by the literature to be the active duration of the COVID-19 pandemic will be used.

### 5.3 Study variables

#### 5.3.1 Exposure variables

The exposure variables are socioeconomic indicators described in table 1 captured by the NPDO from the 2019 GHS; these will be measured as percentages within each district, where values are given as numbers, which will be converted to percentages to ensure the uniformity

of the data. The data is available as original numerical values for the purpose of this study the numbers will be aggregated across districts. The NPDO data has already integrated information from the GHS into the Corona virus district statistics.

### 5.3.2 Outcome Variables

The outcome variables in this study will be Covid 19 related health outcomes (number of cases, number of recoveries, and number of mortalities) aggregated at district level. A description of the variables are in table 2.

Table 1: Describing SES indicator variables

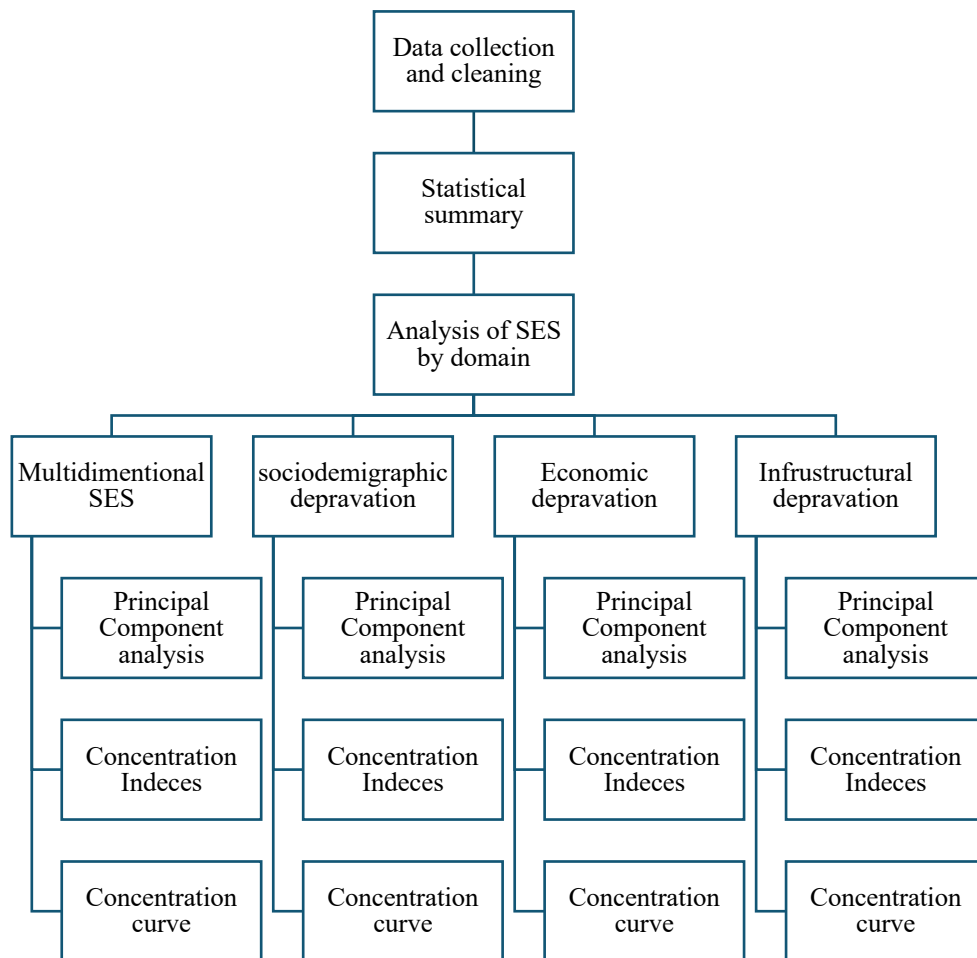
SES indicators	Type of variable
Population	Numerical variable - Discrete
Percentage of individuals with Income	Numerical variable - Continuous
Percentage of individuals with Electricity	Numerical variable - Continuous
Percentage of individuals with Water	Numerical variable - Continuous
Percentage of individuals with Toilets	Numerical variable - Continuous
Percentage of individuals Age 60	Numerical variable - Continuous
Percentage of Adult Unemployment	Numerical variable - Continuous
Percentage of individuals in Poverty	Numerical variable - Continuous
Age Dependency	Numerical variable - Continuous
Percentage of individuals in Informal Dwelling	Numerical variable - Continuous
Percentage of individuals Subsidised by government grants	Numerical variable - Continuous
Person Per Household	Numerical variable - Discrete
Percentage of Female headed households	Numerical variable – Continuous

Table 2: Describing COVID-19 outcome variables

Covid outcomes	Type of variable
Positive Cases per district	Numerical variable – Continuous
Recovered cases per district	Numerical variable – Continuous
Mortality cases per district	Numerical variable – Continuous

### 5.4 Data analysis plan

Drawing on from our conceptual framework, we will divide the SES indicators into 3 domains namely, sociodemographic, economic and infrastructural. These domains will be analysed separately. A multidimensional SES measure will also be analysed where all three domains will be combined.



#### 5.4.1 Principal component analysis

Principal Component Analysis (PCA) is often used to make a Socioeconomic Status (SES) index because it can use statistics to find latent factors or dimensions that explain the differences seen in a set of socioeconomic indicators. The use of Principal Component Analysis (PCA) enables the derivation of weights for each indicator, which are determined by their respective contributions to the overall variability in socioeconomic status.

In the case of principal component analysis, the asset index,  $A_i$ , for individual  $i$  is defined as follows:

$$A_i = \sum_k \left[ f_k \frac{(a_{ik} - \bar{a}_k)}{s_k} \right],$$

where  $a_{ik}$  is the value of asset  $k$  for household  $i$ ,  $\bar{a}_k$  is the sample mean,  $s_k$  is the sample standard deviation, and  $f_k$  are the weights associated with the first principal component.

### 5.4.2 Generalised Concentration index

This section presents an overview of how the measurement of inequality using the concentration index. The standardized concentration index ( $C_h$ ) is typically estimated using the following formula:

$$C_h = \frac{2\text{Cov}(h_i, R_i)}{\mu}$$

where  $h_i$  is health service use or outcome in the context of the study is the COVID-19 related outcomes, the term  $\mu$  is the mean of health service usage and takes the value of 1 if the individual  $I$  had the outcome and 0 if they did not, and  $R_i$  is the individual's fractional socioeconomic rank (Wagstaff, 2011).

A negative index signifies a distribution of poor health that favours individuals with lower income, while a positive index indicates a distribution that favours those with higher income. This can be compared to a concentration curve that lies above (below) the line of equality. Conversely, a concentration index of zero indicates a proportional distribution of poor health across different income groups, similar to a concentration curve that coincides with the line of equality (Wagstaff, 2011).

### 5.4.3 Concentration curves

The concentration index is cumulative proportion of the population by SES ranking against a cumulative proportion of the health outcome. It is referenced against the line of inequality (45 Degree) which indicates no inequality and the distance of the Concentration curve from the line of inequality is the measure of inequality which will show that the distribution of health outcomes is either pro-poor or pro-rich (Kakwani et al., 1997).

## 6 Limitations

The independent and dependent variables are from different population sample, the SES data is derived from the 2021 GHS and the COVID-19 outcomes were reported from the onset of the pandemic in 2020. The different data sources have varying sample sizes, sample compositions, response rates, and measurement errors and thus estimations can be biased. SES index can be considered as a quasi-variable. It is a variable that is not naturally occurring, but rather constructed or derived from other variables. It is not a true variable and thus validity and reliability are affected.

## 7 Ethical consideration

The study will be based on secondary data. The NPDO data is an open access data. As such, there is minimal to no chance of risks to the participants. The data being used in the study are completely secondary data which has already been de-identified. Moreover, no individual-level data is analyzed. The study is based on making inter-district comparisons. As part of the good research etiquettes, this study follows the declaration of Helsinki (World Medical Association, 2013) for good ethical guidance.

## 8 Conclusion

This research protocol presents a comprehensive approach to examining the multifaceted dynamics of social determinants of health and how they affect COVID-19 outcomes. The methodologies chosen are grounded in rigorous scientific practices designed to yield robust and credible results. Utilizing principal component analysis to quantify SES status, correlation methods and concertation indices and curves to assess how SES leads to in/equality in health outcomes, this ensures that the research analysis remains adaptive to the nature of the collected data. In a global context where challenges such as low to middle income country are poor studied, scholarly research plays a pivotal role in guiding informed decisions and interventions. This study aims not only to enrich the academic discourse but also to offer actionable insights that can benefit policymakers, stakeholders, and the broader community. By upholding the highest standards of research integrity, the study is positioned to provide valuable insights and contribute significantly to its field.

## 9 Time frame

Proposal writing	February 2023
Data collection and data cleaning	March 2023
Literature review	April 2023
Data analysis	August 2023
Discussion	September 2023
recommendations	October 2023
Editing and proof reading	January 2024
1 <sup>st</sup> draft submission	February 2024
Final editing and submission	March 2024
Submission	April 2024

## 10 References

- Ataguba, J.E., Akazili, J. & McIntyre, D., 2011. Socioeconomic-related health inequality in South Africa: Evidence from general household surveys. *International Journal for Equity in Health*, 10(1), p.48. Available at: <https://doi.org/10.1186/1475-9276-10-48>.
- Ataguba, J.E.-O., Day, C. & McIntyre, D., 2015. Explaining the role of the social determinants of health on health inequality in South Africa. *Global Health Action*, 8(1), p.28865. Available at: <https://doi.org/10.3402/gha.v8.28865>.
- Ataguba, J.E. & McIntyre, D., 2017. Social determinants of health: the role of effective communication in unlocking their potential. In *Handbook of research on health literacy and communicating health information*. IGI Global, pp.102-121.

- Artiga, S. & Orgera, K., 2020. Communities of colour at higher risk for health and economic challenges due to COVID-19. *KFF*. Available at: <https://www.kff.org/coronavirus-covid-19/issue-brief/communities-of-color-at-higher-risk-for-health-and-economic-challenges-due-to-covid-19/>.
- Ball, K., Timperio, A., Salmon, J., et al., 2007. Personal, social and environmental determinants of educational inequalities in walking: a multilevel study. *Journal of Epidemiology & Community Health*, 61, pp.108–114.
- Bailey, Z.D., Feldman, J.M., Bassett, M.T. & Howerton, O.T., 2020. Racism in healthcare: Implicit bias. *The Lancet*, 395(10236), pp.1644-1646. Available at: [https://doi.org/10.1016/s0140-6736\(20\)31484-9](https://doi.org/10.1016/s0140-6736(20)31484-9).
- Baum, F.E. & Ziersch, A.M., 2003. Social capital. *Journal of Epidemiology & Community Health*, 57, pp.320–323.
- Burki, T.K., 2020. The indirect impact of COVID-19 on women. *The Lancet Infectious Diseases*, 20(8), pp.904-905. Available at: [https://doi.org/10.1016/S1473-3099\(20\)30568-5](https://doi.org/10.1016/S1473-3099(20)30568-5).
- Cohen, J., 2020. Life on lockdown: Scientists around the world scramble to adapt to a new reality. *Science*, 368(6489), pp.348-353. Available at: <https://doi.org/10.1126/science.368.6489.348>.
- Coburn, D., 2000. Income inequality, social cohesion and the health status of populations: the role of neo-liberalism. *Social Science & Medicine*, 51, pp.135–146.
- Galal, S., 2022. South Africa: Population by province, *Statista*. Available at: <https://www.statista.com/statistics/1112169/total-population-of-south-africa-by-province/> (Accessed: November 4, 2022).
- Grossman, M., 1972. On the concept of health capital and the demand for health. *Journal of Political Economy*, 80, pp.223-255. Available at: <http://www.jstor.org/stable/10.2307/1830580>.
- Grossman, M., 2004. The demand for health, 30 years later: a very personal retrospective and prospective reflection. *Journal of Health Economics*, 23, pp.629-636. Available at: <http://dx.doi.org/10.1016/j.jhealeco.2004.04.001>.
- Guan, W. et al., 2020. Clinical characteristics of Coronavirus Disease 2019 in China. *New England Journal of Medicine*, 382(18), pp.1708–1720. doi:10.1056/nejmoa2002032.
- Healthy People 2020, 2014. Social determinants of health. Available at: <https://www.healthypeople.gov/2020/topics-objectives/topic/social-determinants-of-health>.
- Iaccarino, G., Grassi, G., Borghi, C., et al., 2020. Age and multimorbidity predict death among COVID-19 patients. *Hypertension*, 76, pp.366–372.
- Inacio, M.C. et al., 2015. Statistics in brief: An introduction to the use of propensity scores. *Clinical Orthopaedics & Related Research*, 473(8), pp.2722–2726. Available at: <https://doi.org/10.1007/s11999-015-4239-4>.

- Invitado, A., 2020. Critical thinking in a time of pandemic, *Enfoque Educación*. Available at: <https://blogs.iadb.org/educacion/en/criticalthinking/> (Accessed: November 4, 2022).
- Iyanda, A.E., Ajayi, I.A., Falowo, O.O. & Akilapa, A.O., 2020. Global ecological assessment of environmental determinants of COVID-19 fatality rate in different countries. *Science of the Total Environment*, 729, p.138959.
- Kawachi, I., Subramanian, S.V. & Almeida-Filho, N., 2002. A glossary for health inequalities. *Journal of Epidemiology & Community Health*, 56, pp.647–652.
- Kawachi, I. & Berkman, L., 2000. Social cohesion, social capital, and health. In *Social epidemiology*. New York: Oxford University Press, pp.174-190.
- Kawachi, I. & Kennedy, B.P., 1997. Health and social cohesion: why care about income inequality? *BMJ*, 314, pp.1037–1040.
- Kakwani, N., Wagstaff, A. & van Doorslaer, E., 1997. Socioeconomic inequalities in health: Measurement, computation, and statistical inference. *Journal of Econometrics*, 77(1), pp.87–103. doi:10.1016/s0304-4076(96)01807-6.
- Kim, S.W. et al., 2020. A method for measuring spatial effects on socioeconomic inequalities using the concentration index. *International Journal for Equity in Health*, 19(1). Available at: <https://doi.org/10.1186/s12939-019-1080-5>.
- Hirano, K., Imbens, G.W. & Ridder, G., 2003. Efficient estimation of average treatment effects using the estimated propensity score. *Econometrica*, 71(4), pp.1161–1189. Available at: <https://doi.org/10.1111/1468-0262.00442>.
- Mackenbach, J.P. et al., 2008. Socioeconomic inequalities in health in 22 European countries. *New England Journal of Medicine*, 358(23), pp.2468–2481. doi:10.1056/nejmsa0707519.
- McIntyre, D., Thiede, M. & Birch, S., 2009. Access as a policy-relevant concept in low-and middle-income countries. *Health Economics, Policy and Law*, 4(2), pp.179-193.
- Nwosu, C.O. & Oyenubi, A., 2021. Income-related health inequalities associated with the coronavirus pandemic in South Africa: A decomposition analysis. *International Journal for Equity in Health*, 20(1). doi:10.1186/s12939-020-01361-7.
- Oyando, R. et al., 2021. Assessing equity and the determinants of socio-economic impacts of covid-19: Results from a cross-sectional survey in three counties in Kenya. *Wellcome Open Research*, 6, p.339. Available at: <https://doi.org/10.12688/wellcomeopenres.17367.1>.
- Raifman, M.A. & Raifman, J.R., 2020. Disparities in the population at risk of severe illness from covid-19 by Race/ethnicity and income. *American Journal of Preventive Medicine*, 59(1), pp.137–139. doi:10.1016/j.amepre.2020.04.003.
- Sahn, D.E. & Stifel, D.C., 2000. Poverty Comparisons over Time and Across Countries in Africa. *World Development*, 28(12), pp.2123-2155.
- Shumaker, S.A. & Brownell, A., 1984. Toward a theory of social support: closing conceptual gaps. *Journal of Social Issues*, 40, pp.11–36.

- Statistics Solutions, 2013. Data analysis plan: Bivariate (Pearson) Correlation. Available at: <http://www.statisticssolutions.com/academic-solutions/member-resources/member-profile/data-analysis-plan-templates/data-analysis-plan-bivariate-pearson-correlation/>.
- South Africa Population 2022 (live). *South Africa Population 2022 (Demographics, Maps, Graphs)*. Available at: <https://worldpopulationreview.com/countries/south-africa-population> (Accessed: November 3, 2022).
- Townsend, P., Davidson, N. & Black, D.S., 1982. Inequalities in health: The Black report. Harmondsworth: Penguin.
- Wagstaff, A., 2011. The concentration index of a binary outcome revisited. *Health Economics*, 20(10), pp.1155–1160. doi:10.1002/hec.1752.
- WHO, 2018. Health inequities and their causes. *World Health Organization*. Available at: <https://www.who.int/news-room/facts-in-pictures/detail/health-inequities-and-their-causes> (Accessed: December 19, 2022).

## 11 Section D: Ethics Approval



**UNIVERSITY OF CAPE TOWN**  
**Faculty of Health Sciences**  
**Human Research Ethics Committee**



**Room 45 E-52-E-Floor- Old Main Building**  
**Groote Schuur Hospital**  
**Observatory 7925**  
**Telephone [021] 406 6492**  
**Email: [hrec-submissions@uct.ac.za](mailto:hrec-submissions@uct.ac.za)**  
**Website: [www.health.uct.ac.za/home/human-research-ethics](http://www.health.uct.ac.za/home/human-research-ethics)**

19 December 2023

**HREC REF: 783/2023**

**Dr O Alaba**  
Health Economics Division  
FHS  
Email: [Olufunke.alaba@uct.ac.za](mailto:Olufunke.alaba@uct.ac.za)  
Student: [Tshanz006@myuct.ac.za](mailto:Tshanz006@myuct.ac.za)

Dear Dr Alaba

**PROJECT TITLE: SOCIOECONOMIC INEQUALITIES IN COVID-19 OUTCOMES IN SOUTH AFRICA- (MASTERS CANDIDATE-MISS A TSHIPETANE)**

Thank you for your response letter dated 14 December 2023, addressing the issues raised by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

**Approval is granted for one year until the 30 December 2024.**

Please submit a progress form, using the standardised Annual Report Form (FHS016) or FHS017 if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: [www.health.uct.ac.za/fhs/research/humanethics/forms](http://www.health.uct.ac.za/fhs/research/humanethics/forms))

**The HREC acknowledge that the student: Miss A Tshipetane will also be involved in this study.**

**Please quote HREC REF 783/2023 in all your correspondence.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

  
**PROFESSOR M BLOCKMAN**  
**CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE**

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007  
This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of

HREC/ref 783.2023

Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

HREC/ref 783.2023

## 12 Section E: Journal Instructions

Journal : Sage Journals Social Science Information (SSI)

### What do we publish?

#### 1.1 Aims & Scope

*Social Science Information* is a major international forum for the analysis and debate of trends and approaches in social science research and teaching.

Fully peer reviewed, it publishes articles in both English and French, the journal offers a unique window on research currently taking place internationally and in collaboration with the Maison des Sciences de l'Homme in Paris.

*Social Science Information* is cross-disciplinary, presenting research from a broad range of perspectives, including:

- anthropology
- sociology
- psychology
- philosophy
- political science
- economics

*Social Science Information* aims to present new areas of study, focusing on theoretical debates, methodology and comparative and cross-cultural research. The following specialized sections regularly appear:

- Trends and Developments
- Theory and Methods
- Trend Report
- Biology and Social Life
- Rationality and Society
- Studies of Science

The journal also regularly publishes Symposia on specific themes and theme-oriented special issues. It wishes to encourage submission of trend reports.

#### 1.2 Article Types

*Social Science Information* is an international, interdisciplinary, generalist journal that publishes the highest quality original research in the social sciences at large with special

focus on theoretical debates, methodology and comparative particularly cross-cultural research. The journal considers the following kinds of articles for publication:

*Theoretical and methodological articles* in a wide range of disciplines across the social sciences: anthropology; sociology; psychology; philosophy; political sciences; economics.

*Review articles or trend reports* presenting the state of the art in a given discipline or in a given research field; the journal particularly encourages the presentation and discussion of emerging original research topics across the social sciences.

*Comparative particularly cross-cultural studies* in prominent research fields.

*Book reviews* are occasionally published (please contact the editor in advance).

*Symposia* on specific research topics appear occasionally (please contact the editor in advance).

*Special issues* on a specific topic -- including contributions from a range of disciplines and authors from different countries -- with the participation of (a) guest editor(s), are invited twice a year (please contact the editor in advance).

Full papers are generally restricted to a maximum of 12,000 words, including all elements (title page, abstract, notes, references, tables, biographical statement, etc.). We are reluctant to burden our referees with very long manuscripts. Authors who suspect that their articles will have to be cut anyway should make the required deletions before submitting.

### **1.3 Writing your paper**

The Sage Author Gateway has some general advice and on [how to get published](#), plus links to further resources. [Sage Author Services](#) also offers authors a variety of ways to improve and enhance their article including English language editing, plagiarism detection, and video abstract and infographic preparation.

#### ***1.3.1 Make your article discoverable***

When writing up your paper, think about how you can make it discoverable. The title, keywords and abstract are key to ensuring readers find your article through search engines such as Google. For information and guidance on how best to title your article, write your abstract and select your keywords, have a look at this page on the Gateway: [How to Help Readers Find Your Article Online](#)

## **2. Editorial policies**

### **2.1 Peer review policy**

*Social Science Information* operates a strictly anonymous peer review process in which the reviewer's name is withheld from the author and, the author's name from the reviewer. The reviewer may at their own discretion opt to reveal their name to the author in their review but our standard policy practice is for both identities to remain concealed. Each manuscript is reviewed by at least two referees. All manuscripts are reviewed as rapidly as possible, and an editorial decision is generally reached within 8-12 weeks of submission.

Authors must confirm that their contributions have not been published and are not under simultaneous review for publication elsewhere.

As part of the submission process you will be asked to provide the names of X peers who could be called upon to review your manuscript. Recommended reviewers should be experts in their fields and should be able to provide an objective assessment of the manuscript. Please be aware of any conflicts of interest when recommending reviewers. Examples of conflicts of interest include (but are not limited to) the below:

- - The reviewer should have no prior knowledge of your submission
  - The reviewer should not have recently collaborated with any of the authors
  - Reviewer nominees from the same institution as any of the authors are not permitted

Please note that the Editors are not obliged to invite any recommended/opposed reviewers to assess your manuscript.

## **2.2 Authorship**

All parties who have made a substantive contribution to the article should be listed as authors. Principal authorship, authorship order, and other publication credits should be based on the relative scientific or professional contributions of the individuals involved, regardless of their status. A student is usually listed as principal author on any multiple-authored publication that substantially derives from the student's dissertation or thesis.

Please note that AI chatbots, for example ChatGPT, should not be listed as authors. For more [information see the policy on Use of ChatGPT and generative AI tools](#).

## **2.3 Acknowledgements**

All contributors who do not meet the criteria for authorship should be listed in an Acknowledgements section. Examples of those who might be acknowledged include a person who provided purely technical help, or a department chair who provided only general support.

Please supply any personal acknowledgements separately to the main text to facilitate anonymous peer review.

### ***2.3.1 Third party submissions***

Where an individual who is not listed as an author submits a manuscript on behalf of the author(s), a statement must be included in the Acknowledgements section of the manuscript and in the accompanying cover letter. The statements must:

- Disclose this type of editorial assistance – including the individual’s name, company and level of input
- Identify any entities that paid for this assistance
- Confirm that the listed authors have authorized the submission of their manuscript via third party and approved any statements or declarations, e.g. conflicting interests, funding, etc.

Where appropriate, Sage reserves the right to deny consideration to manuscripts submitted by a third party rather than by the authors themselves.

## **2.4 Funding**

*Social Science Information* requires all authors to acknowledge their funding in a consistent fashion under a separate heading. Please visit the [Funding Acknowledgements](#) page on the Sage Journal Author Gateway to confirm the format of the acknowledgment text in the event of funding, or state that: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

## **2.5 Declaration of conflicting interests**

*Social Science Information* encourages authors to include a declaration of any conflicting interests and recommends you review the good practice guidelines on the [Sage Journal Author Gateway](#)

## **3. Publishing Policies**

### **3.1 Publication ethics**

Sage is committed to upholding the integrity of the academic record. We encourage authors to refer to the Committee on Publication Ethics’ [International Standards for Authors](#) and view the Publication Ethics page on the [Sage Author Gateway](#)

#### ***3.1.1 Plagiarism***

*Social Science Information* and Sage take issues of copyright infringement, plagiarism or other breaches of best practice in publication very seriously. We seek to protect the rights of our authors and we always investigate claims of plagiarism or misuse of published articles.

Equally, we seek to protect the reputation of the journal against malpractice. Submitted articles may be checked with duplication-checking software. Where an article, for example, is found to have plagiarised other work or included third-party copyright material without permission or with insufficient acknowledgement, or where the authorship of the article is contested, we reserve the right to take action including, but not limited to: publishing an erratum or corrigendum (correction); retracting the article; taking up the matter with the head of department or dean of the author's institution and/or relevant academic bodies or societies; or taking appropriate legal action.

### **3.1.2 Prior publication**

If material has been previously published it is not generally acceptable for publication in a Sage journal. However, there are certain circumstances where previously published material can be considered for publication. Please refer to the guidance on the [Sage Author Gateway](#) or if in doubt, contact the Editor at the address given below.

### **3.2 Contributor's publishing agreement**

Before publication, Sage requires the author as the rights holder to sign a Journal Contributor's Publishing Agreement. Sage's Journal Contributor's Publishing Agreement is an exclusive licence agreement which means that the author retains copyright in the work but grants Sage the sole and exclusive right and licence to publish for the full legal term of copyright. Exceptions may exist where an assignment of copyright is required or preferred by a proprietor other than Sage. In this case copyright in the work will be assigned from the author to the society. For more information please visit the [Sage Author Gateway](#)

### **3.3 Open access and author archiving**

*Social Science Information* offers optional open access publishing via the Sage Choice programme and Open Access agreements, where authors can publish open access either discounted or free of charge depending on the agreement with Sage. Find out if your institution is participating by [visiting Open Access Agreements at Sage](#). For more information on Open Access publishing options at Sage please [visit Sage Open Access](#). For information on funding body compliance, and depositing your article in repositories, please [visit Sage's Author Archiving and Re-Use Guidelines](#) and [Publishing Policies](#).

## **4. Preparing your manuscript for submission**

### **4.1 Formatting**

The preferred format for your manuscript is Word. LaTeX files are also accepted. Word and (La)Tex templates are available on the [Manuscript Submission Guidelines](#) page of our Author Gateway.

## 4.2 Artwork, figures and other graphics

For guidance on the preparation of illustrations, pictures and graphs in electronic format, please visit Sage's [Manuscript Submission Guidelines](#)

Figures supplied in colour will appear in colour online regardless of whether or not these illustrations are reproduced in colour in the printed version. For specifically requested colour reproduction in print, you will receive information regarding the costs from Sage after receipt of your accepted article.

## 4.3 Supplementary material

*Social Science Information* does not currently accept supplemental files.

## 4.4 Reference style

*Social Science Information* adheres to the Sage Harvard reference style. View the [Sage Harvard](#) guidelines to ensure your manuscript conforms to this reference style.

If you use [EndNote](#) to manage references, you can download the [Sage Harvard EndNote output file](#)

## 4.5 English language editing services

Authors seeking assistance with English language editing, translation, or figure and manuscript formatting to fit the journal's specifications should consider using Sage Language Services. Visit [Sage Language Services](#) on our Journal Author Gateway for further information.

## 5. Submitting your manuscript

*Social Science Information* is hosted on Sage Track, a web based online submission and peer review system powered by ScholarOne™ Manuscripts.

Visit <http://mc.manuscriptcentral.com/SSI> to login and submit your article online.

**IMPORTANT:** Please check whether you already have an account in the system before trying to create a new one. If you have reviewed or authored for the journal in the past year it is likely that you will have had an account created. For further guidance on submitting your manuscript online please visit ScholarOne Online Help.

Review copies of publications and editorial correspondence should be sent to:

David Jaclin, Peter Wagner

*Social Science Information*/Information sur les Sciences Sociales,

Fondation Maison des Sciences de l'Homme,

A1-15, 54 Bd. Raspail  
75270 Paris Cedex 06  
France

Email David Jaclin: [davidjaclin@gmail.com](mailto:davidjaclin@gmail.com)

Email Peter Wagner: [peter.wagner@ub.edu](mailto:peter.wagner@ub.edu)

## 5.1 ORCID

As part of our commitment to ensuring an ethical, transparent and fair peer review process Sage is a supporting member of [ORCID, the Open Researcher and Contributor ID](#). ORCID provides a unique and persistent digital identifier that distinguishes researchers from every other researcher, even those who share the same name, and, through integration in key research workflows such as manuscript and grant submission, supports automated linkages between researchers and their professional activities, ensuring that their work is recognized.

The collection of ORCID iDs from corresponding authors is now part of the submission process of this journal. If you already have an ORCID iD you will be asked to associate that to your submission during the online submission process. We also strongly encourage all co-authors to link their ORCID ID to their accounts in our online peer review platforms. It takes seconds to do: click the link when prompted, sign into your ORCID account and our systems are automatically updated. Your ORCID iD will become part of your accepted publication's metadata, making your work attributable to you and only you. Your ORCID iD is published with your article so that fellow researchers reading your work can link to your ORCID profile and from there link to your other publications.

If you do not already have an ORCID iD please follow this [link](#) to create one or visit our [ORCID homepage](#) to learn more.

## 5.2 Information required for completing your submission

You will be asked to provide contact details and academic affiliations for all co-authors via the submission system and identify who is to be the corresponding author. These details must match what appears on your manuscript. At this stage please ensure you have included all the required statements and declarations and uploaded any additional supplementary files (including reporting guidelines where relevant).

## 5.3 Permissions

**Please also ensure that you have obtained any necessary permission** from copyright holders for reproducing any illustrations, tables, figures or lengthy quotations previously

published elsewhere. For further information including guidance on fair dealing for criticism and review, please see the Copyright and Permissions page on the [Sage Author Gateway](#)

## **6. On acceptance and publication**

### **6.1 Sage Production**

Your Sage Production Editor will keep you informed as to your article's progress throughout the production process. Proofs will be sent by PDF to the corresponding author and should be returned promptly. Authors are reminded to check their proofs carefully to confirm that all author information, including names, affiliations, sequence and contact details are correct, and that Funding and Conflict of Interest statements, if any, are accurate.

### **6.2 Online First publication**

Online First allows final articles (completed and approved articles awaiting assignment to a future issue) to be published online prior to their inclusion in a journal issue, which significantly reduces the lead time between submission and publication. Visit the [Sage Journals help page](#) for more details, including how to cite Online First articles.

### **6.3 Access to your published article**

Sage provides authors with online access to their final article.

### **6.4 Promoting your article**

Publication is not the end of the process! You can help disseminate your paper and ensure it is as widely read and cited as possible. The Sage Author Gateway has numerous resources to help you promote your work. Visit the [Promote Your Article](#) page on the Gateway for tips and advice.

### **13 Section F: Instructions on how to access the data and data analysis**

The dataset was obtained from **National Policy Data Observatory (NPDO)**,

We pulled data for this analyses. The cleaned data and do-files for data analysis can be found by accessing our secure Google Drive.

Email: **Anzatshipetane@gmail.com** to request access.

Link: [https://drive.google.com/drive/folders/1sSIK19zBZ\\_ys2Po6xngty\\_AaNbP48GO?usp=drive\\_link](https://drive.google.com/drive/folders/1sSIK19zBZ_ys2Po6xngty_AaNbP48GO?usp=drive_link)