Journal of Communicable Diseases
Volume 56, Issue 4 - 2024, Pg. No. 23-30
Peer Reviewed & Open Access Journal

Research Article

Epidemiological Determinants of COVID-19 Infection in South Indian Population

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DOI: https://doi.org/10.24321/0019.5138.202466

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How to cite this article:
Arun A, Thendral R, Rakesh A, Nag A, Nath A R, Thankachan B, S Mayookha. Epidemiological Determinants of COVID-19 Infection in South Indian Population. J Commun Dis. 2024;56(4):23-30.

Date of Submission: 2024-11-10
Date of Acceptance: 2024-12-14

A B S T R A C T

Introduction: The COVID-19 pandemic, caused by SARS-CoV-2, has had a significant global impact. In South India, particularly during the second wave in 2021, the situation worsened due to factors such as high population density, urbanisation, and healthcare disparities. This study aims to explore the epidemiological determinants of COVID-19 infection in South India.

Methodology: A cross-sectional online survey was conducted among 317 individuals from South India. Participants, aged 18-65, were selected based on their willingness to participate, with data collected on demographics, health conditions, behavioural factors, and COVID-19-related information. Statistical analysis was performed to identify significant epidemiological factors contributing to COVID-19 infection.

Results: The sample consisted of 56.01% males and 43.99% females, with 68.67% being healthcare/ frontline workers. The majority (55.06%) lived in rural areas. Key findings included 44.94% of participants having travelled during the pandemic and 38.92% involved in essential services. Mental health issues like anxiety (10.44%) and concentration difficulties (10.76%) were common. Self-medication with vitamin C (16.51%) and prophylactic medication use (7.91%) were reported. Socio-economic factors and mental health challenges were associated with an increased risk of COVID-19 infection. Occupation, travel, mental health, and socio-economic status significantly impacted COVID-19 transmission. Healthcare workers were especially vulnerable, highlighting the need for targeted interventions.

Conclusion: This study emphasises the role of socio-economic and behavioural factors in the spread of COVID-19 in South India. Tailored public health strategies, focusing on healthcare access, mental health, and public education, are essential for mitigating future pandemics.

Keywords: COVID-19, Infectious, Disease,Epidemiology, Pandemic

Introduction

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, had a profound impact globally, with more than 280 million confirmed cases and 5.4 million deaths by the end of 2021, making it one of the deadliest health crises in modern history.[1] In India, the pandemic escalated significantly during the second wave in 2021, driven largely by the Delta variant, which resulted in a devastating peak of over 400,000 daily cases by May 2021.[2,3] As of December 2021, India had made substantial progress with vaccination efforts, with approximately 63% of the population receiving at least one dose of the vaccine. Despite these efforts, there were substantial disparities in vaccine coverage, with rural areas and socioeconomically disadvantaged communities facing greater challenges in accessing vaccines.[4]

South India, in particular, experienced a unique set of challenges, including high population density, urbanisation, and regional healthcare disparities, which exacerbated the burden of COVID-19 infections. The region's diverse demographic characteristics, including a large elderly population and significant comorbidities, made it especially vulnerable to severe outcomes of the virus.[5–7] Additionally, the emergence of the Omicron variant in late 2021 further complicated efforts to control the pandemic, highlighting the ongoing need for robust epidemiological surveillance and tailored public health strategies. The healthcare system, already burdened, struggled to meet the demands during the peak of the pandemic, highlighting the limitations of existing infrastructure and the urgent need for public health reforms. Furthermore, the emergence of the Omicron variant in late 2021 complicated efforts to control the virus, underscoring the need for continuous, adaptable strategies in the face of evolving threats.[8–10]

Given these contextual factors, the rationale for this study lies in the need to analyse the epidemiological determinants of COVID-19 infection in South India. This region's unique socio-economic and healthcare landscape requires a targeted approach to better understand the interplay of demographic, clinical, and environmental factors in COVID-19 transmission and severity. By examining these factors, this study aims to generate critical insights that could inform future public health interventions and pandemic preparedness strategies, not just for South India, but also for other regions with similar demographic profiles. The findings are expected to provide a foundation for evidence-based policy decisions and healthcare planning, particularly in the face of emerging variants and potential future outbreaks.

Methodology

The study employed a cross-sectional design, conducted online among the general population of South India duringMay 2021 to October 2021) After obtaining approval from the Institutional Ethical Committee, individuals who met the inclusion criteria were enrolled after giving informed consent. The inclusion criteria consisted of individuals aged 18–65 years, from both genders, who were able to read and understand English and were willing to participate in the study. The exclusion criteria excluded those with depressive symptoms secondary to another primary condition, such as substance abuse or schizophrenia.

A total of 317 participants were recruited for the study, with sample size calculation based on the assumption that 29% of the population would exhibit the factor of interest. Using a 5% absolute precision and 95% confidence level, the calculated sample size was deemed sufficient for accurate representation. The sample size ensures that if 29% of the participants display the factor of interest, the true population proportion is estimated to lie between 24% and 34%, with 95% confidence.[11]

Data collection was done through a self-administered questionnaire distributed via Google Forms, consisting of 25 questions—11 related to demographic factors and 14 to epidemiological determinants. The questionnaire was designed based on WHO training materials for the detection, prevention, response, and control of COVID-19. The collected data were systematically compiled and subjected to statistical analysis to identify significant epidemiological determinants of COVID-19 in South India. Statistical analysis was done using IBM SPSS statistics 25.0.

Result

Demographics

A total of 316 participants took part in this study from South India, with a gender distribution of 56.01% males and 43.99% females. The study's participants included healthcare providers/ frontline workers (68.67%), non-essential service workers (9.49%), and other groups (3.80%). Educationally, 42.41% were undergraduate, 27.22% were postgraduate or had higher education, and 25% had school-level education. The participants were also divided by locality, with 55.06% from rural areas and 44.94% from urban regions. Geographically, 40.5% were from Kerala, 24.92% from Karnataka, 19.88% from Tamil Nadu, and 15.13% from Andhra Pradesh. Employment status revealed that 44.62% were employed, 39.24% were unemployed prior to the pandemic, and 16.14% were unemployeddue to the crisis. In terms of housing, 60.44% had permanent residence, 27.85% lived in rental accommodation, and 11.71% were newly settled. Additionally, the sample included substance users (7.91% alcohol, 4.11% smokers, and 1.90% substance abusers), with 1.99% pregnant women and 45.70% non-pregnant women. Disabilities were reported in 1.28% of the participants, while the remaining 84.66% were not disabled. Finally, the income distribution showed 35.60% with an annual income between

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466

₹ 500,000–1,000,000, 37.68% with ₹ 100,000–500,000, and 26.70% with an income up to ₹ 100,000. This demographic diversity highlights important socio-economic and regional factors, which provide critical insights into understanding the epidemiological determinants of COVID-19 in South India (Table 1).

Health and Behavioural Determinants During COVID-19

During the COVID-19 pandemic, 38.92% of participants were involved in essential services, including roles like drivers (4.19%), food processing and health services (16.75%), nursing or retail pharmacy (14.66%), and others (60.21%). Additionally, 44.94% of participants travelled, with 32.91% using private and 11.71% using public transport. Public transport was utilised less than five times a week by 22.47% of participants and more than five times a week by 14.24%. Social interactions also varied, with 33.54% attending gatherings once a month. Health conditions reported included autoimmune diseases such as type 1 diabetes mellitus (3.48%) and others like depression (2.22%) and pneumonia (0.32%). Mental health challenges were evident, with 19.62% feeling sad or worried, 10.76% struggling to concentrate, and 10.44% experiencing anxiety. 8.23% of participants were on chronic medications, with metformin and thyroxine being common prescriptions.

Self-medication was also prevalent, with 16.51% taking vitamin C and 5.38% using zinc supplements. During the pandemic, 7.91% of participants were prescribed medications by a registered medical practitioner as prophylactic measures, while 80.06% were not. Notably, 7 participants self-prescribed AYUSH remedies and 2 used hydroxychloroquine, despite no formal medical recommendation. This highlights the varied approaches to health management during the pandemic, with some individuals relying on professional prescriptions while others sought alternatives or engaged in self-medication (Table 2).

Table 1.Demographic Profile of Participants

Demographic Parameter	Frequency	Percentage
Gender		
Male	177	56.01
Female	139	43.99
Occupation		
Healthcare provider/ frontline worker	217	68.67
Non-essential services	30	9.49
Others	12	3.80
Level of education		
Undergraduate	134	42.41
Postgraduate and above	86	27.22
School	79	25.00
Not applicable	17	5.37
Locality		
Rural	174	55.06
Urban	142	44.94
State of domicile		
Kerala	135	40.50
Karnataka	84	24.92
Tamil Nadu	67	19.88
Andhra Pradesh	51	15.13
Current employment status		
Employed	141	44.62
Unemployed before crisis	124	39.24
Unemployed due to crisis	51	16.14

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466

Residential status		
Permanent residence	191	60.44
Rental assistance	88	27.85
Newly settled	37	11.71
History of substance abuse		
Not applicable	272	86.08
Alcohol	25	7.91
Smoking	13	4.11
Substance abuse	6	1.90
Pregnancy status		
Not applicable	158	52.32
Non-pregnant	138	45.70
Pregnant	6	1.99
Disabilities		
Not disabled	265	84.66
Disabled	4	1.28
Not applicable	44	14.06
Annual income (₹)		
500000–1000000	120	35.60
100000–500000	127	37.68
Up to 100000	90	26.70

Table 2.Health, Behaviour, and Medication Usage During the Pandemic

S. No.	Determinants	Parameter	Number	Percentage
1	Have you done any essential services during the lockdown period?	Yes	123	38.92
		No	193	61.08
2	Essential services	Drivers	8	4.19
		Food processing unit or wholesale health and welfare	32	16.75
		Nursing/ retail pharmacist	28	14.66
		Import or export services	8	4.19
		Others	115	60.21
3	Have you travelled during the time of pandemic?	Yes	142	44.94
		No	174	55.06
4	Mode of transport	Not applicable	175	55.38
		Private	104	32.91
		Public	37	11.71
5	How often do you use public transport?	< 5 times a week	71	22.47
		> 5 times a week	45	14.24
		Not applicable	200	63.29
6	How often do you attend friends and family gatherings?	More than once in a month	55	17.41
		More than once in a week	21	6.65
		Once in a month	106	33.54
		Once in a week	28	8.86
		Not applicable	106	33.54

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466

7	Have you been diagnosed with any autoimmune disease?	Coeliac disease	2	0.63
		Corona	1	0.32
		Depression	1	0.32
		Pneumonia	1	0.32
		Polycystic ovarian syndrome	1	0.32
		Rheumatoid arthritis	1	0.32
		Systemic lupus erythromatus	2	0.63
		Type 1 diabetes mellitus	11	3.48
		None	1	0.32
		Not applicable	295	93.35
8	Have you been diagnosed with any autoimmune disease?	Allergies	1	0.32
		Coronary artery disease	1	0.32 1.58
		Hypertension	5	0.32
		Hypertension, liver disease	1	2.22
		Type 1 diabetes mellitus type 1 diabetes mellitus, type 2 diabetes mellitus,	7	0.32
		Hypertension		
		No		
		Not applicable		
9	Do you have any neurological conditions?	Dementia	1	0.32
		Major depression	7	2.22
		No	3	0.92
		None	3	0.92
		Not applicable	302	95.57
10	What was your mental status during time of pandemic?	Difficulty in concentrating	34	10.76
		Anxiety/ fear	33	10.44
		Sad/ worried	62	19.62
		Sleeping difficulty/ nightmares	26	8.23
		Not applicable	159	50.33
		All of the above	1	0.32
11	Are you taking any chronic medications?	Yes	26	8.23
		No	290	91.77
12	If yes, mention the medication.	Metformin	4	7.15
		Thyroxine	3	5.37
		Thyronorm	1	1.79
		Formonide 200	1	1.79
		Insulin Humalog mix	1	1.79
		Salbutamol inhalers	1	1.79
13	Were you prescribed any medication by a registered medical practitioner during the pandemic as a prophylactic measure?	Yes	25	7.91
		No	253	80.06
		Prefer not to say	38	12.03

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466

14	Did you self-prescribe any of the following medications during the pandemic?	Zinc supplements	17	5.38
		Vitamin C	52	16.51
		Vitamin D3	12	3.80
		Probiotics	1	0.32
		Hydroxychloroquine	2	0.64
		AYUSH	7	2.24
		Not applicable	21	6.72
		Homeo medications	1	0.32

Discussion

The COVID-19 pandemic, caused by the SARS-CoV-2 virus, posed significant challenges globally, and South India was no exception. This study aimed to analyse the epidemiological determinants of COVID-19 in the South Indian population, focusing on demographic, health, and behavioural factors. The findings suggest that various socio-economic, behavioural, and healthcare-related factors influenced COVID-19 transmission and severity, underscoring the need for tailored public health strategies. The demographic profile of the participants revealed several significant socio-economic factors that could influence COVID-19 susceptibility and severity. A majority of the study participants were healthcare workers (68.67%), which aligns with the heightened exposure to COVID-19 in frontline workers, a well-documented risk factor for infection and severe outcomes.[12–14] The study found a substantial proportion of participants from rural areas (55.06%), indicating that rural populations in South India may be at higher risk due to limited access to healthcare resources, lower vaccination rates, and challenges in adherence to preventive measures.[15,16] Moreover, income disparity was evident, with a significant percentage of participants (37.68%) having an annual income between ₹ 100,000–500,000. Financial limitations can impede access to healthcare and vaccines, a critical determinant of infection rates in lower-income populations.[17,18]

Health-related behaviours and conditions also emerged as significant factors. Around 38.92% of participants reported being involved in essential services during the lockdown period, including healthcare and food processing roles, which placed them at increased risk of exposure. The higher exposure in essential services workers can be linked to increased infection rates in these occupational groups, as seen in other studies.[19] Additionally, a large proportion of participants (44.94%) reported using public transport, a known risk factor for transmission due to close proximity to others and inadequate ventilation.

The mental health burden observed in the study was substantial. About 19.62% of participants reported feeling sad or worried, and 10.76% had difficulty concentrating. These findings reflect the widespread psychological impact of the pandemic, which has been noted in several studies highlighting increased rates of anxiety, depression, and stress during lockdowns.[13] Anxiety and fear related to COVID-19 may contribute to non-compliance with health measures and self-medication, as seen in the current study, where 16.51% of participants self-medicated with vitamin C and 5.38% with zinc supplements. This behaviour reflects the widespread reliance on over-the-counter and non-prescribed medications during health crises, which can lead to potential adverse effects or delays in seeking professional medical care.[20] The study also found that a considerable portion of the population had pre-existing conditions, including autoimmune diseases, diabetes, hypertension, and depression. About 3.48% of participants reported having type 1 diabetes mellitus, and 2.22% had hypertension or coronary artery disease. These chronic conditions have been consistently linked to worse outcomes in COVID-19 patients, as they compromise the immune system or predispose individuals to severe respiratory complications.[21] The study's finding that 8.23% of participants were on chronic medications like metformin and thyroxine further supports the vulnerability of individuals with pre-existing comorbidities during the pandemic. Furthermore, only 7.91% of participants were prescribed prophylactic medications by healthcare providers, highlighting the underutilisation of professional medical advice for prevention.

This finding may suggest gaps in public health messaging or a tendency for individuals to rely on self-medication or unverified treatments, which have been observed in other studies during health emergencies. The regional variation in the study population also provides important insights. The highest percentage of participants was from Kerala (40.5%), followed by Karnataka (24.92%), Tamil Nadu (19.88%), and Andhra Pradesh (15.13%). Kerala, known for its strong healthcare system, had a relatively higher vaccination rate compared to other states, which could have influenced COVID-19 transmission rates. However, Kerala also faced significant challenges with the Delta variant surge in 2021, which necessitated stringent lockdowns and extensive testing and vaccination campaigns. On the other hand, Tamil Nadu and Andhra Pradesh reported higher

ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466

case numbers during the peak of the pandemic, which might have been due to delayed responses or healthcare infrastructure limitations.

The study's limitations include the reliance on self-reported data, which may be subject to recall bias or social desirability bias. Additionally, the cross-sectional design limits the ability to establish causal relationships between the identified determinants and COVID-19 outcomes. Despite these limitations, the study provides valuable insights into the socio-demographic and behavioural factors influencing COVID-19 in South India.

In terms of public health implications, the findings emphasise the need for region-specific interventions, particularly in rural areas, where healthcare access and vaccine coverage remain limited. The study also underscores the importance of addressing mental health issues and chronic comorbidities as part of comprehensive public health strategies. Furthermore, the role of essential workers in the pandemic should be recognised, with targeted vaccination and preventive measures for these high-risk groups.

Conclusion

In conclusion, this study highlights the significant demographic, health, and behavioural determinants of COVID-19 in South India. The results emphasise the need for tailored public health strategies that consider the unique socio-economic and healthcare characteristics of the region. Addressing the gaps in healthcare access, mental health support, and vaccine distribution will be essential in controlling future outbreaks and improving pandemic preparedness in South India.

Source of Funding: None

Conflict of Interest: None

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ISSN: 0019-5138
DOI: https://doi.org/10.24321/0019.5138.202466