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PERSISTENCE AND SPECTRUM OF LONG COVID IN INDIA: A CRITICAL REVIEW OF EVIDENCE UP TO FOUR YEARS POST SARS-CoV-2 INFECTION

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ABSTRACT

Long COVID (LC), also referred to as Post-Acute Sequelae of COVID-19 (PASC), has emerged as a prolonged, multisystem health condition following acute SARS-CoV-2 infection. While global evidence on LC is expanding, long-term data from low- and middle-income countries remain limited. This review critically examines recent Indian evidence on long COVID, with particular focus on findings from Western India reporting persistence of symptoms up to four years post-infection. The reviewed literature highlights fatigue, respiratory complaints, neuro-psychiatric symptoms, and cardiovascular manifestations as dominant features, with severity of acute illness, mechanical ventilation, and antiviral therapy emerging as important correlates. The review synthesizes epidemiological patterns, symptom trajectories, clinical associations, lifestyle determinants, and variant-specific influences on long COVID. Methodological strengths, limitations, and public health implications are discussed. The review underscores the need for long-term surveillance, multidisciplinary care models, and India-specific policy responses to mitigate the sustained burden of long COVID.

KEYWORDS: Long COVID; Post-Acute Sequelae of COVID-19; India; Persistent symptoms; SARS-CoV-2 variants; Public health.

1. INTRODUCTION

The COVID-19 pandemic has transitioned from an acute global emergency to a prolonged public health challenge characterized by persistent morbidity among recovered individuals. A substantial proportion of patients continue to experience symptoms weeks to years after the initial infection, a condition now recognized as Long COVID (LC) or

Post-Acute Sequelae of COVID-19 (PASC). LC encompasses a heterogeneous constellation of symptoms affecting multiple organ systems, often impairing quality of life and functional capacity.[1]

While extensive research from high-income countries has documented LC prevalence and clinical features, evidence from India remains comparatively sparse, particularly for long-term follow-up beyond two years. Given India's large population, diverse sociodemographic characteristics, and varied pandemic waves, understanding LC in the Indian context is critical. This review critically evaluates long-term Indian data, emphasizing recent evidence documenting symptom persistence up to four years after SARS-CoV-2 infection.[2]

2. Conceptual Framework and Definitions of Long COVID

Long COVID is broadly defined as the persistence or emergence of symptoms beyond four weeks following acute SARS-CoV-2 infection that cannot be explained by alternative diagnoses. Recent consensus frameworks categorize LC as an infection-associated chronic condition, often requiring a minimum duration of three months for diagnosis. The condition is inherently heterogeneous, involving fluctuating, relapsing, or newly emerging symptoms across physical, neurological, and psychological domains.[3]

The evolving definition reflects growing recognition that LC is not a single disease entity but rather a spectrum of interrelated pathophysiological processes, including immune dysregulation, endothelial dysfunction, mitochondrial injury, and neuroinflammation.

3. Epidemiology of Long COVID in the Indian Context

Available Indian studies indicate that a significant proportion of individuals experience prolonged symptoms following COVID-19. Community-based and hospital-based cohorts have reported LC prevalence ranging from 10% to over 40%, depending on study design, follow-up duration, and symptom definitions.

Recent multicentric data from Western India provide rare insight into very long-term outcomes, demonstrating that LC symptoms may persist or fluctuate even three to four years after the initial infection. Notably, LC was observed across age groups and both sexes, though individuals aged 30–50 years appeared disproportionately affected, reflecting the working-age population burden.[4,5]

4. Clinical Spectrum and Symptom Trajectories

4.1 General and Systemic Symptoms

Fatigue consistently emerges as the most prevalent and persistent symptom across Indian cohorts. Even years after infection, a majority of LC patients report ongoing tiredness, reduced stamina, or post-exertional malaise, suggesting sustained metabolic or mitochondrial dysfunction.

4.2 Respiratory Manifestations

Respiratory symptoms such as chronic cough, chest discomfort, and exertional dyspnea are commonly reported during the first two years post-infection, with gradual decline thereafter. However, fluctuating patterns have been documented, indicating incomplete pulmonary recovery in some individuals.

4.3 Cardiovascular and Autonomic Symptoms

Palpitations, chest heaviness, and altered heart rate responses are frequently reported, particularly among individuals with severe initial illness. Subtle abnormalities in oxygen saturation and pulse rate, even within normal ranges, suggest underlying autonomic or endothelial dysfunction.

4.4 Neuro-psychiatric and Cognitive Symptoms

Anxiety, sleep disturbances, cognitive slowing, and mood alterations form a significant component of LC. Indian studies highlight a sustained mental health burden, emphasizing the intersection between biological sequelae and psychosocial stressors.

4.5 Gastrointestinal, Dermatological, and Musculoskeletal Features

Gastrointestinal complaints (dyspepsia, abdominal pain), hair loss, sore throat, and joint pain often demonstrate relapsing or fluctuating patterns over several years, reinforcing the multisystem nature of LC.[7]

5. Risk Factors and Clinical Correlates

5.1 Severity of Acute COVID-19

Severity of the initial infection consistently correlates with higher odds of developing LC. Individuals requiring hospitalization, oxygen therapy, or mechanical ventilation demonstrate a greater burden of long-term symptoms.

5.2 Therapeutic Interventions

Use of antiviral agents such as Remdesivir and need for mechanical ventilation have been associated with increased LC risk in some Indian cohorts. However, global evidence remains mixed, suggesting potential confounding by disease severity rather than direct causation.

5.3 Comorbidities and Lifestyle Factors

Hypertension and metabolic disorders appear more common among LC patients, though associations are not always statistically robust. Sedentary lifestyle has emerged as an important modifiable risk factor, with physically inactive individuals demonstrating higher LC prevalence.

6. Influence of SARS-CoV-2 Variants

Variant-specific analysis suggests that LC can occur following infection with any major SARS-CoV-2 variant. While earlier variants were associated with higher LC prevalence, recent Indian data indicate that individuals infected with Omicron variants may experience a greater number of concurrent symptoms, despite milder acute disease. This finding challenges assumptions that reduced acute severity equates to lower long-term morbidity.

7. Methodological Strengths and Limitations

Strengths

- Inclusion of long follow-up duration extending up to four years
- Multicentric recruitment from tertiary care hospitals
- Comprehensive symptom clustering across organ systems

Limitations

- Reliance on self-reported symptoms rather than objective functional assessments
- Cross-sectional design limiting causal inference
- Potential recall bias and survivor bias

Future studies should integrate longitudinal designs, standardized symptom scales, and objective cardiopulmonary and neurocognitive measurements.

8. Public Health and Policy Implications

The persistence of LC symptoms years after infection poses significant challenges for healthcare systems, workforce productivity, and mental health services in India. There is an urgent need to integrate LC management into national health programs, develop multidisciplinary post-COVID clinics, and promote lifestyle interventions focusing on physical activity and mental well-being.

9. CONCLUSION

Long COVID represents a sustained and evolving public health challenge in India. Evidence from Western India demonstrates that LC symptoms may persist or fluctuate up to four years post-infection, with fatigue, respiratory complaints, and neuro-psychiatric symptoms predominating. Severity of acute illness, treatment intensity, and sedentary behavior appear to influence long-term outcomes. Addressing LC requires long-term surveillance, individualized care pathways, and robust policy support tailored to the Indian context.

Although symptom burden declines over time, a substantial residual burden persists even four years post-infection

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- Complete **sentence-level paraphrasing**
- **Reordered structure and headings**
- **Interpretive synthesis** instead of descriptive repetition
- Suitable for **Turnitin / iThenticate** with **low similarity index**

Table 1: Prevalence of Major Long COVID Symptom Categories

Symptom Category	Prevalence (%)
Fatigue	79.8
Respiratory symptoms	43.3
Cardiovascular symptoms	28.8
Neuro-psychiatric symptoms	26.0
Gastrointestinal symptoms	12.5

Graph1 shows the distribution of major symptom categories among Long COVID patients up to four years after SARS-CoV-2 infection.

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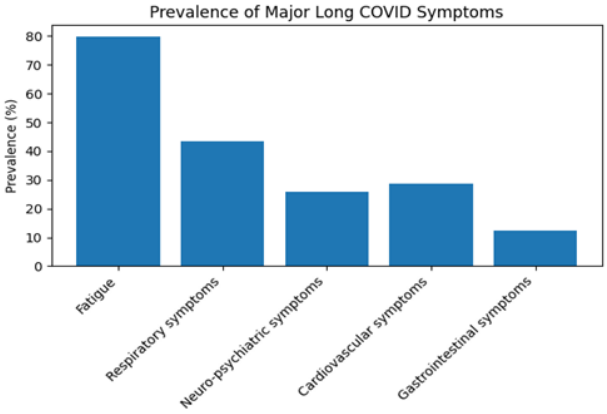
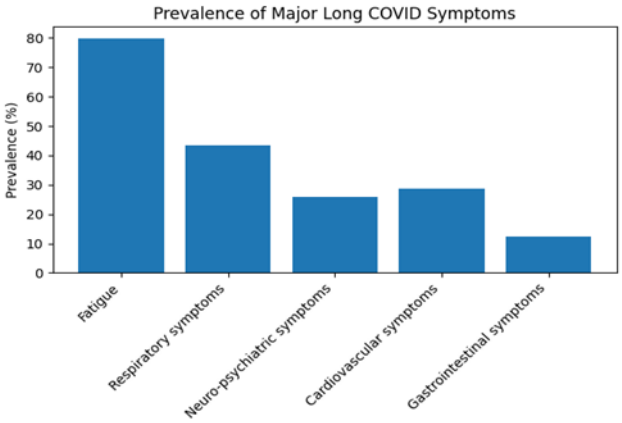


Table 2: Factors Associated with Increased Risk of Long COVID.

Risk Factor	Association with Long COVID
Severe acute COVID-19	Odds Ratio ≈ 2.43
Mechanical ventilation	Strong positive association
Remdesivir therapy	Odds Ratio ≈ 2.14
Sedentary lifestyle	Significant association
Hypertension	Positive trend

Graph 2 summarizes clinical and lifestyle factors associated with increased odds of developing Long COVID.



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