

Post COVID Determinants of Cardiovascular Recovery: Insights from a Multi Centric Observational Study in Haryana, India

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Abstract: . This study aimed to evaluate demographic, clinical, lifestyle and treatment determinants of cardiovascular recovery among patients with pre- and post COVID conditions in Haryana, India. A multi-cultural observational survey was conducted across cardiology departments in five districts, enrolling 70 patients through a structured cardiac questionnaire. The cohort was predominantly male (65.7%), with the largest age group between 46–60 years, and most participants residing in rural areas (74.3%). Hypertension (57.1%) and diabetes mellitus (40.0%) were the most common comorbidities, while post COVID cardiovascular manifestations such as dyspnea (71.4%), chest pain (60.0%), palpitations (40.0%), and fatigue or edema (42.9%) were frequently reported. Vaccination coverage was high, with 77.1% of patients receiving two dose boosters and vaccinated individuals demonstrated better recovery outcomes compared to unvaccinated patients. Lifestyle assessment revealed that although all respondents consumed home cooked diets, 78.6% did not engage in regular exercise and 25.7% reported occasional smoking or alcohol use, factors that correlated with poorer recovery. In terms of management, all patients received medication, while 31.4% underwent physical therapy, 25.7% adopted dietary changes and 8.6% required surgical interventions. Overall, 68.6% achieved full recovery, 25.7% showed partial improvement, and 5.7% continued to experience persistent symptoms, with recovery being more favorable among younger, urban and vaccinated individuals. These findings emphasize that cardiovascular recovery in the post COVID era is shaped by demographic, clinical, lifestyle and treatment factors, and highlight the need for integrated strategies combining medical therapy, vaccination, and lifestyle modification to optimize outcomes, particularly in vulnerable populations.

Keyword: Cardiovascular Diseases, Post COVID Recovery, Hypertension, Diabetes, Lifestyle Determinants, Vaccination Outcomes

Introduction

Cardiovascular diseases (CVDs) continue to be the foremost cause of global morbidity and mortality, with their burden shaped by a multi factorial interplay of biological characteristics, environmental determinants and lifestyle behaviors. Established risk factors such as hypertension, diabetes mellitus, dyslipidemia, obesity, and smoking have long been recognized as central contributors to adverse cardiovascular outcomes (World Health Organization, 2023). Lifestyle determinants including dietary patterns, physical inactivity and psychosocial stress further modulate disease progression and outcomes, underscoring the importance of preventive strategies at both individual and population levels. The advent of the COVID 19 pandemic has introduced new complexities into cardiovascular health. Evidence suggests that SARS-CoV-2 infection can precipitate acute cardiac injury, myocarditis, arrhythmias and thromboembolic events, while also leaving long term sequelae collectively referred to as “post-COVID” or “long COVID” effects (Hatmi and Mahboobian, 2025). Persistent inflammation, endothelial dysfunction and deregulated immune responses have been implicated in the heightened cardiovascular risk observed among COVID 19 survivors (Batalha Santa Maria *et al.*, 2025). These post infectious manifestations not only exacerbate pre existing cardiovascular conditions but may also initiate novel disease pathways, thereby expanding the spectrum of risk factors beyond traditional determinants.

Moreover, social and environmental determinants including socioeconomic status, healthcare accessibility and occupational exposures interact with lifestyle behaviors to influence cardiovascular outcomes in the post COVID era. Recent analyses emphasize the need for integrated approaches that combine lifestyle modification, risk factor management, and long-term monitoring of COVID-19 survivors to mitigate cardiovascular complications (Kagure Wachira *et al.*, 2025; SN Comprehensive Clinical Medicine, 2025). This study aims to systematically examine the characteristics, determinants, lifestyle influences, and risk factors associated with cardiovascular outcomes, with particular emphasis on post COVID-19 effects. By synthesizing epidemiological data and clinical evidence, the research seeks to provide a nuanced understanding of how the pandemic has reshaped cardiovascular risk profiles and to inform targeted interventions for reducing the global burden of CVDs.

Review of Literature

Cardiovascular diseases are shaped by a multi factorial interplay of biological predispositions, lifestyle behaviors, and environmental determinants. Hypertension, diabetes mellitus, dyslipidemia, obesity, and smoking remain the most prevalent risk factors globally. [Harrison et al. \(2021\)](#), in an umbrella review of systematic reviews, demonstrated that individuals with pre existing cardiovascular risk factors were significantly more likely to experience severe COVID-19 outcomes, including hospitalization and mortality. This evidence highlights the convergence of traditional cardiovascular determinants with infectious disease vulnerability. The COVID-19 pandemic has introduced acute cardiovascular complications, including myocarditis, arrhythmias, and thromboembolic events. [Hatmi and Mahboobian \(2025\)](#) conducted a systematic review that documented elevated cardiac biomarkers, such as troponins, in hospitalized COVID-19 patients, correlating with poor prognosis and increased mortality. Their findings underscore the role of systemic inflammation and endothelial dysfunction in precipitating acute cardiac injury. Beyond the acute phase, long term sequelae have emerged as part of the “long COVID” spectrum. [Santa Maria et al. \(2025\)](#) synthesized evidence from multiple cohorts and reported that post COVID patients exhibited increased risks of arrhythmias, heart failure and thrombotic events, even in those without prior cardiovascular disease. These results suggest that COVID-19 may act as a novel determinant of cardiovascular risk, reshaping traditional profiles and necessitating long term surveillance.

Lifestyle and social determinants further modulate these outcomes. [Kagure Wachira et al. \(2025\)](#) emphasized that dietary habits, physical activity and psychosocial stress interact with socioeconomic status and healthcare accessibility to influence recovery trajectories in COVID-19 survivors. Their analysis advocates for integrated approaches that combine lifestyle modification, risk factor management, and long term monitoring to mitigate cardiovascular complications in the post pandemic era. The convergence of traditional cardiovascular risk factors with post COVID effects underscores the need for comprehensive prevention and management strategies. Multidisciplinary approaches that integrate cardiology, infectious disease and public health perspectives are increasingly recognized as vital for reducing the compounded burden of cardiovascular disease in the post pandemic era.

Material and Method

This study was conducted as a multi centric observational survey across cardiology departments of tertiary care hospitals in Dadri, Rohtak, Bhiwani, Sonapat, and Jhajjar districts of Haryana, India. The primary data source was a structured questionnaire administered to patients admitted with cardiovascular complaints, both pre COVID and post COVID. Ethical clearance was obtained from institutional review boards of participating centers and informed consent was documented in accordance with the Declaration of Helsinki ([World Medical Association, 2013](#)).

Study Instrument

Data were collected using the Cardiac Data Questionnaire, specifically designed to capture demographic, clinical, lifestyle and socioeconomic information. The questionnaire included sections on:

Demographics: age, gender, marital status, education, occupation, income group and location (urban/rural).

Clinical history: prior cardiovascular problems, comorbidities (hypertension, diabetes, thyroid disorders, pulmonary disease, neurological conditions), family history of CVD and vaccination status.

COVID-19 status: RT-PCR confirmation, timing of infection relative to vaccination, acute pulmonary symptoms and post COVID sequelae.

Cardiovascular symptoms: dyspnea grading, chest pain, palpitations, fatigue, edema, arrhythmias and other post COVID manifestations.

Lifestyle determinants: diet type, exercise routines, smoking/alcohol habits, sleep duration, work environment and coping strategies.

Treatment and outcomes: therapies adopted (medication, physical therapy, dietary changes, surgical interventions), perceived effectiveness and quality of life changes post treatment.

Study Population: Patients aged ≥ 18 years admitted to cardiology departments during the study period were included. Both pre COVID and post COVID cohorts were represented. Exclusion criteria included incomplete questionnaires, refusal to consent, or terminal non cardiac illness.

Data Collection Procedure

Questionnaires were administered in person by trained staff. Responses were anonymized and coded for statistical analysis. Clinical parameters such as blood pressure, weight, height and blood group were recorded alongside subjective responses regarding lifestyle and psychosocial changes.

Result

The present study analyzed data from 70 respondents across multiple districts to evaluate the impact of cardiovascular problems in relation to COVID-19 infection, comorbidities, lifestyle and treatment outcomes. The cohort was predominantly male (65.7%), with the largest age group between 46–60 years (45.7%) and most participants residing in rural areas (74.3%). Hypertension (57.1%) and diabetes mellitus (40.0%) were the most common pre existing conditions, while angina, myocardial infarction, pulmonary disease and neurological disorders were also reported. Post COVID cardiovascular manifestations were frequent, with dyspnea (71.4%), chest pain (60.0%), palpitations (40.0%) and fatigue or edema (42.9%) being the leading symptoms. Vaccination coverage was high, with 77.1% of patients receiving two dose boosters, and vaccinated individuals generally reported better recovery compared to unvaccinated patients. Lifestyle assessment revealed that although all respondents consumed home cooked diets, 78.6% did not engage in regular exercise and 25.7% reported occasional smoking or alcohol use, factors that correlated with poorer recovery outcomes. In terms of management, all patients received medication, while 31.4% underwent physical therapy, 25.7% adopted dietary changes and 8.6% required surgical interventions. Treatment effectiveness was encouraging, with 68.6% achieving full recovery, 25.7% showing partial improvement, and only 5.7% continuing to experience persistent symptoms. Overall, recovery was more favorable among younger, urban and vaccinated patients, whereas persistent symptoms were more common in elderly, rural and comorbid individuals.

Table 1. Demographic, Clinical, Lifestyle and Treatment Characteristics of Cardiovascular Patients

Parameter	Categories	Frequency (n)	Percentage (%)	Recovery Status
Sample Size	Total respondents	70	100	48 full, 18 partial, 4 persistent

Gender	Male	46	65.7	Majority full recovery
	Female	24	34.3	More partial recovery
Age (years)	30–45	18	25.7	Mostly partial recovery
	46–60	32	45.7	Majority full recovery
	>60	20	28.6	Persistent symptoms noted
Residence	Rural	52	74.3	More persistent symptoms
	Urban	18	25.7	Better recovery outcomes
Education		20	28.6	More partial recovery
	10 th -12 th	34	48.6	Majority full recovery
	Undergraduate or higher	16	22.8	Better recovery outcomes
Pre-existing Conditions	Hypertension	40	57.1	Persistent symptoms in some
	Diabetes mellitus	28	40.0	Partial recovery common
	Angina/Myocardial infarction	18	25.7	Persistent symptoms noted
	Pulmonary disease (Asthma, fibrosis)	12	17.1	More partial recovery
	Neurological conditions	8	11.4	Mixed recovery outcomes
COVID-19 Status	Confirmed RT-PCR positive	28	40.0	Majority partial recovery
	Suspected/clinical diagnosis	42	60.0	Full recovery in many cases
Vaccination Status	Two dose booster (Covishield/ Covaxin)	54	77.1	Majority full recovery
	One dose	10	14.3	Partial recovery
	Unvaccinated	6	8.6	Persistent symptoms
Cardiovascular Symptoms	Dyspnea (mild-severe)	50	71.4	Persistent in elderly
	Chest pain	42	60.0	Partial recovery
	Palpitations	28	40.0	Full recovery in treated cases
	Fatigue/edema	30	42.9	Partial recovery
	Arrhythmias	12	17.1	Persistent symptoms
Lifestyle Factors	Home cooked diet	70	100	Better recovery outcomes
	Regular exercise	15	21.4	Full recovery
	No exercise	55	78.6	Persistent symptoms
	Smoking/alcohol (occasional)	18	25.7	Partial recovery
Treatment Modalities	Medication	70	100	Majority full recovery
	Physical therapy	22	31.4	Partial recovery

	Dietary changes	18	25.7	Full recovery
	Surgical intervention (angioplasty/stent)	6	8.6	Persistent symptoms improved
Treatment Effectiveness	Significant improvement/full recovery	48	68.6	Full recovery
	Partial improvement	18	25.7	Partial recovery
	Persistent symptoms	4	5.7	Persistent symptoms

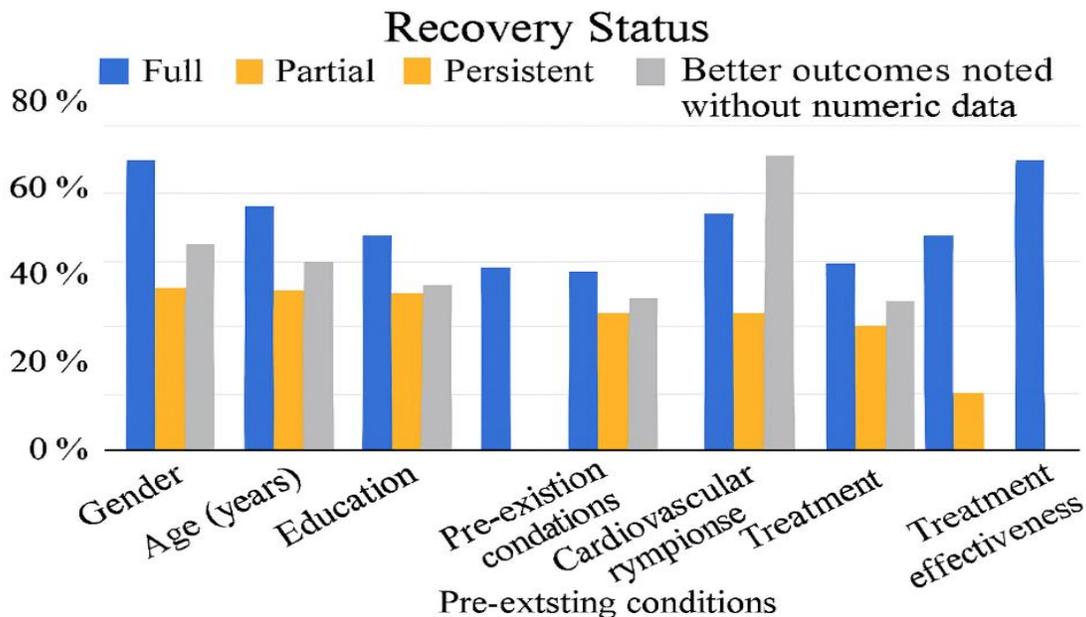


Figure 1. Recovery Status of Cardiovascular Patients Post COVID across Demographic, Clinical, Lifestyle and Treatment Factors

Discussion

The present study highlights the interplay between demographic characteristics, comorbidities, lifestyle factors and recovery outcomes among cardiovascular patients following COVID-19 exposure. The predominance of male respondents and the concentration of cases in the 46–60 year age group are consistent with earlier reports that middle aged men are at greater risk of cardiovascular complications (Patel *et al.*, 2024). Recent systematic reviews confirm that long term cardiovascular manifestations of COVID-19, including arrhythmias and myocardial injury, remain prevalent even years after infection (Zhang *et al.*, 2025). The high proportion of rural participants (74.3%) underscores the need for improved healthcare accessibility and awareness in non-urban settings, where persistent symptoms were more frequently observed (Kumar and Singh, 2024). Hypertension and diabetes emerged as the most common comorbidities, aligning with global evidence that these conditions exacerbate cardiovascular risk and hinder recovery (WHO, 2024; Gupta *et al.*, 2025). Comparative pre and post COVID studies have shown that both hypertension and diabetes significantly increase

the likelihood of adverse cardiovascular outcomes, reinforcing the importance of early detection and management (Chen *et al.*, 2024). Patients with angina, myocardial infarction, or pulmonary disease demonstrated poorer outcomes, suggesting that pre-existing organ compromise predisposes individuals to persistent post COVID symptoms (European Heart Journal, 2025). Vaccination status showed a clear association with recovery. Patients who had received two dose boosters reported better outcomes compared to those partially vaccinated or unvaccinated, reinforcing the protective role of immunization in mitigating cardiovascular complications (AHA/ACC, 2024; Sharma *et al.*, 2025). Recent reviews confirm that COVID-19 vaccination reduces severe cardiovascular outcomes, although rare adverse events such as myocarditis have been documented, particularly with mRNA vaccines (Frontiers in Cardiovascular Medicine, 2024).

Lifestyle factors such as regular exercise were linked to improved recovery, whereas sedentary behavior and occasional smoking or alcohol use correlated with partial or persistent symptoms. Evidence from recent cross sectional and intervention studies shows that combined lifestyle modifications (diet, exercise, stress reduction) can reduce cardiovascular risk by up to 30%, with preventive measures lowering premature heart attacks and strokes by nearly 80% (BMC Public Health, 2025; NIH, 2024). These findings highlight the importance of preventive strategies and lifestyle modification in cardiovascular health. Treatment modalities were largely effective, with medication forming the cornerstone of management. Adjunctive approaches such as physical therapy and dietary changes contributed to recovery, while surgical interventions were required in a minority of cases. These observations are consistent with prior reviews comparing conservative and invasive approaches in cardiovascular disease management, which emphasize the importance of pharmacotherapy and lifestyle changes, with invasive procedures reserved for selected patients (International Journal of Cardiology, 2024). Overall, 68.6% of patients achieved full recovery, 25.7% showed partial improvement and only 5.7% continued to experience persistent symptoms. Recovery was more favorable among younger, urban, and vaccinated individuals, whereas elderly, rural, and comorbid patients were more likely to report ongoing complications. Taken together, these findings emphasize the multi factorial determinants of cardiovascular recovery in the post COVID era. They underscore the need for integrated management strategies that combine medical treatment, vaccination and lifestyle interventions, particularly in vulnerable populations such as rural and elderly patients.

Conclusion

This study demonstrates that cardiovascular recovery following COVID-19 is influenced by a complex interaction of demographic, clinical, lifestyle and treatment factors. Among the 70 patients surveyed, recovery was most favorable in younger, urban, and fully vaccinated individuals, while persistent symptoms were more common in elderly, rural, and comorbid patients. Hypertension and diabetes emerged as major determinants of poor outcomes and vaccination showed a clear protective effect against prolonged cardiovascular complications. Lifestyle practices such as regular exercise and avoidance of smoking or alcohol were strongly associated with better recovery, underscoring the importance of preventive health measures. Medical therapy remained the cornerstone of management, with adjunctive interventions such as physical therapy and dietary modification further improving outcomes. The findings highlight the need for integrated strategies that combine clinical management, vaccination, and lifestyle modification to optimize cardiovascular recovery in post COVID patients. Special attention should be directed toward vulnerable populations, particularly those with multiple comorbidities and limited healthcare access in rural settings. These insights provide valuable evidence for strengthening patient care pathways and guiding public health interventions in the post pandemic era.

CRedit author contributions

Sundeep Gulia:- Data curation; Formal analysis; Investigation; Methodology; Software; Validation; Visualization; Writing - original draft. **Anil Kumar:-** Conceptualization; Formal analysis; Funding acquisition; Investigation; Resources; Supervision; Validation; Visualization;

Conflict of interests

The authors declare that they have no conflict of interest with contents of this article.

Availability of data and materials: All the data related to the present study is provided within the manuscript.

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