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Prevalence and determinants of post-COVID morbidity in adult survivors: A community-based cross-sectional study

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Abstract:
Persistent health problems following recovery from coronavirus disease 2019 (COVID-19) have emerged as an important public health concern, yet community-based evidence regarding their prevalence, associated determinants and healthcare-seeking behaviour remains limited. Therefore, it is of interest to evaluate the prevalence and determinants of post-COVID morbidity and to assess health-seeking behaviour among adult COVID-19 survivors in Gwalior city. A community-based cross-sectional study was conducted among 400 laboratory-confirmed adult COVID-19 survivors using a structured questionnaire and the collected data were analyzed using appropriate statistical methods to identify factors associated with post-COVID morbidity. Overall, 54% of the participants experienced post-COVID morbidity, with significant associations identified for family type, socioeconomic status and body mass index, family history of COVID-19, hospitalization, repeated COVID-19 infection, dietary practices, sleep pattern and alcohol consumption. Thus, data shows the substantial burden of post-COVID morbidity and emphasize the need for long term community based follow-up, early identification of high-risk individuals and accessible rehabilitation services to improve post-COVID health outcomes.

Keywords: COVID-19, long COVID, post-COVID morbidity, health-seeking behaviour, community-based study, adult survivors

Background:
Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has resulted in substantial global morbidity and mortality. Although most infected individuals recover from the acute phase, a considerable number continue to experience persistent or newly emerging symptoms for weeks or months after the initial illness. This condition, widely referred to as post-COVID condition or Long COVID, has increasingly been recognized as an important public health issue because of its adverse effects on physical health, psychological well-being, daily activities and healthcare utilization **[1–3]**. Post-COVID morbidity is characterized by a wide range of multisystem manifestations, including fatigue, breathlessness, persistent cough, musculoskeletal pain, sleep disturbances, cognitive impairment, anxiety and depression and reduced exercise capacity. Previous studies have shown that factors such as obesity, severe acute illness and hospitalization increase the likelihood of developing prolonged symptoms following COVID-19 infection **[4, 5]**. Persistent post-COVID symptoms frequently lead to repeated healthcare visits, rehabilitation requirements and long-term supportive care. Identifying individuals who are at greater risk and understanding their health-related behavioural practices are essential for developing effective community based interventions and strengthening post-COVID healthcare services **[6]**. Therefore, it is interest to evaluate the prevalence and determinants of post-COVID morbidity and to assess health-seeking behaviour among adult COVID-19 survivors residing in Gwalior city through a community based cross-sectional study.

Materials and Methods:
This community-based descriptive cross-sectional study was conducted over a period of 12 months from 1 April 2023 to 31 March 2024 in the urban field practice area of Gwalior city, Madhya Pradesh, under the Department of Community Medicine, Gajra Raja Medical College and Gwalior. The study included 400 adult (≥18 years) RT-PCR-confirmed COVID-19 survivors residing in the urban area of Gwalior. The sample size was calculated using the standard formula $n = Z^2pq/d^2$, assuming a prevalence of 50%, 95% confidence level and 5% absolute precision, yielding a minimum required sample size of 400 participants. Data were collected using a pre-designed, pre-tested, structured interview schedule during household visits after obtaining informed consent.

Inclusion criteria:
[1] Adult individuals aged 18 years or older.
[2] RT-PCR-confirmed COVID-19 positive cases.
[3] Residents of the urban area of Gwalior city.
[4] Individuals who provided written informed consent for participation.

Exclusion criteria:
[1] Individuals who declined to participate in the study.
[2] COVID-19-positive individuals younger than 18 years.
[3] Individuals reported as deceased or those with unavailable age records in the sampling list.

Data collection and study variables:
Information was collected using a pre-designed, pre-tested structured questionnaire covering socio-demographic characteristics, previous COVID-19 illness and family history of COVID-19, post-COVID morbidity, lifestyle-related factors and health-seeking behaviour. Eligible participants were contacted telephonically to schedule appointments, followed by household visits for face-to-face interviews. Confidentiality was maintained

throughout the study and all collected information was anonymized before analysis.

Statistical analysis:
The collected data were compiled, coded and analyzed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were presented as frequencies, percentages and proportions. Associations between categorical variables were assessed using the Chi-square test. A two-tailed p-value of <0.05 was considered statistically significant.

Ethical approval:
The study protocol was approved by the Institutional Ethics Committee, Gajra Raja Medical College, Gwalior and Madhya Pradesh (Approval No. 99/IEC-GRMC/2023).

Results:
More than half of the study participants experienced post-COVID morbidity: 216 of 400 (54.0%) reported persistent health problems after recovering from acute COVID-19, while 184 (46.0%) did not **(Figure 1)**. This indicates a substantial burden of long-term health problems among adult COVID-19 survivors in the study population. Several socio-demographic characteristics were associated with post-COVID morbidity. The proportion with post-COVID morbidity was highest among participants aged 18–30 years (63.4%) and lowest among those aged 31–40 years (48.8%). It was similar in the 41–50 years (55.7%), 51–60 years (54.5%) and above 60 years (52.7%) age groups, and the association with age was not statistically significant (p = 0.631). Post-COVID morbidity was reported by 54.1% of males and 53.8% of females, with a reported p-value of 0.002. Participants from joint families had a significantly higher proportion of post-COVID morbidity (58.8%) than those from nuclear families (47.3%) (p = 0.023), possibly reflecting greater household exposure and caregiving burden. Educational status was not significantly associated with post-COVID morbidity (p = 0.705), with roughly half of the participants at each educational level reporting persistent symptoms **(Table 1)**. Socioeconomic status showed a clear and statistically significant gradient (p = 0.001). The highest proportion of post-COVID morbidity was found in the upper middle class (72.5%), followed by the middle class (65.0%) and the upper class (53.6%). It was markedly lower in the lower middle (26.7%) and lower (26.6%) classes. Possible explanations include greater symptom awareness, better access to healthcare and more frequent testing among higher socioeconomic groups, and under-reporting among lower socioeconomic groups. Body mass index was also significantly associated with post-COVID morbidity (p = 0.001). The proportion was highest among overweight participants (67.7%), followed by obese (54.5%), normal weight (43.8%) and underweight (28.6%) participants **(Table 1)**. This is consistent with the role of excess adiposity in chronic low-grade inflammation and impaired immune response. A family history of COVID-19 was significantly associated with post-COVID morbidity **(Table 2)**. Among participants with an affected family member, 65.4% developed post-COVID morbidity, compared with 35.7% of those without a family history of the disease (p = 0.001). Participants with an affected family member therefore had nearly twice the burden of persistent symptoms, which may reflect repeated household exposure, higher viral load, or shared environmental and genetic susceptibility. The clinical presentation of the acute infection also influenced the outcome. Participants with symptomatic COVID-19 infection were more likely to develop post-COVID morbidity than those with asymptomatic infection **(Figure 2)**. This suggests that the severity of the initial illness plays a role in the persistence of symptoms. Similarly, repeated COVID-19 infection was significantly associated with post-COVID morbidity (p = 0.002) **(Table 3)**. Post-COVID morbidity was reported by 45.8% of participants who tested positive once, 63.6% of those who tested positive twice and 62.7% of those who tested positive more than twice. This indicates a cumulative effect of repeated inflammatory insults and incomplete recovery between episodes. Hospitalisation during the acute phase of COVID-19 was significantly associated with post-COVID morbidity (p = 0.001) **(Table 4)**. Among hospitalised participants, 62.6% developed post-COVID morbidity, compared with 40.8% of those who were not hospitalised. Since hospitalisation reflects more severe acute disease, this finding supports the observation from **Figure 2** that more severe initial illness carries a greater risk of persistent symptoms. Systemic inflammation, organ involvement, oxygen therapy and prolonged immobility may all contribute to that risk. Among health-related behavioural factors, dietary practices sleep pattern and alcohol consumption were significantly associated with post-COVID morbidity, whereas physical activity and smoking were not **(Table 5)**. Participants with a mixed diet had a higher proportion of post-COVID morbidity (62.4%) than vegetarians (49.0%) (p = 0.009). Sleep showed one of the strongest associations in the study (p = 0.001): 75.2% of participants with inadequate sleep reported post-COVID morbidity, compared with 40.9% of those with adequate sleep. However, the cross-sectional design does not allow the direction of this relationship to be established. Physically inactive participants had a higher proportion of post-COVID morbidity (64.7%) than physically active participants (51.8%). This difference approached but did not reach statistical significance (p = 0.052), indicating a possible trend. Alcohol consumption was significantly associated with post-COVID morbidity (p = 0.001): 66.0% of alcohol consumers reported persistent symptoms, compared with 47.5% of non-consumers. Smokers had a slightly higher proportion of post-COVID morbidity (57.1%) than non-smokers (52.4%), but this difference was not statistically significant (p = 0.373) **(Table 5)**.

Table 1: Association of sociodemographic variables with post-covid morbidity among the study participants

Socio Demographic Variables		Post Covid-19 Morbidity		P-Value
		Yes (n=216)	No (n=184)	
Age Groups (In Years)	18-30	26 (63.4%)	15 (36.6%)	0.631
	31-40	42 (48.8%)	44 (51.2%)	
	41-50	54 (55.7%)	43 (44.3%)	

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	51-60	36 (54.5%)	30 (45.5%)	
	More than 60	58 (52.7%)	52 (47.3%)	
Gender	Male	132 (61.2%)	112 (60.8%)	0.002
	Female	84 (38.8%)	72 (39.2%)	
Type of Family	Joint	137 (58.8%)	96 (41.2%)	0.023
	Nuclear	79 (47.3%)	88 (52.7%)	
Education	Graduate/Post Graduate	62 (52.1%)	57 (47.9%)	0.705
	Higher secondary	62 (52.1%)	57 (47.9%)	
	Secondary	22 (55%)	18 (45%)	
	Primary/Middle School	58 (53.7%)	50 (46.3%)	
	Illiterate	39 (50.6%)	38 (49.4%)	
Socioeconomic status	I (Upper Class)	15 (53.6%)	13 (46.4%)	0.001
	II (Upper Middle class)	66 (72.5%)	25 (27.5%)	
	III (Middle Class)	102 (65%)	55 (35%)	
	IV (Lower Middle)	12 (26.7%)	33 (73.3%)	
	V (Lower class)	21 (26.6%)	58 (73.4%)	
BMI	Under weight	4 (28.6%)	10 (71.4%)	0.001
	Normal weight	63 (43.8%)	81 (56.3%)	
	Over weight	88 (67.7%)	42 (32.3%)	
	Obese	61 (54.5%)	51 (45.5%)	

Table 2: Association between family history of Covid-19 and Post-Covid Morbidity

Family history of Covid-19	Post Covid-19 Morbidity		P-Value
	Yes (n=216)	No (n=184)	
Yes	161 (65.4%)	85 (34.6%)	0.001

Table 3: Association between the number of times participants tested positive for COVID-19 and post-COVID morbidity

Number of times tested Positive	Post Covid-19 Morbidity		P-Value
	Yes (n=216)	No (n=184)	
1 Time	97 (45.8%)	115 (54.2%)	0.002
2 Times	82 (63.6%)	47 (36.4%)	
More than 2 Times	37 (62.7%)	22 (37.3%)	

Table 4: Association between hospitalization status during COVID-19 illness and post-COVID morbidity

Hospitalized for covid-19	Post Covid-19 Morbidity		P-Value
	Yes (n=216)	No (n=184)	
Yes	152 (62.6%)	91 (37.4%)	0.001
No	64 (40.8%)	93 (59.2%)	

Table 5: Association of health-related behavioural factors with post-COVID morbidity

Health-related behavioural factors		Post Covid-19 Morbidity		P-Value
		Yes (n=216)	No (n=184)	
Dietary practices	Vegetarian	123 (49%)	128 (51%)	0.009
	Mixed	93 (62.4%)	56 (37.6%)	
Sleep pattern	Adequate	101 (40.9%)	146 (59.1%)	0.001
	Inadequate	115 (75.2%)	38 (24.8%)	
Physical activity	Yes	172 (51.8%)	44 (64.7%)	0.052
	No	160 (48.2%)	24 (35.3%)	
Habit of alcohol consumption	Yes	93 (66%)	48 (34%)	0.001
	No	123 (47.5%)	136 (52.5%)	
Smoking Habit	Yes	76 (57.1%)	57 (42.9%)	0.373
	No	140 (52.4%)	127 (47.6%)	

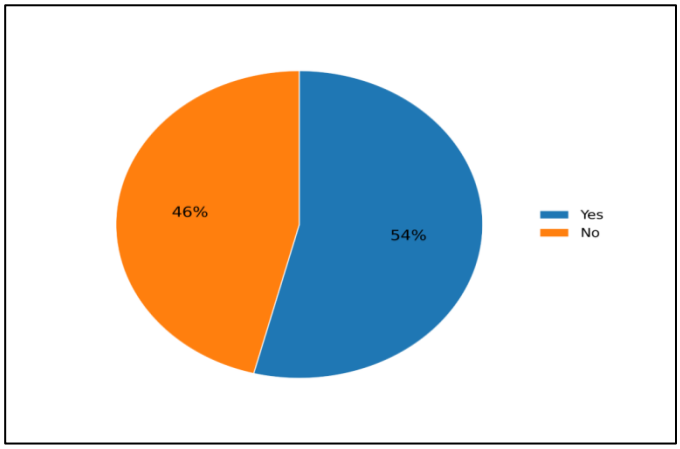


Figure 1: Distribution of study participants according to post-COVID morbidity

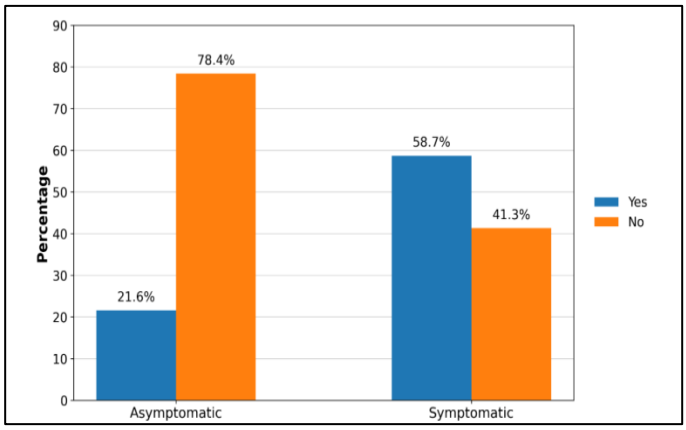


Figure 2: Association between clinical presentation of COVID-19 infection and post-COVID morbidity

Discussion:

The present community-based cross-sectional study found that more than half of the adult COVID-19 survivors experienced post-COVID morbidity, indicating that persistent health problems remain common even after recovery from acute SARS-CoV-2 infection. This observation is in agreement with recent evidence showing that long COVID affects a substantial proportion of recovered individuals and continues to pose a significant public health challenge requiring long-term follow-up and rehabilitation services **[7]**. Several demographic, clinical and lifestyle-related factors were significantly associated with post-COVID morbidity in the present study. Participants with a history of hospitalization, higher body mass index and other clinical risk factors were more likely to report persistent symptoms. Similar associations have been documented by Sudre *et al.* **[8]** and Kamilova *et al.* **[9]**, who identified disease severity, hospitalization and obesity as important predictors of prolonged post-COVID manifestations. Lifestyle-related behaviours also appeared to influence post-COVID recovery. Inadequate sleep, unhealthy dietary practices and alcohol consumption were significantly associated with persistent morbidity, highlighting

the potential contribution of modifiable behavioural factors to long-term recovery. These findings support the incorporation of nutritional counselling, healthy lifestyle promotion and behavioural interventions into routine post-COVID care. Although physical activity and smoking were not significantly associated with post-COVID morbidity in the present study, further prospective studies are needed to clarify their long-term impact. Participants who experienced symptomatic COVID-19 infection or repeated episodes of infection were more likely to develop post-COVID morbidity. Similar findings have been reported previously, suggesting that recurrent infection and greater disease severity increase the likelihood of persistent symptoms and delayed recovery **[10].** Furthermore, the observed behavioural patterns highlight the importance of multidisciplinary rehabilitation and community-based follow-up services for improving long-term outcomes among COVID-19 survivors **[11, 12].** The present study provides useful community-based evidence on the burden and determinants of post-COVID morbidity among adult COVID-19 survivors in central India. Nevertheless, the cross-sectional design limits the ability to establish causal relationships and the use of self-reported information may have introduced recall bias. Future prospective longitudinal studies are recommended to better understand the natural course of post-COVID morbidity and to evaluate the effectiveness of long-term rehabilitation strategies **[13, 14].**

Conclusion:

Post-COVID morbidity was common among adult COVID-19 survivors, with more than half of the participants reporting persistent health problems after recovery from acute infection. Socio-demographic characteristics, family history of COVID-19, repeated infection, hospitalization and selected lifestyle-related factors were significantly associated with post-COVID morbidity. These findings underscore the importance of structured post-COVID follow-up, early identification of individuals at greater risk, promotion of healthy lifestyle practices and community-based rehabilitation programmes to improve long-term health outcomes among COVID-19 survivors.

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