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Original Article

Association of Sociodemographic and Clinicopathological Characteristics with Severity of COVID-19 Disease: A Cross-Sectional Study

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ABSTRACT

Background: COVID-19 exhibits variable clinical severity influenced by host-related factors, including sociodemographic characteristics and metabolic status. Identifying these determinants is essential for early risk stratification and improved patient management.

Objective: To evaluate the association of sociodemographic and clinicopathological characteristics, particularly insulin and glucose levels, with the severity of COVID-19 disease.

Methods: This hospital-based cross-sectional observational study included 122 RT-PCR confirmed COVID-19 patients admitted to Government Medical College Srinagar associated Chest Disease Hospital. Sociodemographic data, clinical characteristics, and biochemical parameters were collected. Fasting blood glucose was measured by the GOD-POD method, and insulin levels were estimated using chemiluminescent microparticle immunoassay (CMIA). Statistical analysis was performed using SPSS version 25. Associations were assessed using the chi-square test, with $p<0.05$ considered statistically significant.

Results: Among the 122 patients, 55.7% had severe disease. Age ≥50 years was significantly associated with severity ($p<0.001$; OR=7.6). Rural residence ($p=0.003$), unknown source of infection ($p=0.007$), and absence of travel history ($p=0.021$) were also significantly associated with increased severity. A significant association was observed between insulin levels and disease severity ($p=0.004$), with the highest severity seen in patients with low insulin levels (78.5%). However, gender ($p=0.097$), comorbidities ($p=0.204$), glucose levels ($p=0.445$), and HOMA-IR ($p=0.691$) were not significantly associated with severity.

Conclusion: Advanced age, sociodemographic factors, and altered insulin levels are significantly associated with increased severity of COVID-19. These findings highlight the importance of early identification of high-risk patients and emphasize the role of metabolic assessment in clinical management.

Keywords: *COVID-19, Insulin, Blood Glucose, Severity, Sociodemographic Factors.*

INTRODUCTION

Coronavirus disease 2019 (COVID-19), caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has emerged as a major global public health challenge since its first identification in Wuhan, China, in December 2019 [1]. The disease rapidly progressed into a pandemic, affecting millions of individuals worldwide with significant morbidity

and mortality [2]. SARS-CoV-2 belongs to the family *Coronaviridae* and is an enveloped, positive-sense single-stranded RNA virus characterized by high mutation and transmission potential [3].

COVID-19 presents with a wide spectrum of clinical manifestations ranging from asymptomatic infection to severe pneumonia, acute respiratory distress syndrome (ARDS), and multi-organ failure [4]. The severity of the disease is influenced by multiple host-related factors, including age, gender, comorbidities, and metabolic status [5]. Among these, advanced age has consistently been identified as one of the strongest predictors of poor outcomes and increased mortality [6].

Diabetes mellitus has emerged as a significant comorbidity associated with increased severity and mortality in COVID-19 patients [7]. The relationship between COVID-19 and glucose metabolism is complex and bidirectional. On one hand, pre-existing diabetes predisposes individuals to severe infection; on the other hand, SARS-CoV-2 infection itself may induce new-onset hyperglycemia and metabolic complications [8,9]. This interaction is thought to be mediated through the virus's ability to bind to angiotensin-converting enzyme 2 (ACE2) receptors, which are expressed in pancreatic beta cells and other metabolic tissues [10].

Damage to pancreatic beta cells may impair insulin secretion, leading to hyperglycemia and, in severe cases, diabetic ketoacidosis [11]. Additionally, the inflammatory response triggered by COVID-19, often referred to as a "cytokine storm," contributes to insulin resistance and worsens glycemic control [12]. Stress-related hormonal changes and the use of corticosteroids in treatment further exacerbate hyperglycemia in affected patients [13].

Sociodemographic factors such as residence, travel history, and exposure source also play an important role in disease transmission and severity patterns [14]. However, there is limited data from regional populations, particularly in Kashmir, evaluating the combined impact of sociodemographic and clinicopathological variables on COVID-19 severity.

Therefore, the present study was undertaken to assess the association of sociodemographic characteristics and biochemical parameters, particularly insulin and glucose levels, with the severity of COVID-19 disease in a hospital-based population.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based cross-sectional observational study was conducted in the Department of Biochemistry at Government Medical College (GMC), Srinagar, in collaboration with associated Chest Disease and SMHS Hospitals, the tertiary care centers in Jammu and Kashmir, India [1].

Study Population

A total of 122 patients with confirmed COVID-19 infection were included in the study. All patients were admitted to GMC Srinagar associated Chest Disease and SMHS Hospitals during the study period [1].

Inclusion Criteria

- Patients aged >10 years
- Laboratory-confirmed COVID-19 cases by RT-PCR
- Patients admitted to the hospital
- Patients willing to participate and provide informed consent

Exclusion Criteria

- Pediatric patients aged 1–10 years
- Known cases of diabetes mellitus
- Patients unwilling to participate in the study

Ethical Considerations

The study was conducted after following all the norms set by the Institutional Ethical Committee of Government Medical College Srinagar. Written informed consent was obtained from all participants prior to inclusion in the study [1].

Data Collection

Detailed clinical history and demographic data were recorded using a structured proforma. The variables collected included:

- Age and gender
- Residence (rural/urban)
- Travel history
- Source of infection
- Smoking status

- Presence of comorbidities

Clinical severity of COVID-19 was categorized into moderate and severe based on clinical assessment and hospital records [1].

Sample Collection

Approximately 3 mL of fasting venous blood was collected under aseptic conditions from each participant. Blood samples were obtained from the antecubital vein using standard phlebotomy techniques.

- 2 mL was collected in sodium fluoride (grey-top) tubes for glucose estimation
- 1 mL was collected in green top tubes for insulin estimation

Samples were processed promptly, and serum/plasma was separated and analysis done on the same day [1].

Biochemical Analysis

Glucose Estimation

Fasting blood glucose levels were measured using the Glucose oxidase per oxidase method, where glucose is oxidized to gluconic acid and hydrogen peroxide is formed and subsequently hydrogen peroxide reacts with a chromogen (phenol plus 4- aminoantipyrine) to produce a pink coloured dye ,the intensity of which is measurable spectrophotometrically at 520 nm [1].

Insulin Estimation

Serum insulin levels were measured using a chemiluminescent microparticle immunoassay (CMIA) on the ARCHITECT iSystem autoanalyzer (Abbott Diagnostics). The assay is based on antigen–antibody reaction with detection through relative light units (RLUs), which are directly proportional to insulin concentration [1].

Statistical Analysis

Data were analyzed using IBM Statistical Package for the Social Sciences (SPSS) version 25.

- Categorical variables were expressed as frequency (n) and percentage (%)
- Continuous variables were expressed as mean ± standard deviation (SD)
- Chi-square test was used to assess associations between categorical variables
- A p-value <0.05 was considered statistically significant

Outcome Measures

The primary outcome was to evaluate the association between sociodemographic and clinicopathological variables (including insulin and glucose levels) and severity of COVID-19 disease.

RESULTS

A total of 122 patients with confirmed COVID-19 infection were included in this study. The sociodemographic and clinicopathological characteristics of the study population are summarized in Table 1.

The age of patients ranged from 10 to 90 years, with the majority belonging to the ≥50 years age group (71.3%), while 28.6% were <50 years. Males constituted 57.3% of the study population, whereas females accounted for 42.6%. A slightly higher proportion of patients were from rural areas (52.4%) compared to urban areas (47.5%).

Regarding disease severity, 55.7% of patients had severe COVID-19, while 44.2% had moderate disease. Most patients (65.5%) had an unknown source of infection, and 80.3% reported no travel history. Comorbidities were present in 47.5% of patients, while 52.4% had no associated illnesses. The majority were non-vegetarian (93.4%) and non-smokers (81.9%). Biochemical analysis revealed that 40.9% of patients had normal insulin levels, 36.0% had elevated insulin levels, and 22.9% had low insulin levels. In terms of glycemic status, 55.7% of patients were diabetic, 11.5% were pre-diabetic, and 32.7% had normal glucose levels. Additionally, 47.6% of patients exhibited high insulin resistance.

Table 1: Sociodemographic and Clinicopathological Characteristics of COVID-19 Patients (n=122)

Characteristics	Frequency (n)	Percentage (%)
Age		
<50 years	35	28.6
≥50 years	87	71.3
Gender		
Female	52	42.6
Male	70	57.3
Dwelling		
Rural	64	52.4
Urban	58	47.5

Severity		
Moderate	54	44.2
Severe	68	55.7
Source of Infection		
Unknown	80	65.5
Known	42	34.4
Travel History		
No	98	80.3
Yes	24	19.6
Co-morbidity		
No	64	52.4
Yes	58	47.5
Food Intake		
Non-vegetarian	114	93.4
Vegetarian	8	6.5
Smoking Status		
Non-smoker	100	81.9
Active smoker	22	18.0
Insulin Levels		
Normal	50	40.9
Low	28	22.9
Elevated	44	36.0
Glucose Levels		
Normal	40	32.7
Pre-diabetic	14	11.5
Diabetic	68	55.7
HOMA-IR		
Insulin sensitive	40	32.7
Low IR	24	19.6
High IR	58	47.6

The levels of biochemical parameters are summarized in Table 2. The mean fasting insulin level was 22.8 ± 29.5 µIU/mL, with a range of 0.30 to 138.30 µIU/mL. The mean fasting blood glucose level was 148 ± 60.3 mg/dL, with values ranging from 54 to 298 mg/dL.

Table 2: Levels of Insulin and Fasting Blood Glucose in COVID-19 Patients

Parameter	N	Minimum	Maximum	Mean	Standard Deviation
Insulin (µIU/mL)	122	0.30	138.30	22.8	29.5
Glucose (mg/dL)	122	54.00	298.00	148.0	60.3

The association between sociodemographic and clinicopathological variables and severity of COVID-19 is presented in Table 3.

Age was significantly associated with disease severity. Patients aged ≥50 years had a higher proportion of severe disease (68.9%) compared to those aged <50 years (22.8%) ($p<0.001$), with an approximately 7.6-fold increased risk.

Gender was not significantly associated with severity ($p=0.097$). Rural residence showed a significantly higher proportion of severe cases (68.7%) compared to urban areas (41.3%) ($p=0.003$).

Source of infection and travel history were also significantly associated with disease severity. Patients with unknown exposure (65.0%) and those without travel history (61.3%) showed higher severity compared to their counterparts ($p=0.007$ and $p=0.021$, respectively).

No significant association was observed with comorbidities ($p=0.204$), food intake ($p=0.137$), or smoking status ($p=1.000$). Among biochemical parameters, insulin levels showed a statistically significant association with severity ($p=0.004$). Patients with low insulin levels had the highest proportion of severe disease (78.5%), followed by elevated insulin levels (59.0%) and normal insulin levels (40.0%). However, glucose levels ($p=0.445$) and HOMA-IR ($p=0.691$) were not significantly associated with disease severity.

Table 3: Association of Sociodemographic and Clinicopathological Variables with Severity of COVID-19 (n=122)

Variable	Category	Cases (n, %)	Moderate n (%)	Severe n (%)	OR (95% CI)	p-value
Age	<50	35 (28.6)	27 (77.1)	8 (22.8)	Ref	
	≥50	87 (71.3)	27 (31.0)	60 (68.9)	7.6 (3.03–20)	<0.001
Gender	Female	52 (42.6)	28 (53.8)	24 (46.1)	Ref	
	Male	70 (57.3)	26 (37.1)	44 (62.8)	2.0 (0.95–4.16)	0.097
Dwelling	Rural	64 (52.4)	20 (31.2)	44 (68.7)	Ref	
	Urban	58 (47.5)	34 (58.6)	24 (41.3)	0.32 (0.15–0.67)	0.003
Source	Unknown	80 (65.5)	28 (35.0)	52 (65.0)	Ref	
	Known	42 (34.4)	26 (61.9)	16 (38.0)	0.33 (0.15–0.71)	0.007
Travel History	No	98 (80.3)	38 (38.7)	60 (61.3)	Ref	
	Yes	24 (19.6)	16 (66.6)	8 (33.3)	0.317 (0.12–0.81)	0.021
Co-morbidity	No	64 (52.4)	32 (50.0)	32 (50.0)	Ref	
	Yes	58 (47.5)	22 (38.0)	36 (62.0)	1.63 (0.8–3.44)	0.204
Food Intake	Non-veg	114 (93.4)	48 (42.1)	66 (57.8)	Ref	
	Veg	8 (6.5)	6 (75.0)	2 (25.0)	0.24 (0.04–1.26)	0.137
Smoking	Non-smoker	100 (81.9)	44 (44.0)	56 (56.0)	Ref	
	Active	22 (18.0)	10 (45.4)	12 (54.5)	0.94 (0.37–2.38)	1.000
Insulin	Normal	50 (40.9)	30 (60.0)	20 (40.0)	Ref	
	Low	28 (22.9)	6 (21.4)	22 (78.5)	—	
	Elevated	44 (36.0)	18 (40.9)	26 (59.0)	—	0.004

DISCUSSION

The present study evaluated the association between sociodemographic and clinicopathological characteristics and the severity of COVID-19. The findings demonstrate that advanced age, rural residence, exposure-related factors, and insulin levels are significantly associated with disease severity, while gender, comorbidities, glucose levels, and HOMA-IR did not show significant associations.

Age was identified as the strongest predictor of disease severity in this study. Patients aged ≥50 years had significantly higher odds of developing severe COVID-19 (OR=7.6, p<0.001). This finding is consistent with previous international studies. Zhou et al. reported that increasing age was associated with higher mortality among hospitalized COVID-19 patients [6], while Wu et al. demonstrated that older individuals are more likely to develop severe respiratory complications such as ARDS [7]. The increased susceptibility in elderly individuals may be attributed to immunosenescence, chronic inflammation, and the higher prevalence of underlying comorbidities.

In the present study, gender was not significantly associated with disease severity (p=0.097), although males showed a higher proportion of severe cases. This contrasts with global evidence suggesting male predominance in severe COVID-19 outcomes. A meta-analysis by Peckham et al. reported that males have a significantly higher risk of ICU admission and mortality [8]. The absence of statistical significance in this study may be due to sample size limitations or regional variations.

Residence was found to be significantly associated with disease severity, with rural patients exhibiting a higher proportion of severe cases compared to urban patients (p=0.003). This may reflect disparities in healthcare accessibility, delayed presentation, and limited awareness in rural populations. Similar observations have been noted in studies examining healthcare inequalities, where delayed access to care contributes to worse outcomes [9].

Exposure-related variables, including source of infection and travel history, were significantly associated with severity in this study. Patients with an unknown source of infection and those without travel history had higher proportions of severe disease. These findings may indicate delayed diagnosis, unrecognized transmission chains, or higher viral exposure. Epidemiological studies, such as those by Bi et al., have demonstrated that transmission dynamics and exposure intensity play a critical role in disease progression [10].

A key finding of this study is the significant association between insulin levels and disease severity (p=0.004). Patients with low insulin levels showed the highest proportion of severe disease (78.5%), followed by those with elevated insulin levels (59.0%), while patients with normal insulin levels had comparatively lower severity (40.0%). This suggests that both hypoinsulinemia and hyperinsulinemia may be linked to worse outcomes, reflecting underlying metabolic dysregulation.

These findings are supported by existing literature. Apicella et al. reported that patients with metabolic abnormalities are more likely to develop severe COVID-19 [11]. Bornstein et al. further emphasized the bidirectional relationship between

COVID-19 and metabolic disorders, highlighting that SARS-CoV-2 infection can worsen glycemic control and precipitate metabolic complications [12].

The underlying mechanisms may involve direct viral damage to pancreatic β-cells via ACE2 receptors, leading to impaired insulin secretion [13]. Additionally, the inflammatory response associated with COVID-19, characterized by elevated cytokine levels, contributes to insulin resistance and metabolic imbalance [14]. Stress-related hormonal responses and corticosteroid therapy may further aggravate hyperglycemia in these patients [15].

Interestingly, glucose levels and HOMA-IR were not significantly associated with disease severity in this study. This finding differs from some international reports where hyperglycemia has been linked to poor outcomes. The lack of significance in the present study may be due to the exclusion of known diabetic patients, relatively small sample size, or variability in metabolic response among individuals.

Comorbidities, food intake, and smoking status were also not significantly associated with severity. While previous studies have identified comorbidities as important risk factors, the findings of this study suggest that their impact may vary across populations and may be influenced by sample characteristics.

Overall, the findings of this study reinforce the importance of age and metabolic factors, particularly insulin levels, in determining COVID-19 severity. Additionally, sociodemographic factors such as residence and exposure patterns play a significant role, highlighting the need for population-specific risk assessment strategies.

The present study underscores the multifactorial nature of COVID-19 severity and highlights the importance of integrating clinical, biochemical, and sociodemographic parameters for effective risk stratification and management.

CONCLUSION

Advanced age, rural residence, and exposure-related factors are significantly associated with increased severity of COVID-19. Altered insulin levels further highlight the role of metabolic dysfunction in disease progression. Early identification of these risk factors may aid in better risk stratification and improved clinical management of COVID-19 patients.

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