Malaysian Journal of Medical Research, 9(3), 45-54
https://doi.org/10.31674/mjmr.2025.v09i03.006

MJMR
Malaysian Journal of Medical Research

Malaysian Journal of Medical Research

Online ISSN: 2550-1607

www.mjmr.com.my

Original Article

ABO Rh Blood Groups and Socio-Demographic Factors in COVID-19 Susceptibility and Severity: A Cross-Sectional Survey in India

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Abstract

Introduction: Conflicting evidence regarding the association between blood groups with COVID-19 susceptibility as also Rh status implored investigation to determine the association between blood groups as also the effect of various sociodemographic factors on the severity and susceptibility of COVID-19. **Methods:** An online cross sectional survey using Google Form was used to recruit participants by snowball sampling method. The study included COVID-19 patients who were positive for the SARS-CoV-2 RNA test through RT-PCR from the nasopharyngeal swab between March 2020 and December 2021. Sample size was estimated using the formula for estimating proportion. Taking 20% as incomplete data forms, the final sample size worked out to be 167. However, finally a total of 259 patients and 518 controls were enrolled. Chi square for independence was used to find the association between COVID status and blood groups, rhesus status and some sociodemographic variables. **Results:** Blood group B was found to be associated with increased susceptibility while AB was found to have the least susceptibility to COVID-19 infection. Gender, educational status of the individual, place of residence (urban or rural) and use of air conditioner at home were found to be significantly associated with the COVID-19 status (p value < 0.05), whereas, rhesus status, smoking both active and passive, dietary habits of being veg/nonveg, pets at home, cow sheds in the vicinity were not found to have significant association with the COVID-19 status (p value > 0.05). **Conclusion:** The study reports blood group B, gender, educational status, place of residence and use of air conditioners to be significantly associated with COVID-19 infection. The non association of smoking status with COVID infection is an interesting finding along with the dietary habits and presence of pets not being associated with infection. The study findings provide evidence which may be considered for future modelling and developing forecasting algorithms for COVID-19 outbreaks.

Keywords: *ABO Blood Group; COVID-19; Rhesus Factor; Sociodemographic Variables*

Introduction

In December 2019, novel coronavirus related to SARS-CoV presented as an outbreak of pneumonia in Wuhan, Hubei Province, China. Subsequently, because of the global burden of morbidity and mortality related to it, World Health Organisation declared it as a pandemic on 12 March 2020. Being the novel disease pandemic, it introduced uncertainty regarding the modes of transmission, management and prevention. Hence, extensive studies were planned to ascertain the risk factors, protective factors, the

Received: 20th May 2025; Revised version received on: 2nd June 2025; Accepted: 30st June 2025

influence of various socio- demographic factors, definitive management and preventive guidelines to reduce the uncertainty related to the disease (Ciotti *et al*., 2020).

Since the discovery of ABO blood groups in 1901, studies have found its association with diseases like Hepatitis B, Norwalk virus, *Helicobacter pylori* infection and malignancies. Novel SARS-CoV virus uses Angiotensin Converting Enzyme 2 (ACE2) for this transmission and relationship of ABO blood group to the ACE activity has been well established (Gassó *et al*., 2014). Hence it has been postulated that ABO blood group plays a role in susceptibility to COVID-19 too. Demystifying the association of COVID-19 with ABO blood group will help in quantifying the risk and prognosis. Studies have shown that antibodies against blood group A which are protective against COVID are present in O and B blood groups. Hence, blood type A might be more susceptible to COVID-19 infection while blood type O might be less susceptible (Dai, 2020; Hoiland *et al*., 2020). Similarly, Rh positive individuals are more susceptible than Rh negative to COVID infection (Taha *et al*., 2020). A Systematic review and metanalysis suggests no correlation between ABO blood group and severity or death due to COVID-19 and this implored further investigation and research to clarify the relationship between COVID-19 and ABO blood type (Wu *et al*., 2020).

The risk of COVID-19 is significantly influenced by various social and demographic factors and it also varies amongst different demographic groups. These factors play a very crucial role in the spread, susceptibility, and impact of COVID-19. Age and sex play a significant role with men being more prone to COVID-19 due to their occupational status, working in closed spaces and essential workers who cannot work from home thereby increasing the risk of exposure. The proportion of men admitted in the Intensive care unit and the mortality rates were significantly higher than those of women. Additionally, older individuals were found to be at higher risk of severe illness and mortality as compared to younger people due to associated co-morbidities signifying the association of age with severe outcomes of COVID-19. Lower-income groups may face disproportionately higher risks due to overcrowding, and poor access to healthcare (Karmakar *et al*., 2021; Nwalozie & Ikpo, 2025). The educational status of individuals can influence the spread of communicable diseases by influencing their knowledge and adherence to measure like social distancing, hand hygiene and other personal protective measures. Housing conditions, like joint families, overcrowding and poor ventilation, may increase transmission risks. Smoking habits both active and second hand (passive smoking) highly influences the susceptibility to respiratory diseases due to poor lung function and chances of hand-to-mouth transmission of the virus in the community. The effects of smoking have been well established by many researchers (Baker *et al*., 2022; Jatrana *et al*., 2022). Dietary factors also play a significant role, with plant-based diets being considered advantageous, likely due to their anti-inflammatory effects.

The present study has been undertaken to further investigate the association between ABO blood groups, sociodemographic factors and COVID-19 susceptibility or severity in India.

Methodology

An online cross-sectional survey using Google Form platform was undertaken to primarily assess the relationship of Blood group with the COVID-19 susceptibility and severity. In addition, an attempt was made to explore the relationship of COVID-19 susceptibility and severity with gender, education, urban-rural location, active smoking, passive smoking, dietary habits, use of air conditioning, family history, owning pets and presence of nearby cowsheds. A self-reported questionnaire was sent to COVID-19 patients regarding demographic data, blood group, history of contact with any COVID positive patient in the past 14 days, comorbidities, date of onset of symptoms, date of test positivity, date of hospital admission, duration of oxygen requirement (if any), duration of hospital stay and ICU admission (if any). The comparison group was recruited through snowball sampling technique by imploring family members of COVID-19 cases to participate in the study. The required sample size for this cross-sectional online survey was estimated using the formula for estimating proportion: $n = Z\alpha^2 P (1 - P)/d^2$; where $Z\alpha = 1.96$; $P = 90\%$ (response rate for online survey >90%) (Howard *et al*., 2016); and $d = 5\%$. Thus, the minimum required sample size for this study was estimated to be 139 in each group. However, anticipating 20% incomplete forms, the final minimal required sample size worked out to be 167. During

the survey, 259 patients were recruited and for each patient two controls i.e. 518 controls were enrolled. The present study included COVID-19 patients who were positive for the SARS-CoV-2 RNA test through RT-PCR from the nasopharyngeal swab between March 2020 and December 2021. Chi square for independence was used to find the association between COVID status and the variables under study (Odoom *et al.*, 2025).

Results

In the present study, the association of COVID-19 with ABO-Rh blood group, gender, education, residential status, dietary preferences, family history, use of air conditioner, smoking, pets at home and cow sheds in the vicinity was assessed.

A total of 777 subjects participated in the study. The majority of participants belonged to the age group of 45-60 years & 19-30 years while children aged 1-10 years were the least represented. The age distribution of the participants is shown in Figure 1.

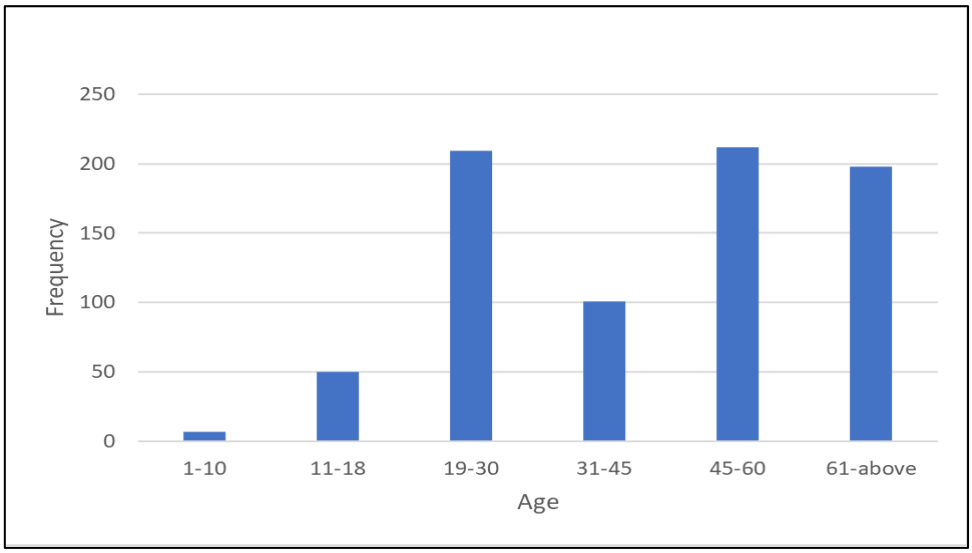

Figure 1: Age Distribution of the Participants

Among the total participants, 374 were females and 445 were males (Figure 2). The study reveals a significant association between COVID and gender (Chi Square p value < 0.05).

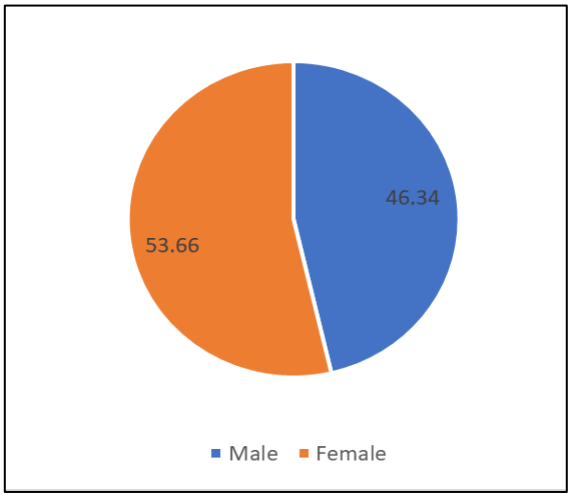

Figure 2: Sex Distribution of the Participants

Blood group wise distribution of the cases and controls is presented in Table 1 and 2.

Table 1: Blood Group Wise Distribution of the Cases

S.NO	Blood Group	Rh^+	Rh^-	Total No of Cases
1.	0	69	2	71
2.	A	61	6	67
3.	B	100	4	104
4.	AB	15	2	17
5.	Total	245	14	259

Table 2: Blood Group Wise Distribution of the Controls

S.NO	Blood Group	Rh+	Rh^-	Total No of Controls
1.	0	159	9	168
2.	A	119	7	126
3.	B	167	13	180
4.	AB	40	4	44
5.	Total	485	33	518

Further distribution of cases as per their management and duration of hospital stay is presented in Table 3:

Table 3: Distribution of Cases as Per Their Management and Duration of Hospital Stay

Blood group	O			A			B			AB			Grand Total
Rh status	Rh^+	Rh^-	Total	Rh^+	Rh^-	Total	Rh^+	Rh^-	Total	Rh^+	Rh^-	Total	
No. of Covid Patients	69	2	71	61	6	67	100	4	104	15	2	17	259
No. not requiring hospitalisation	50	1	51	44	5	49	83	3	86	11	2	13	199
No. requiring hospitalisation	19	1	20	17	1	18	17	1	18	4	0	4	60
Hospitalisation less than 7 days	5	1	6	12	0	12	9	1	10	0	0	0	28
Hospitalisation 7 - 14 days	11	0	11	5	1	6	7	0	7	1	0	1	25
Hospitalisation more than 14 days	3	0	3	0	0	0	1	0	1	3	0	3	7

The results indicate that there was no significant association between COVID-19 infection and rhesus positive/negative blood group (Chi Square *p*-value > 0.05).

Among the cases, maximum cases were B^+ (100) followed by O^+ (69) and then A^+ (61). Rh positive patients were 245 and Rh negative were 14.

Among the 69 O^+ patients, the majority – 50 patients (72.5%) did not require hospital admission. A smaller proportion of 5 (7.2%), were admitted for less than 7 days, while 11 (15.9%) were admitted for 7 to 14 days. Only 3 (4.3%) patients needed admission for more than 14 days. This distribution indicates that most O^+ patients had a relatively mild condition, with only a minority requiring an extended hospital stay.

There was a small subset of only 2 O^- patients. Among them, one patient did not require admission, and the other was admitted for less than 7 days. Although this suggests a variability in the clinical course of O^- patients, the limited sample size makes it challenging to draw broader conclusions.

Among the 61 A^+ patients involved in this study, 44 (72.1%) did not require hospital admission. Twelve patients (19.7%) were admitted for less than 7 days, while 5 patients (8.2%) needed admission for 7 to 14 days. This distribution suggests that the majority A+ patients experienced a less severe clinical course and only a small portion required longer hospital stays.

There were a total of 6 A^- patients in this study, out of which, 5 (83.3%) did not require hospital admission. Only 1 patient (16.7%) was admitted for 7 to 14 days, this distribution suggests that the extended hospital care was needed in only a small fraction of A^- cases.

Among a total of 100 patients with a B+ blood group, a significant majority of 83 patients (83%) did not require hospital admission. 9 patients (9%) were admitted for less than 7 days, and 7 patients (7%) required admission for 7 to 14 days. Only 1 patient (1%) needed a hospital stay longer than 14 days. This distribution shows that while most B+ patients experienced mild symptoms, a small subset needed short to moderate hospital care, and very few required an extended hospital admission.

Among the 4 B^- patients, 3 (75%) did not require hospital admission, reflecting a probable mild clinical presentation. Only 1 patient (25%) was admitted for less than 7 days. This distribution shows that the majority of B^- cases were managed without the requirement for a prolonged hospital stay.

Among 15 AB^+ patients, 11 required no admission and 4 were hospitalised with 1 requiring 7 to 14 days admission and 3 requiring more than 14 days admission. There were only two patients who were AB^- and both did not require any hospitalisation.

It is evident that those with rhesus positivity status were affected more and among the Rh^+, B^+ were the most susceptible and among Rh^-, AB^- were the least susceptible.

In the present study, various socio demographic factors such as education, urban-rural location, smoking, dietary habits, use of air conditioning, family history, owning pets and presence of nearby cowsheds were also evaluated.

Amongst the total number of participants (n= 777), 446 participants were postgraduates, 225 were undergraduates, 52 were in 12th standard, 17 participants were in 10th standard and 37 were below 10th standard as shown in Figure 3. Majority of the participants possessed higher educational qualification, while significantly fewer had qualifications below 12th standard. The study found that education status of the individual was significantly associated with the COVID status (Chi square *p* value < 0.05).

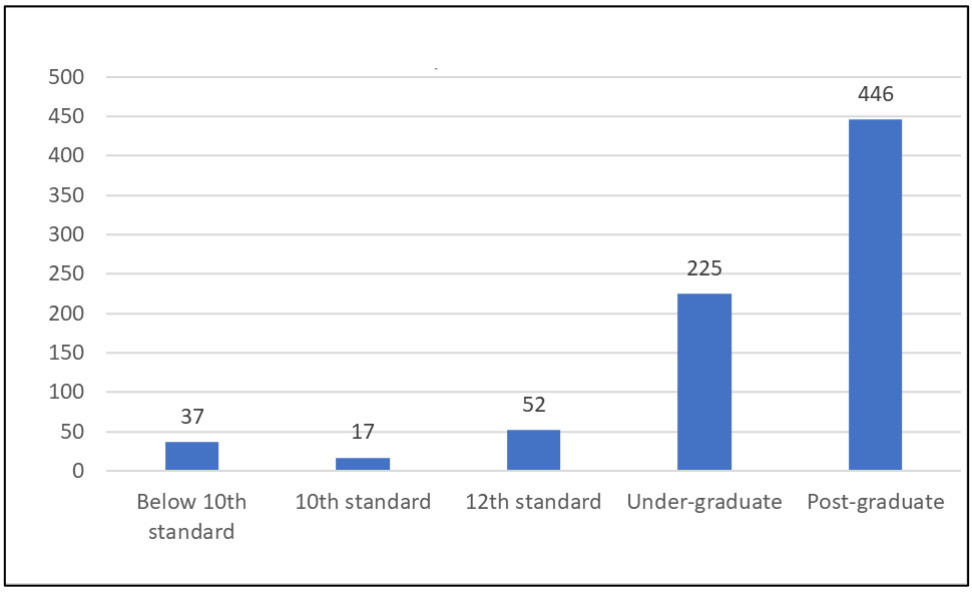

Figure 3: Distribution of Participants as per Educational Status

Amongst the total number of participants (n=777), 665 participants belonged to the urban and sub–urban area, implying that COVID-19 had higher impact on the urban population, particularly due to higher population density, closer contact and higher transmission rates in the cities. A total of 112 participants belonged to rural areas as shown in Figure 4. It was found that residential area location was significantly associated with the COVID status (Chi square *p* value < 0.05).

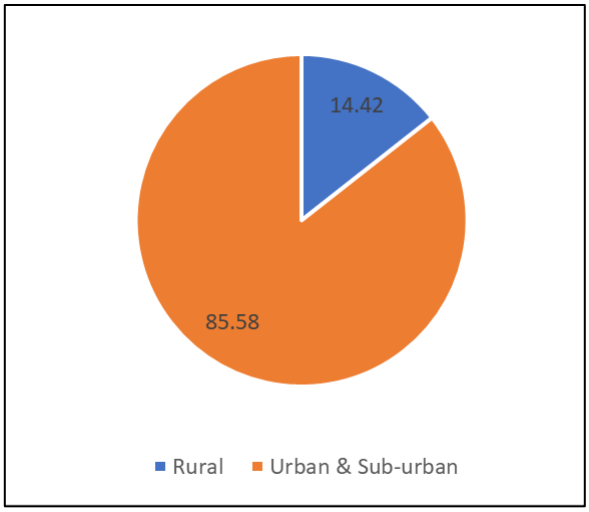

Figure 4: Distribution of Participants Based on Rural-Urban Location

The majority of participants who had COVID-19 were non-vegetarians (n=462), the vegetarians were 227 and a smaller group of participants (78) were vegetarians but consumed eggs (Figure 5). The results indicate the association of COVID infection with the dietary preferences to be non-significant (Chi Square *p*-value > 0.05).

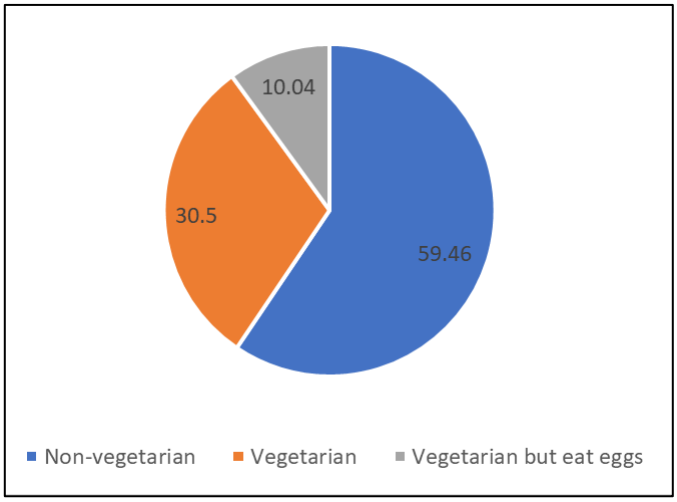

Figure 5: Distribution of Participants as per Their Meal Preferences

Amongst the total participants (n=777), 663 participants did not own pets, suggesting that pet ownership is not a common factor among this group; 80 participants owned dogs, 18 owned cats, 8 owned rabbits and 8 owned dogs as well as another pet (cat or rabbit) as shown in Figure 6. Pets particularly dogs might have helped in allaying mental health challenges due to companionship or improved physical activity from walking the pets. However, the association of COVID infection with the ownership of pets was found to be non-significant (Chi Square p-value > 0.05).

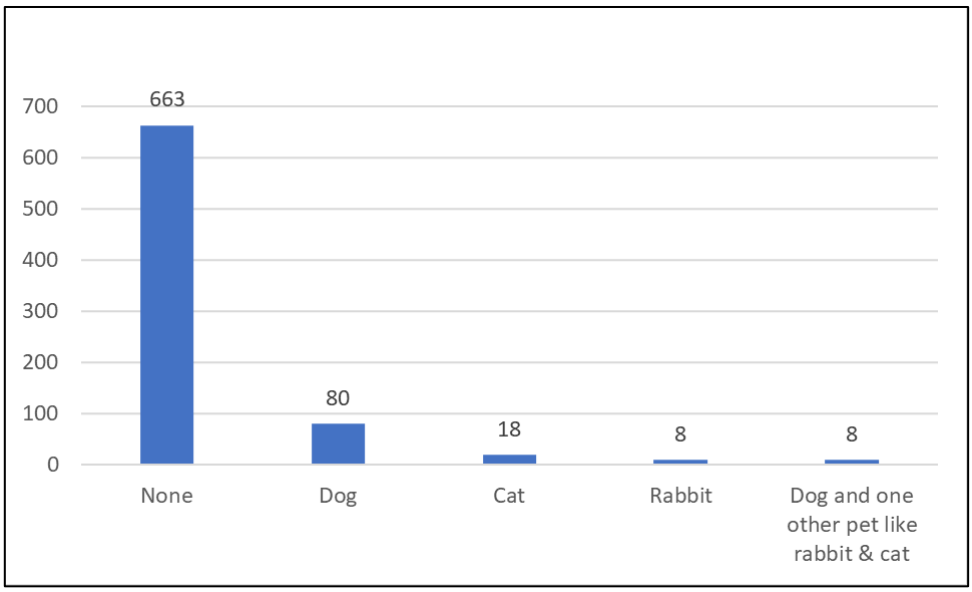

Figure 6: Distribution of Participants as per Their Ownership of Pets

Among the 777 participants, 523 used air conditioners in their room/house as shown in Figure 7. The result reveals a significant association between COVID and use of air conditioner (Chi Square *p*-value < 0.05).

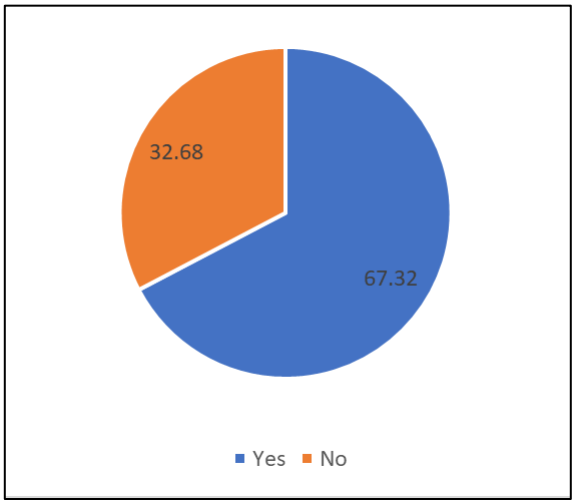

Figure 7: Distribution of Participants as per the Use of Air Conditioner

Among the participants, majority (725) were non-smokers (Figure 8) which indicates that the association of COVID with smoking status is not-significant (Chi Square *p*-value > 0.05). Cow sheds in the vicinity have also shown non-significant association with the COVID status (Chi Square *p* value > 0.05).

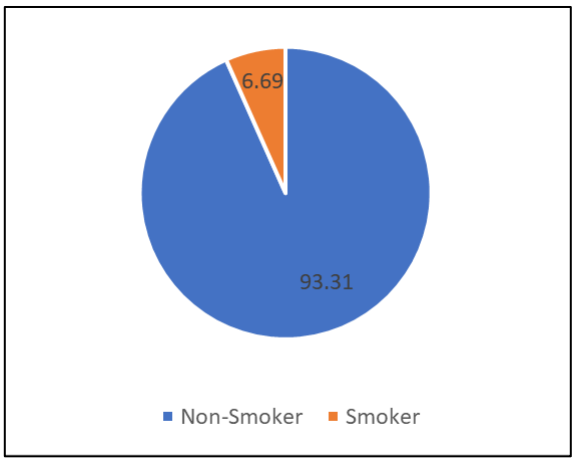

Figure 8: Distribution of Participants as per Their Smoking Status

Discussion

The present study was undertaken to determine the association between blood groups and the effect of various sociodemographic factors on the severity and susceptibility to COVID-19. The results reveal that blood group B is associated with increased susceptibility to the disease whereas AB is associated with least susceptibility. Similar findings have been reported by Rana *et al* in their study in New Delhi (Rana *et al*., 2021).

Ray *et al* reported O and Rh− blood groups to be associated with a slightly lower risk for SARS-CoV-2 infection (Ray *et al*., 2021). The present study found O blood group to be associated with higher infection rate in addition to B blood group, which had the highest infection. This study, however, reports O^- blood group to be the least susceptible blood group to SARS-CoV-2 infection. Solmaz *et al* found in their cross-sectional study that there was a statistically significant increase in COVID-19 patients among blood group A and AB compared with healthy individuals and the reverse in COVID-19 patients with blood group O (Solmaz & Araç, 2021). However, this study found least COVID-19 positive cases among AB blood group and second most common among O blood group.

Though the present study has found that blood groups B+, O+, and A+ are at more risk of COVID-19 infection, compared to AB^+, AB^-, O^-, B^- and A^-, however, Singh *et al* in their study in Uttar Pradesh state of India reported that A^+ and B^+ blood group were severely affected compared to blood group O^+ and AB^+ (Singh *et al*., 2021). Further, another study in India had entirely different findings that A^+ and B^+ blood groups were more severely affected as compared to those with O^+ and AB^+ blood groups (Garg *et al*., 2021).

Contrary to the above findings, Ramo A *et al* had reported that ABO blood groups and Rhesus factor were neither associated with ICU admission/intubation nor mortality (Ramo *et al*., 2020). Anderson *et al* also reported that Blood type was neither associated with disease susceptibility nor with severity, including viral positivity, hospitalisation, or ICU admission (Anderson *et al*., 2021).

This present study provides evidence on the relationship between socio demographic factors and COVID-19 severity and susceptibility. It reveals significant associations between certain factors such as educational status, place of residence, and use of air conditioning. Sharma *et al.* however, reported significant relationship of educational status with adverse outcome (Sharma *et al*., 2022). Mohanan *et al* in their study in Southern India reported contrasting findings of rural urban differences with relatively high prevalence in rural areas which is consistent with the higher level of mobility likely due to agricultural activity (Mohanan *et al*., 2020). Ahmadzadeh *et al* also reported higher risk of transmission with the use of air conditioning (Ahmadzadeh *et al*., 2021). Further, the present study did not find any significant association with smoking, pet owning and the dietary habits of the participants. In contrast, Reddy *et al*. in their systematic review and meta-analysis reported that patients with any smoking history were vulnerable to severe COVID-19 and worse in-hospital outcomes (Reddy *et al*., 2021).

Limitation

The study suffers from the limitation that authors relied on the patient's self-reporting of their blood groups rather than testing their blood groups in the health facility. Another limitation is that the study includes data from second wave which was due to delta variant and had higher and differential mortality which may have confounded the results as the survey did not include the data of dead persons. Another limitation was that the number of participants owning pets was small, and therefore the relationship between owning pets and occurrence and severity of COVID-19 could not be commented upon. Further studies are needed to explore and address the limitations mentioned as understanding these relationships could have important implications for public health interventions.

Conclusion

The study findings reveal blood group B to be more susceptible to COVID-19 infection. A significant association between COVID-19 infection and gender, educational status of an individual, place of residence (urban or rural), and use of air conditioner at home was found in the study. However, interestingly the much-discussed smoking both active and passive was not found to be significantly associated with COVID-19 infection. Rhesus factor, dietary habits - veg/nonveg, pets at home or presence of cow sheds in the vicinity were not found to have any significant association with the COVID status. The study findings provide evidence for future modelling and developing forecasting algorithms for COVID-19 outbreaks.

Conflict of Interest

The authors affirm that there are no conflicting objectives.

Acknowledgement

The authors extend their sincere appreciation to the advisors for their constructive criticisms and valuable suggestions, which have significantly improved the quality of this paper. They also express profound gratitude to all the respondents who willingly participated in the study

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