Original Article

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Predictors of Mortality due to COVID-19 Infection among Adults: A Cross-sectional Study

Public Health Section

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ABSTRACT

Introduction: Coronavirus diseases-2019 (COVID-19) has emerged as a pandemic with significant mortality risk. The early predictors of mortality in COVID-19 patients are older age, male gender, co-morbidities like uncontrolled diabetes, hypertension, severe asthma, Chronic Obstructive Pulmonary Disease (COPD), Chronic Kidney Disease (CKD), Coronary Artery Disease (CAD), Chronic Liver Disease and malignancy and raised pro-inflammatory markers in most of the studies from China, Western Europe and US.

Aim: To determine the various risk factors associated with outcomes of COVID-19 infection among laboratory confirmed COVID-19 patients.

Materials and Methods: This descriptive cross-sectional study was conducted among 420 laboratory confirmed COVID-19 patients, aged 18 years and above, who were admitted in a designated COVID-19 hospital in Puducherry, India. Pretested structured questionnaire was used to collect the data through telephonic interview. Descriptive statistics, frequency, mean and standard deviation was estimated for demographic characteristics as appropriate. Chi-square test was used to investigate demographic and health related predictors of COVID-19 outcomes.

Results: The mean age of the study participants was 41.38 (±17.552) years. Thirty five (8.3%) patients died during their treatment. The common presenting symptom was fever (142, 33.80%), followed by cold and cough (96, 22.85% each). Factors such as more than 60 years of age, female gender, resident of rural area, patients owning yellow ration card, unemployment, overcrowding, current smoking and alcoholics, attending social gathering, social distancing, hand washing, level of wearing mask were found to be significantly associated with fatal prognosis.

Conclusion: Risk factors such as older age, females, rural residence, unemployment, overcrowding, smoking and alcoholism, co-morbidities, social gathering, social distancing, hand washing and mask usage were found to be associated with COVID-19 deaths.

Keywords: Co-morbidities, Coronavirus disease-2019, Deaths, Pandemic, Risk factors

INTRODUCTION

Coronavirus disease-2019 (COVID-19), has emerged as a new disease, which has emerged as a pandemic with significant mortality risk. Currently COVID-19 pandemic has affected 274,628,461 crore people and 5,358,978 deaths till 20th December 2021, globally [1]. In India, 478,007(1.4%) deaths have been recorded, out of 34,752,164 confirmed cases. The case mortality rate is projected to range from 2% to 3% [2]. Puducherry, a Union territory in Southern India with a population of around 1,247,953 reported 125,472 cases and 1,869 (1.4%) deaths due to COVID-19 [3,4].

In several countries, the rapid spread of the disease has certainly become a burden to health systems as a significant proportion of elderly, immunosuppressed and those with underlying metabolic, cardiovascular or respiratory diseases continue to develop severe forms of COVID-19, and thereby are at an increased risk for adverse outcomes [5]. In a meta-analysis, a total of 58 studies were analysed, where significant association was found between COVID-19 deaths and older age, males, obesity, hypertension, diabetes, cardiovascular disease, cancer and Intensive Care Unit (ICU) admitted patients [6]. A study done by "The open SAFELY collaborative", death was associated with older age and male gender, uncontrolled diabetes, severe asthma and other prior medical conditions [7]. Another study by Li X et al., found older age, underlying hypertension had a highly significant association with the severity of COVID-19 on admission [8]. Also, mortality risk was higher for patients with COPD, CKD, CAD, diabetes, hypertension, chronic liver disease and malignancy [9].

Studies from India also reported similar findings. A study in Madurai, Tamil Nadu observed that the mortality was associated with old age, male gender, breathlessness, with two or more symptoms, CKD, malignancy, diabetes, diabetes with hypertension, diabetes with heart disease, hypertension with heart disease, diabetes with both hypertension and heart disease and other chronic diseases [10]. Similarly, another study found older age, male sex, cancer, diabetes, hypertension, chronic circulatory disorders, respiratory disorders, CKD and other endocrine disorders, smoking, alcohol consumption, co-morbidities, oxygen saturation <90% at admission, Acute Respiratory Distress Syndrome (ARDS), C-Reactive Protein (CRP) >100 mg/L, higher D dimer were significantly associated with mortality among COVID-19 patients [11-13]. In another study done in Pune, Maharashtra reported that the case fatality rate among the admitted cases was 29.4% and co-morbidity was one of the significant risk factors for the progression of disease and death [14].

COVID-19 has its presence wide across the globe, generating new information and fresh evidence based knowledge continuously. But currently available literature indicates varying information across regions and countries, emphasising the need for generating evidence for a specific geography, population, and context. Also, current therapeutic strategies to deal with COVID-19 are only supportive, and prevention efforts aimed at reducing transmission in the community are considered as the most effective measures to combat COVID-19 deaths [15].

With this background, this study was conducted to determine the various risk factors associated with mortality due to COVID-19 infection among laboratory confirmed COVID-19 patients in a designated COVID hospital in Puducherry, India.

MATERIALS AND METHODS

This was a descriptive cross-sectional study, involving 420 laboratory confirmed COVID-19 patients admitted in the Indira Gandhi Medical College and Research Institute, Puducherry, India. The study period

was three months from September 2020 to November 2020. Institute Scientific Research Committee as well as Institute Ethical Committee (N0.8/275/IEC-30/PP/2020) approval was obtained before data collection.

Inclusion criteria: Laboratory confirmed COVID-19 infected patients who were admitted in the study hospital, with age more than 18 years, and who were willing to participate in the study.

Exclusion criteria: Severe COVID-19 infected patients who were admitted in ICU or under Non Invasive Ventilation (NIV) with oxygen support were excluded from the study.

Sample size calculation: The sample size was calculated using the formula: $n=z^2pq/d^2$ using a proportion of COVID-19 infection among the suspect cases in the study hospital, in the month of August 2020 (number of persons tested positive for COVID-19 among the suspects) was 44.7%, at 95% confidence interval with a sample error of 5% which comes to 379. Adding 10% non response rate to this, the sample size calculated was 416 which was rounded off to 420 [16].

Study Procedure

Total number of COVID-19 patients who were positive in the month of September 2020 was 3163. Out of this 3163, 1025 patients were admitted. Using simple random sampling methods the required sample of 420 was drawn from the sampling frame. Identification details (contact numbers) of all 420 patients were obtained from the COVID-19 control room.

A predesigned and pretested structured interviewer administered questionnaire (socio-demographic variables, co-morbidities, COVID-19 appropriate behaviour and other risk factors) was used to collect the data. The demographic variables like colour of ration card was based on the annual income of the families, overcrowding (based on number of persons per room) and socio-economic condition (based on updated BG Prasad Socio-economic Classification). Hypertension was defined based on systolic and diastolic blood pressure and Body Mass Index (BMI) was classified based on cut-off values for normal Asian Indian adults [17-21]. Data collection was done by the investigator through telephonic interview, after obtaining oral informed consent.

STATISTICAL ANALYSIS

Data entry and analysis was done using Microsoft Excel 2010 and Statistical Package for the Social Science (SPSS) for windows version 23, Chicago, IL) software respectively. Descriptive statistics, frequency, mean and standard deviation was estimated for demographic characteristics as appropriate. Chi-square test was used to find the association between attributes. The p-value <0.05 was considered as significant.

RESULTS

Total number of samples tested during the study period was 7347. Out of this sample, 3163 samples were found to be COVID-19 positive. Hence, the total positivity rate was 43.05%.

Out of the selected 420 participants, 35 died for which the details were collected from their respective family members. The death rate was 8.3%. The mean age of the participants was 41.38±17.552 years.

Frequency distribution of socio-demographic, co-morbidities and COVID-19 appropriate behaviour study practises of study participants was shown in [Table/Fig-1]. Out of the 420 participants, majority 340 (80.95%) were less than 60 years of age. Males were 252 (60%) in number. Almost two third 311 (74.05%) were residents of urban areas. Nearly half of the participants 189 (45%) possessed red colour ration card. Overcrowding was present in 71 (16.90%) houses of the participants. Two-third of participants 328 (78.10%) belonged to low socio-economic conditions (class IV and class V). Majority of the patients 277 (65.95%) were employed. More than one fourth of the participants 118 (28.10%) had associated co-morbidities, among them 59 (50%) were diabetic. A 277 (65.95%) of them had no prior exposure to COVID-19 infection. Overall, 349 (83.10%) of them did not participate in social gathering before contacting the infection. Patients who always followed social distancing was 222 (52.85%). Almost half 193 (45.95%) of the patients washed their hands always. Majority 306 (72.86%) of COVID patients used their masks always. A 297 (70.71%) wear their masks at the level of the nose [Table/Fig-1].

Variables	Characteristics	n (%)
Age	<60 years	340 (80.95%)
	≥ 60 years	80 (19.05%)
Gender	Male	252 (60%)
	Female	168 (40%)
Residence	Rural	109 (25.95%)
	Urban	311 (74.05%)
Ration card*	Red	189 (45%)
	Yellow	231 (55%)
Overcrowding#	No	349 (83.10%)
	Yes	71 (16.90%)
Socio-economic status€	Upper (I, II, III)	92 (21.90%)
	Lower (IV, V)	328 (78.10%)
Occupation	Employed	277 (65.95%)
	Unemployed	143 (34.05%)
Current smoker	Yes	63 (15%)
	No	357 (85%)
Current alcoholic	Yes	97 (23.09%)
	No	323 (76.91%)
Co-morbidities	No	302 (71.90%)
	Yes	118 (28.10%)
Co-morbidities (n=118)	Diabetes Mellitus (DM)	59 (50%)
	HT$	34 (28.81%)
	Diabetes and HT	25 (21.19%)
BMI§ (n=377)	Underweight	11 (2.92%)
	Normal	140 (37.13%)
	Overweight	76 (20.16%)
	Obese	150 (39.79%)
Prior exposure to COVID-19 case	Yes	143 (34.05%)
	No	277 (65.95%)
Social gathering (in the past two weeks)	Yes	71 (16.90%)
	No	349 (83.10%)
Social distancing	Always	222 (52.85%)
	Intermittent	101 (24.05%)
	Never	97 (23.10%)
Hand washing	Always	193 (45.95%)
	Intermittent	164 (39.05%)
	Never	63 (15.00%)
Mask usage	Always	306 (72.86%)
	Intermittent	101 (24.04%)
	Never	13 (3.10%)
Level at which they wear mask	At the level of nose	297 (70.71%)
	At the level of mouth	106 (25.24%)
	At the level of chin	17 (4.05%)

[Table/Fig-1]: Socio- demographic and co-morbidity characteristics of the participants. (n=420).
*Red colour ration card- <15,000 annual income, Yellow colour- 15,000 to 1,20,000 annual income.
#Overcrowding - based on persons per room criteria.
€Modified BG Prasad scale 2020 for socio- economic status classification.
$Hypertension- Patients already diagnosed to have hypertension/newly diagnosed, patients with BP above a systolic of 140 mmHg and/or diastolic of 90 mmHg.
§Body Mass Index- Patients with BMI <18.5 kg/m² considered as underweight, 18.5 to 22.9 kg/m² as normal, 23-24.9 kg/m² as overweight, ≥25 kg/m² as obese

[Table/Fig-2] shows the common presenting symptoms. Out of 565 responses, 142 (33.80%) reported fever, 96 (22.85%) had cough and an equal proportion suffered cold.

Symptoms	n (%)
Fever	142 (33.80%)
Cough	96 (22.85%)
Cold	96 (22.85%)
Myalgia	57 (13.57%)
Breathing difficulty	45 (10.71%)
Head ache	45 (10.71%)
Loss of smell sensation	28 (6.66%)
Sore throat	17 (4.04%)
Asymptomatic	28 (6.66%)
Others (loss of taste and loose stools)	11 (2.61%)

[Table/Fig-2]: Distribution of presenting symptoms (n=565)*.
*Multiple response

Association of factors related to death due to COVID-19 was tested by Chi-square test [Table/Fig-3]. Among the socio-demographic variables studied, death were more among older patients (≥60 years) (χ^2=23.723; p≤0.05), females compared to males (χ^2=3.928; p=0.047), houses which were overcrowded (χ^2=76.627; p<0.05). Similarly, death was associated with 80% of the patients who were unemployed (p<0.05). Out of the total 35 deaths, the proportion of patients who were current smokers and current alcoholics was found to be significantly associated with deaths (p<0.05). Presence of any co-morbidities was also found to be significantly associated with deaths. Among the co-morbidities, patients who were diabetic were found to be statistically significant with fatal COVID-19 prognosis (p<0.05). Among the COVID-19 appropriate behaviours practised, patients who participated in social gathering, practised social distancing intermittently, intermittent hand washing practices were found to be significantly associated with COVID-19 deaths (p<0.05). Also, patients who used mask intermittently were significantly associated with COVID-19 mortality (p<0.05). In addition, wearing mask at level of mouth was found to be significantly associated with death due to COVID-19 infection (p<0.05) [Table/Fig-3].

DISCUSSION

Most of the studies done on COVID-19 mortality focussed on clinical characteristics, laboratory parameters and inflammatory markers. These are applicable in critical care management and resource

Characteristics		Total (n=420)	Survivors (n=385) n (%)	Non survivors (n=35) n (%)	Chi-square value	p-value
Age	<60	340	323 (83.90%)	17 (48.57%)	23.723	<0.05
	≥60	80	62 (16.10%)	18 (51.43%)		
Gender	Male	252	237 (61.55%)	15 (42.86%)	3.928	0.047
	Female	168	148 (38.45%)	20 (57.14%)		
Residence	Rural	109	96 (24.94%)	13 (37.14%)	2.732	0.098
	Urban	311	289 (75.06%)	22 (62.86%)		
Ration card	Red	189	181 (47.01%)	8 (22.86%)	7.278	0.005
	Yellow	231	204 (52.99%)	27 (77.14%)		
Overcrowding	Yes	71	46 (11.95%)	25 (71.43%)	76.627	<0.05
	No	349	339 (88.05%)	10 (28.57%)		
Socio-economic status	Lower	328	311 (80.78%)	17 (48.57%)	16.525	<0.05
	Upper	92	74 (19.22%)	18 (51.43%)		
Occupation	Employed	277	270 (70.13%)	7 (20%)	33.377	<0.05
	Unemployed	143	115 (29.87%)	28 (80%)		
Current smoker	Yes	63	45 (11.69%)	18 (51.43%)	38.983	<0.05
	No	357	340 (88.31%)	17 (48.57%)		
Current alcoholic	Yes	97	79 (20.52%)	18 (51.43%)	16.770	<0.05
	No	323	306 (79.48%)	17 (48.57%)		
Co-morbidities	Yes	118	92 (23.89%)	26 (74.29%)	37.869	<0.05
	No	302	293 (76.11%)	9 (25.71%)		
Diabetes mellitus	Yes	59	36 (9.35%)	23 (65.71%)	79.043	<0.05
	No	361	349 (90.65%)	12 (34.29%)		
Hypertension	Yes	34	30 (7.80%)	4 (11.43%)	0.186	0.666
	No	386	355 (92.20%)	31 (88.57%)		
DM and HT	Yes	25	24 (6.24%)	1 (2.86%)	0.261	0.609
	No	395	361 (93.76%)	34 (97.14%)		
BMI#	Underweight	11	8 (2.34%)	3 (8.57%)	4.3616	0.112
	Normal	140	128 (37.43%)	12 (34.28%)		
	Overweight and obese	226	206 (60.23%)	20 (57.14%)		
Prior exposure to COVID-19	Yes	143	136 (35.32%)	7 (20%)	2.707	0.099
	No	277	249 (64.68%)	28 (80%)		
Social gathering	Yes	71	50 (12.99%)	21 (60%)	47.189	<0.05
	No	349	335 (87.01%)	14 (40%)		
Social distancing	Always	222	209 (54.28%)	13 (37.14%)	15.937	<0.05
	Intermittent	101	83 (21.56%)	18 (51.43%)		
	Never	97	93 (24.16%)	4 (11.43%)		

Hand washing	Always	193	189 (49.10%)	4 (11.43%)	27.354	<0.05
	Intermittent	164	136 (35.32%)	28 (80%)		
	Never	63	60 (15.58%)	3 (8.57%)		
Mask usage	Always	306	291 (75.58%)	15 (42.86%)	19.776	<0.05
	Intermittent	101	83 (21.57%)	18 (51.43%)		
	Never	13	11 (2.85%)	2 (5.71%)		
Level at which they wear mask	Level of nose	297	291 (75.58%)	6 (17.14%)	56.685	<0.05
	Level of mouth	106	80 (20.78%)	26 (74.29%)		
	Level of chin	17	14 (3.64%)	3 (8.57%)		

[Table/Fig-3]: Association between socio-demographic factors and co-morbidities with outcomes.
#BMI=377 (Survivors=341, Non survivors=36); p-value <0.05 considered significant

planning. But understanding the demographic, clinical characteristics and preventive measures of deceased COVID-19 patients could outline public health interventions focusing on preventing mortality. Hence, this study was undertaken to study the preventable risk factors of mortality of COVID-19 positive patients with special emphasis on COVID-19 appropriate behaviour.

Comparison of present study findings with other published studies on COVID-19 deaths were presented in [Table/Fig-4] [10,12,13,22-24]. The mean age of the study participants was 41.38±17.55 years. In other studies the mean age ranged from 40.1±13.1 to 62.5±13.7 [10,12,13,22-24]. In the current study, the overall death rate was 8.3%, and recovery rate was 91.7% among the study participants. Other studies observed similar findings, where the death rate ranged from 2%-10% [10,12,22-24]. But a higher death rate (47.34%) was observed in a study conducted in Jaipur by Jain SK et al., [13]. This may be due to fact that case fatality rate varies globally and across different regions, due to different stages of pandemic experienced in different parts of the world.

The two most common symptoms presented in this study was fever (33.80%) followed by cough (22.85%) and cold (22.85%). This findings from current study was similar to other studies [12,13,24,25]. A case series by Gupta N et al., also found that fever was the most common symptom [26]. Other studies observed breathlessness and fever as the chief complaint during hospital admission [10,22]. Chauhan NK et al., reported fever and sore throat as the principle complaints by the COVID patients [23].

In this study, 51.43% of COVID-19 deaths was observed in the older age group (>60 years), which was similar to the findings of other studies [10,12,22,23]. The study also observed that 57.14% of deaths occurred in females. This finding was in contrast to other studies where majority of the deaths occurred in males [10,12,13,22,23]. This difference may be because of the small sample size, and the death rate was also low in the present study. In the present study, overcrowding was found to be one of the risk factors of COVID death. These findings are similar to the study done by Ahmad K et al., which showed that with each 5% increase in percent households with poor housing conditions, there were a 50% higher risk of COVID-19 incidence and a 42% higher risk of COVID-19 mortality [27].

In the current study, 51.43% of the patients who died due to COVID-19 were smokers which are similar to the findings of by Chauhan NK et al., [23]. In this study, among the COVID-19 positive patients, 74.29% reported associated co-morbidities. Similar findings were reported by other studies where co-morbidities like diabetes mellitus and hypertension were commonly associated with deaths [10,12,13,22-24].

This study reported 60% mortality rate among patients who attended social gathering in the recent past. Mohan A et al., found that 82.8% of deceased patients participated in social gathering [24]. In the present study, practising social distancing only intermittently was found to be associated with mortality. Also, intermittent hand washing practices was found to be associated with fatal prognosis. Similar finding was observed by Szczuka Z et al., where higher number of total cases and deaths from COVID-19 were related to lower levels of hand washing adherence [28]. In this study, patients who never wore a mask and intermittent users were highly observed among those who died. Similarly, incorrect practice of wearing mask (at mouth level and at the level of chin) was also found to be associated with death. An experiment across 200 countries showed

Study variables N (%)	Priya S et al., [10] (n=4530)	Marimuthu Y et al., [12] (n=854)	Asirvatham ES et al., [22] (n=1761)	Chauhan NK et al., [23] (n=125)	Jain SK et al., [13] (n=1007)	Mohan A et al., [24] (n=144)	Present study (n=420)
Age (y) (Mean±SD)	46.59	45.3±17.2	62.5±13.7	49.94±17.59	53.5±14.8	40.1±13.1	41.38±17.55
Male gender	2720 (60%)	483 (56.6%)	1257 (71.4%)	93 (74.4)	131 (58%)	134 (93.1%)	252 (60%)
Gender ratio#	3:1	1.2:1	3:1	3:1	1.4:1	13:1	1.5:1
Most common symptoms (%)	Breathlessness (41.5%)	Cough (39.9%)	Fever (78.7%)	Fever (52.8%)	Fever (69%)	Cough/cold (34.7%)	Fever (33.80%)
	Fever (12.6%)	Fever (33.80%)	Breathlessness (75.8%)	Sore throat (51.2%)	Cough/Sore throat (55.8%)	Fever (17.4%)	Cough/Cold (22.85%)
Death rate	8.4%	87 (10.2%)	2.44%	24 (19.2%)	47.34%	2 (1.4%)	35 (8.3%)
Association of deaths with demographic variables							
Age (years)	≥70	>60	60-74	>60	-	-	≥60
	122 (28.4%)	36 (52.7%)	783 (44.5)	65.83±9.21	-	-	18 (51.43%)*
Gender	Male	Male	Male	Male	Male	-	Female
	122 (28.4%)	60 (12.4%)	1258 (71.4)	17 (70.8%)	69 (58%)	-	20 (57.14%)*
Smoking	-	10 (1.1%)	-	12 (50%)	-	9 (6.3%)	18 (51.43%)*
Alcoholics	-	14 (1.6%)	-	-	-	-	18 (51.43%)*
Association of deaths with co-morbidities							
Diabetes mellitus	86 (13.5%)	48 (24%)	62%	8 (33.3%)	60 (50.4%)	16 (11.1%)	23 (65.71%)*
Hypertension	64 (61.5%)	35 (17.5%)	49.2%	12 (50%)	56 (47.1%)	3 (2.1%)	4 (11.43%)

[Table/Fig-4]: Comparison of present study with published studies on COVID-19 deaths [10,12,13,22-24].
#Gender ratio- Males: Females, *p<0.05 statistically significant

45.7% fewer COVID-19 related mortality in countries where wearing mask was mandatory [29]. A recent survey noted that only 44% of Indians were wearing it properly in compliance with the guidelines [30]. Hence, it is important to ensure appropriate use of face mask for it to be effective.

The major advantage of this study was the involvement of multiple and rare factors of this study like demography, personal habits, co-morbidities and COVID-19 appropriate behaviour were studied. This can be used in future to adopt preventive strategies.

Limitation(s)

The study was conducted in a single centre with a limited sample size hence generalising it to the whole population is questionable. A multivariate analysis to identify risk factors by adjusting the confounders could not be performed, due to the low mortality rate (8.3% deaths).

CONCLUSION(S)

The most common presenting symptom of COVID-19 infection was fever followed by cough and cold. Risk factors such as old age, females, rural residents, unemployment, overcrowding, smoking and alcoholism, co-morbidities, diabetes mellitus, social gathering, social distancing, hand washing, mask usage and level at which mask is worn was found to be significantly associated with COVID-19 deaths. Hence, preventable risk factors with special emphasis on COVID-19 appropriate behaviour need to be reinforced to general public through proper health education. In addition, special attention should be given to the COVID-19 patients with co-morbidities during admission for better prognosis.

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