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Association of Body Mass Index (BMI) and Severity of COVID-19: A Multi-centric Study from Maharashtra, India

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Abstract

Objective: The COVID-19 pandemic has led to the global research efforts to identify the risk factors which would lead to severe COVID-19 disease. This study aimed to investigate the relationship between Body Mass Index (BMI) and severity of Coronavirus Disease 2019 (COVID-19).

Methods: A total of 2820 patients hospitalized with COVID-19 disease in nine government medical colleges, COVID hospitals or COVID care centers of Maharashtra were included in the study. Interviews were conducted on the telephone and counseling was done.

Results: Among 2820, 2442 (86.60%) were asymptomatic or had a mild or moderate illness. More than half of the total COVID-19 positive cases, 1591 (56.41%), were in the normal BMI range, and of these only 183 (11.50%) had severe COVID-19 disease. On the other hand, 647 (22.94%) patients were overweight and 106 (16.38%) had severe COVID-19 disease. Similarly, the patients who were obese, 363 (84.03%) were asymptomatic and 69 (15.97%) had severe COVID-19 disease. Odds ratio for this association was found as 1.5, which indicates that patients who were obese (BMI ≥ 27.5) had one and half times increased odds of progression to severity as compared to patients having normal BMI. This association was found to be statistically significant (p-value <0.05).

Conclusion: Our findings highlight the significant role of BMI in clinical progression of COVID-19 disease. Patients with underweight and obesity experienced more severe outcomes than those of normal weight when being hospitalized with COVID-19 disease.

Keywords: BMI; COVID-19; Outcome; Obesity

Introduction

After the first case of Coronavirus Disease 2019 (COVID-19) which was reported in Wuhan, the disease has rapidly spread across international borders, causing a pandemic [1]. This pandemic has posed substantial risks and challenges to global public health. Clinically the spectrum of COVID-19 patients ranges from mild to severe illness [2,3]. Several studies have been done across the globe to identify the risk factors associated with disease severity and outcome, concurrent cardiovascular or cerebrovascular diseases, or Acute Respiratory Distress Syndrome (ARDS), were at an increased risk of death from COVID-19 pneumonia [4,5].

Past studies and meta-analysis note that obesity could be a risk factor for severity of COVID-19. A descriptive study in the Seattle region with 24 critically ill patients diagnosed with COVID-19 were among the first to report BMI data, showing that 85% of the patients with obesity required mechanical ventilation and 62% of the patients with obesity died [6]. These proportions were more significant than those in the patients without obesity. In a cohort study in The United States, with more than 5700 patients, obesity (BMI ≥ 30 kg/m^2) was suggested as one of the most common comorbidities and accounted for 41.7% of the total study population [7]. A meta-analysis including 30 studies indicated that obesity increased risks for hospitalization, Intensive Care Unit (ICU) admission, Invasive Mechanical Ventilation (IMV) requirement and death among individuals with COVID-19 [4]. However, the effect of underweight on the outcomes of COVID-19 remained undetermined. Therefore, this study was conducted with the objective to study the association between BMI and severity of COVID 19 in hospitalized adult patients.

Materials and Methods

This cross-sectional study was carried out in nine government medical colleges of Maharashtra where Master in Public Health in Nutrition (MPHN) course is being run by the Directorate of Medical Education and Research, Mumbai and in COVID

hospitals or COVID care centers where the COVID cases were being managed in this pandemic. All adults (age ≥ 18 years) having asymptomatic, mild, moderate or severe COVID-19 illness and admitted in these selected centers, were enrolled in the study. Any case in which is Reverse Transcriptase Polymerase Chain Reaction (RTPCR) confirmed COVID-19 positive with SPO_2 less than 90% and respiratory rate more than 30 per minute was defined as a severe case. The mild/moderate case was defined as any case with RTPCR confirmed COVID-19 positive with SPO_2 more than 90% and respiratory rate less than 30/minute.

Sample size and sampling method

All those cases aged >18 years reported consecutively from 1st Aug 2020 to 30th Apr 2021 and fitting into selection criteria were included in the study.

Data collection

A self-reported height and weight of the patient was recorded at the time of admission. Other details regarding travel history, addiction (alcohol/tobacco) were collected by telephonic call on the registered mobile number at the time of registration of patients. In addition, patient's records were checked for the SPO_2 and respiratory rate.

Data analysis

Data was extracted in excel and analyzed by EPI INFO 2007 software. BMI was calculated as body weight in kg divided by height in meters squared (kg/m^2). Recommended cut-points for BMI categories in Asian populations as per WHO are as follows: [8].

- Underweight BMI<18.5 kg/m^2;
- Normal weight BMI 18.5–22.9 kg/m^2;
- Overweight BMI 23–27.5 kg/m^2;
- Obesity BMI ≥ 27.5 kg/m^2

Qualitative variables were expressed in percentages, and quantitative variables were expressed in mean and standard deviation. Odds ratios with 95% confidence interval were calculated to measure exposure and strength of association and p-value of <0.05 was considered statistically significant.

Results

A total of 2820 patients hospitalized with COVID-19 pneumonia were included in this study (Table 1).

Table 1: Socio-demographic details.

Characteristics		Number N=2820	Percentage (%)
Age group (years)	19-30	648	22.98
	31-40	605	21.45
	41-50	573	20.32
	51-60	534	18.94
	>60	460	16.31
Sex	Female	1046	37.1
	Male	1774	62.9
Alcoholic	Yes	335	11.88
	No	2485	88.12
Smoker	Yes	323	11.45
	No	2497	88.55
Travel history	Present	568	20.14
	Absent	2252	79.86
COVID severity group	Severe COVID 19 positive cases	378	13.4
	Asymptomatic/mild/moderate COVID-19 positive cases	2442	86.6

The above table shows that maximum number of study subjects *i.e.,* 22.98% were belonging to 19-30 years of age group, majority *i.e.,* 62.9% study subjects were males. About 11.88% study subjects were alcoholic, 11.45% were smokers. Travel history was present in 20.14% study subjects. Majority *i.e.*, 86.60% subjects were asymptomatic/mild/moderate COVID 19 positive cases while rest were severe COVID-19 positive cases (Table 2).

Table 2: Association of BMI and COVID severity.

BMI MIGP	Severe COVID-19 positive cases (%)	Asymptomatic/ mild/moderate COVID-19 positive cases (%)	Total	OR (95%CI)	*Chi square* P value
<18.5 (underweight)	20 (13.33)	130 (86.67)	150 (100.0)	1.18 (0.721-1.942)	0.44 0.5041
18.5-22.9 (normal)	183 (11.5)	1408 (88.5)	1591 (100.0)	1	
23-27.5 (overweight)	106 (16.38)	541 (83.62)	647 (100.0)	1.51 (1.164-1.953)	9.745 0.0017
>27.5 (obese)	69 (15.97)	363 (84.03)	432 (100.0)	1.5 (1.084-1.974)	6.225 0.0125
Total	378	2442	2820		

Only 150 (5.31%) population was underweight (BMI-<18.5 kg/m^2) in which majority, 130 (86.67%) were asymptomatic, and only 20 (13.33%) patients had severe illness. Odds of having of severe COVID-19 illness was 1.18 times more as compared to patients with normal BMI but this association was found to be statistically not significant (p-value>0.05).

About 647 (22.94%) of the total patients were in the overweight, in which 541 (83.62%) were asymptomatic, and 106 (16.38%) had severe COVID-19 pneumonia. Odds ratio for this association was found as 1.51 which suggests that as compared to patients with normal BMI, overweight patients have one and half times more odds of having severe COVID-19 disease and this association was also found to be statistically highly significant (p-value<0.005).

Similarly, the patients who were obese, maximum 363 (84.03%) patients were asymptomatic and 69 (15.97%) had severe COVID-19 pneumonia. Odds ratio for this association was found as 1.5, which indicates that patients who were obese had 1.5 times increased odds of severe COVID-19 illness as compared to patients with normal BMI. This association was also found to be statistically significant (p-value<0.05).

Discussion

Global research efforts are being taken to identify individuals at a greater risk of developing critical illness, including death, due to COVID-19. In a previous study we have seen that old age and those having metabolic comorbidities are particularly vulnerable [6,9]. In this study, we investigated the association of BMI with the severity of COVID-19 in 2820 patients aged more than 18 years. We observed that in our study overweight and obesity augmented the disease progression of COVID-19. Recently evidence have emerged regarding the association between a higher prevalence of obesity among COVID-19 patients and an increased risk of poor prognosis from SARS-CoV-2 infection.

We found that patients who were underweight had a slightly higher risk of severe COVID-19 illness (OR-1.18, 95% CI-0.721-1.942), but this association was statistically not significant. In a study done by Kim, et al., in 10,861 patients with COVID-19 infection, being underweight and obese was suggested to have a higher risk of death (OR=1.44, 95% CI 1.08-1.92) respectively [10]. It can be speculated that being underweight is often associated with malnutrition, impaired immune function, underlying frailty along with coexisting chronic conditions. Furthermore, being underweight is at an increased risk for pneumonia, and worse outcomes among older hospitalized patients [11].

In our study, we found that patients who were overweight and obese had 1.5 times increased risk of severe COVID-19 illness as compared to patients with normal BMI. Data from Shenzhen, China with 383 COVID-19 patients revealed that overweight and obese were at 86% and 142% higher risk of developing severe pneumonia respectively as compared with patients with normal weight [12].

Tartof, et al., reported that a higher BMI (≥ 40 kg/m2) was associated with an increased risk of death from COVID-19 [13], particularly in male patients and younger individuals (≤ 60 years), in both outpatients and inpatients. S. Hendren, et al., found that the association of BMI with death or mechanical ventilation was strongest in adults ≤ 50 years and severely obese individuals (BMI ≥ 40 kg/m^2) had an increased risk of in-hospital death [9].

Obesity and excess fat mass are commonly related to other comorbidities, such as hypertension, diabetes, cerebrovascular disease and renal disease indirectly. These comorbidities are

considered to result in increased vulnerability to pneumonia-associated organ failures [14]. For example, beta cell function is impaired in individuals with diabetes, obesity, and excess ectopic fat, resulting in insulin resistance. So, during an immunologic challenge, an appropriate metabolic response is limited. Because of this, some diabetic patients require substantial amounts of insulin during severe infections [15]. In addition, alterations in respiratory mechanisms, increased airway resistance, impaired gas exchange, diminishing forced volume and forced vital capacity are some respiratory problems often seen in patients with obesity which could possibly leading to ARDS [11].

In summary, underweight, overweight and obese patients are at a higher risk of developing severe COVID-19 disease as compared to the patients with normal BMI. As the COVID-19 infection may continue to spread world-wide, clinicians should maintain a high level of attention towards BMI as well while treating the patient. Particularly, overweight and obese patients should be carefully monitored and managed with prompt and aggressive treatment.

Conclusion

In conclusion, our study suggested that patients with underweight and obesity experienced more severe outcomes than those of normal weight when being hospitalized with COVID-19 disease. Our findings highlight the significant role of BMI in clinical progression of COVID-19 disease, and this should be kept in mind while treating the patients.

Limitation

As the height and weight values were self-reported, this could lead to measurement bias. Secondly, the definition of obesity (BMI ≥ 27.5 kg/m^2) in this study was appropriate for Asians, so comparing the findings with other studies that have used the BMI cutoff of 30 kg/m^2 is compromised. Third, our results might be confounded by other factors that are unavailable in current study, such as lifestyle information and therapeutic agents use.

Ethical Consideration

Ethics committee permission from the State ethics committee of Wadia hospital, Mumbai was taken. The autonomy and confidentiality of participant was respected. A prior verbal consent was taken. After data collection, the counseling was done.

Ethics Approval

Ethics committee permission from state ethics committee of Wadia hospital, Mumbai was taken.

Consent to Participate

Informed consent was obtained verbally from the patients.

Consent for Publication

Informed consent was obtained verbally from the patients.

Conflicts of Interest

The authors have no potential conflicts of interest to report.

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