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Obesity as a Predominant Factor in Covid-19 Mortality; Relationship between Increased BMI and Mortality in Covid-19

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Authors' contributions

This work was carried out in collaboration among all authors. Author AQ designed the study and wrote the first draft of the manuscript. Author SABSS provided overall supervision and guidance, Author PAAAQ helped in data collection and author MB provided the statistical assistance. All authors read and approved the final manuscript.

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ABSTRACT

Severe Acute Resperatory Syndrome Corona Virus 2(SARS-CoV-2) is related to a class of virus that affects respiratory system to cause respiratory distress and can lead to harmful consequences. It has been estimated that there could be various predisposition factors that may precipitate these poor outcomes. Obesity is one of the factors that elevate the risk of respiratory complications. A retrospective cohort study was performed, to figure out the relationship among COVID-19 related mortality and obesity. Information on 7036 patients was meet inclusion criteria. The prime focus of this study was to check the rate of mortality and extent of illness in relation to body mass index

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(BMI).Out of a total of 127 mortalities, 25.2% of deaths had normal weight ranges, whereas 33.9% of deaths were overweight and 40.9% were at obesity of different levels (p-value < 0.001), which shows the strong correlation between obesity and chances of mortality. Logically, in light of all the above mentioned facts, it can be concluded that the outcomes of this pandemic would have proven more dreadful and life threaten in societies where people have any of the above mentioned factors, specifically, increased BMI.

Keywords: COVID-19; obesity; body mass index; mortality; death-cases.

1. INTRODUCTION

It was a forlorn start of a fatal and most prevalent type of respiratory viral infection in late 2019 first identified in Wuhan; China [1]. In the commencement of 2020, the World Health Organization (WHO) had announced the prevalence of corona virus across the globe. As of April 2020 there were more than 80000 active corona virus cases with were reported in China and over two hundred thousand cases, reported globally [2].

Up to October 2020, 3.87 million cases erupted, with more than 1 million deaths. In the same report, WHO mentioned that, specifically in Pakistan, more than 300,000 cases were reported with more than six thousand have virus related deaths [3].

Moreover, various predisposition factors may precipitate disease severity such as hypertension, diabetes, obesity and old age. The factors attribute to the rise of Corona-virus-Disease 2019 (COVID-19) induced severity and complication(s). More than 44,000 cases suffered from various fatal consequences due to co-morbidities, such as diabetes and cardio-vascular complications [4]

Subsequently, obesity is one of the most crucial factors that elevate respiratory complication risks, and it may be highly prevalent in both males and females [5,6]. As a matter of fact, fat tissues beneath skin are more likely to act as a storage house for certain types of virus i.e.; adenoviruses, human immunodeficiency virus, flu viruses and other viruses. Therefore, it has been hypothesized that SARS-CoV-2 virus may utilize this channel for its dwelling [7]. It has been estimated that the impact of elevated height to body weight ratio among the adults plays a powerful role in COVID-19 cases [8]. According to a one study, weight beyond the upper limit, was present in >50% of severe cases [9]. Since the first decade of 21st century, there was little apparent evidence that can provide a linkage between influenza and its growing impact due to obesity [10].At contrary, one study has clearly provided facts regarding inclination of influenza-induced hospitalizations [11].

Physiologically, patients with obesity are more likely to have weaker immune system. Our hypothesis is that this fact leads obese people to develop poorer COVID-19 related outcomes. Obese patients have impaired lungs performance, cardiovascular-complications and other health related problems. Hence, obesity can precipitate the symptoms and complications associated to COVID-19 [12]. Similarly, the countries, having ubiquitous obese population have rampant cases of COVID-19 with harmful consequences. Thus, the patients suffer from obesity and COVID-19 simultaneously require proper attention for both issues [13]. Scientifically, COVID-19 patients have impaired immunity to kill SARS-CoV-2 thus requiring physicians to provide critical care and keen monitoring [14]. In cases of obesity, the level of criticalness is elevate and many times increases the chances of death [15,16]. Pragmatically, ample deaths occurred among the obese patients who were infected with COVID-19 in the USA. Certainly, a potential threat is roaming around the population with abnormally increased body weight. This is perhaps an alarming situation [17,18].

Technically, ACE II-receptors are present on various organs including, blood vessel endothelial tissues, adipose-tissues, pancreatic-tissues and respiratory-tissues [19]. Research highlights, those normal adipose tissues produce a substance named “Adiponectin”, which gives adequate inhibition against inflammatory conditions/states. In contrast, during obese conditions this substance is released in lower amounts. Resulting, a higher inflammatory response and tissues become more vulnerable to invasion from heinous pathogens [20].

2. METHODS

A retrospective cohort study was performed, to figure out the relationship among covid-19

related mortalities and Obesity. For the purpose of study, the data was collected from the official data sheets of Government of Sindh, Pakistan, after obtaining written approval from the provincial health services authority, for the use of data in research. The data of 7883 cases was obtained; however, a total of 7036 cases were meeting the inclusion criteria and were included in study. The remaining 847 cases were excluded, as they were not meeting the inclusion criteria.

2.1 Inclusion

All covid19 positive, diabetic, hypertensive, cardiovascular disease, tuberculosis, and asthma patients were included in this study.

2.2 Exclusion

Patients without covid19 or having any malignancies such as tumors / cancers were not part of this study.

The data comprised of all Covid-19 admissions from March 2020 to December 2020, at tertiary care hospital Karachi, Pakistan. Various factors, including; demographic factors; age, gender, body mass index, locality along with co-morbidity factors such as; diabetic history, hypertensive history, cardiovascular disease history, asthma, tuberculosis, cases on ventilation and death / recovered cases were considered. Also smoking habit & alcohol addiction history was taken. The prime focus was to check the rate of mortality and extent of illness in covid-19, as per body mass index.

Primarily, all death cases were evaluated on the basis of all demographic, co-morbidity and other included factors. Secondly, all recovered cases were sorted out along with various included factors. Thirdly, both death and recovered cases were collectively analyzed. World health organization standards were applied for the body mass index. To estimate the relationship among all variables, mortalities and ventilated cases were compared with BMI and other co-morbidities. Statistical significance in all studied variables was analyzed by applying Chi-square statistical test using SPSS (version 23) software. All p-values (two-tailed) with $p<0.05$ were considered statistically significant.

3. RESULTS

The data of total 7036 Covid-19 positive in-patients were collected through purposive sampling technique, including 5423 (77.1%) males and 1613 (22.9%) females. Total 7036, include, 86.1% (n=6055) urban and 13.9% (n=981) rural. Generally, it was noticed that majority of Covid-19 cases were among 31 to 40 years i.e. 26.0 % (n=1519) and least cases were present < 10 years i.e. 1.1% (n=80). Moreover, 21.4% cases were among 41 to 50 years, 15.8% positive cases belonged to 51 to 60 years, 10.8% positive cases belonged to $\geq$ 60 years and 3.2% cases were among 21 to 30 years (Table 1). Consequently, 13.7 % (n=961) were smokers and 86.3% (n=6075) non-smokers. Furthermore, 3.7% (n=262) patients had alcohol consuming history and 96.3% (n=6774) were not alcohol users.

Table 1.Demographic details

Demographic	Number	Percentage
Gender		
Male	5423	77.1%
Female	1613	22.9%
Total	7036	100%
Locality		
Urban	6055	86.1%
Rural	981	13.9%
Total	7036	100%
Age		
9 years and Below	80	1.1%
10 to 20 years	226	3.2%
21 to 30 years	1832	26%
31 to 40 years	1519	21.6%
41 to 50 years	1503	21.4%
51 to 60 years	1115	15.8%
61 years and above	761	10.8%
Total	7036	100%

Subsequently, out of total 7036 patients, 6.7% (n=468) of patients were diabetic and 93.3% (n=6568) were non-diabetic. Similarly, 6.6% (n=465) of patients hypertensive and 93.4% (n=6571) were non-hypertensive. Additionally, 4% (n=283) had cardiovascular diseases (CVDs) and 96% (n=6753) without any cardiovascular crisis (Table 2 co-morbidities).

Likewise, 3% (n=210) were asthmatic patients and 97% (n=6826) non-asthmatic. At the same time, 1.9% (n=132) had history of tuberculosis and 98.1% (n=6904) did not have tuberculosis history (Table 3 co-morbidities).

As per BMI, 3% (n=211) cases were underweight, 68.7% (n=4831) cases were normal weight, 22.2% (n=1560) were overweight and 6.2% (n=434) were obese to severely obese patients. Meanwhile, it was estimated that

Table 2. Co-morbidity details (Diabetic, hypertensive, cardiovascular disease)

Gender	Diabetic	Non diabetic	Hypertensive	Non-Hypertensive	With CVDs	Without CVDs
Male	312	5111	359	5064	211	5212
Female	156	1457	106	1507	72	1541
Total	468	6568	465	6571	283	6753

Table 3. Co-morbidity details (Asthma, Tuberculosis)

Gender	Asthmatic	Non-asthmatic	Tuberculosis history	Without Tuberculosis history
Male	149	5274	101	5322
Female	61	1552	31	1582
Total	210	6826	132	6904

2.2% (n=156) COVID-19 positive cases had to undergo invasive mechanical ventilation. Whereas, 6880 (97.8%) patients not undergone invasive mechanical ventilation (I.M.V). (Table 4).

Table 4. Ventilation cases

IMV Status	Number	Percent
Patients On IMV	156	2.2
Patients without IMV	6880	97.8
Total	7036	100.0

Out of the total sample size (n=7036) enrolled for the study, the mortality was 1.8% (n=127) and 98 .2% (n=6909) patients were discharged from the hospital after their recovery from COVID-19. Among the total death cases (n=127), 70.9% (n=90) were males and 29.1% (n= 37) were females (Table 5).

Table 5. Gender wise death and recovered cases

Gender	Death cases	Recovered Cases	Total
Male	90	5333	5423
Female	37	1576	1613
Total	127	6909	7036

Out of total deaths, the most frequent deaths were among 61 years and above age group i.e. 31.5% (n=40 deaths), the second most frequent death cases were marked in the age group 51 to 60 years i.e. 30.7% (n=39 deaths). Subsequently, least cases were marked between 10 to 20 years age i.e. 2.4% (n=3 deaths). No death was reported below 10 years age. (Table 6).

The deaths cases with smoking history were 27.6 % (n = 35), and non smokers were 72.4% (n = 92), with chi-square = 21.192 and p-value < 0.001. Whereas, 7.1% (n = 9) were alcoholic and 92.9% (n =118) were non-alcoholic. Consequently, on further analysis of co-morbidity factors among COVID-19 death and recovered cases, 42.5% (n = 54) cases were diabetic and 57.5% (n = 73) were non-diabetic. Similarly, 58.3 % (n =74) death-cases were hypertensive and 41.7% (n =53) death-cases were non-hypertensive. It was also analyzed that 44.1% (n=56) had history of CVDs. In contrast, 55.9% (n=71) death-cases had no history of cardiovascular diseases. Subsequently, 9.4 % (n=12) were asthmatic. In contrast, 90.6% (n=115) cases were non-asthmatic. Furthermore, 14.2% (n=18) death cases had tuberculosis positive history and 85.8% (n=109) had no history of tuberculosis (Table 7).

Table 6. Death and recovered cases among various age groups

Age	Death cases	Recovered Cases	Total
9 years and below	0	80	80
10 to 20 years	3	223	226
21 to 30 years	9	1823	1832
31 to 40 years	14	1505	1519
41 to 50 years	22	1481	1503
51 to 60 years	39	1076	1115
61 years and above	40	721	761
Total	127	6909	7036

Table 7. Co-morbidity details of overall death and recovered cases

Co-morbidity status	Death cases	Recovered cases	Total cases	Chi-square value	p-value
Diabetics	54	414	468		0.000
Non Diabetics	73	6495	6568	267.98	
Total	127	6909	7036		
Hypertensive	74	391	465		0.000
Non Hypertensive	53	6518	6571	559.2	
Total	127	6909	7036		
With known CVD	56	227	283		0.000
Without CVD	71	6682	6753	537.9	
Total	127	6909	7036		
Asthmatic	12	198	210		0.000
Non-Asthmatic	115	6711	6826	18.664	
Total	127	6909	7036		
History of T.B	18	114	132		0.000
Without T.B History	109	6795	6904	106.2	
Total	127	6909	7036		

On analyzing the data of body mass index and age, it was found that 9 years and below age had no underweight case, but contained 80 cases with normal body mass index and no overweight or obese case in this age was seen, 10 to 20 years age group contained 111 cases in normal body mass index range 115 over weight, but not case from underweight, and obese category, 21 to 30 years group contained 80 underweight cases, 1492 normal body mass index cases, 222 over weight cases and 38 were the obese cases. Similarly, among 31 to 40 years age group 51 were underweight, 1106 were normal, 299 were overweight and 63 were obese. Among 41 to 50 years 79 were underweight, 899 were normal, 482 were overweight and 43 were obese cases. Meanwhile, 51 to 60 year age group contained 01 underweight, 730 normal, 310 were overweight and 74 were obese. Subsequently, among 61 years and more age group, 524 were normal, 222 were overweight, 15 were obese and no one was underweight.

The details of patients on invasive-ventilation revealed that no any underweight case observed on ventilation, 24 cases had normal BMI values, 54 had overweight and 78 were obese. This clearly indicates that with increasing body mass index there is increased number of cases who acquired mechanical-ventilation, chi-square value 1131.7 and p-value = < 0.001 (highly significant). (Table 8).

Moreover, the foremost focusing point of this study was the mortalities as per BMI, according to which 23 death cases were reported in normal weight range (18.5-24.9), whereas 46 death cases among overweight (25-29.9) and 58 death cases were among obese category ($\geq$ 30), it shows the proportional relationship between obesity and mortality, with chi-square value 763.6 and p-value = < 0.001 (Table 9).

On analyzing the data of various co-morbid conditions in correlation to the body mass index it was found that all those factors were closely associated with body mass index, all with p-values < 0.001, as shown in Table 10.

Table 8. Ventilation details of Death and recovered cases

BMI values	Death cases	Recovered cases	Total cases	Chi-square value	p-value
Underweight (< 18.5)	0	211	211		
Normal (18.5 – 24.9)	24	4918	4942		
Over weight (25.0 – 29.9)	54	1596	1650		< 0.001
Obese (30 $\geq$)	78	155	233	1131.7	
Total	156	6880	7036		

Table9. Body mass index values and death / recovered cases

Category as per BMI value	Death cases	Recovered cases	Total cases	Chi-square value	p-value
Underweight (<18.5)	0	211	211		
Normal (18.5-24.9)	23	4919	4942	763.6	
Over weight (25-29.9)	46	1604	1650		0.000
Obese (≥30)	**58**	175	233		
Total	127	6909	7036		

Table 10. Paired samples correlations

Body mass index versus co-morbidities		N	Correlation	Sig.
Pair 1	Body mass index & hypertension history	7036	-.138	.000
Pair 2	Body mass index & diabetes history	7036	-.083	.000
Pair 3	Body mass index & cardiovascular disease history	7036	-.101	.000
Pair 4	Body mass index & asthma history	7036	-.107	.000
Pair 5	Body mass index & tuberculosis history	7036	-.070	.000
Pair 6	Body mass index & copd history	7036	-.135	.000

This shows the strong correlation of body mass index with factors, such as with death cases, ventilation cases, co-morbidities. Therefore it is utmost necessary to consider all the above factors in linkage to the BMI and deaths in COVID-19.

4. DISCUSSION

It is a retrospective cohort study that elaborates 7036 hospitalized patients who had been suffering from COVID-19. Moreover, in this study several factors have been included to estimate the predominant nature of those factors and their impact on severity of COVID-19 outcomes and even mortality but the main factor for focus is BMI. In contrast one past study was done on sixty eight in-patients at one of the hospital in China with prevalence of pneumonia and influenza virus, according to which 15% was mortality, whereas, 30% were hospital admissions [10]. This study has a far larger sample size as mentioned above along with some different results with 1.8% mortality among COVID-19 related hospitalizations. As per the previously discussed study, obesity was considered as one of the prime factors linked with slow or no improvement in patients' health. [10].

Another study has tried to bring attention of health care providers towards over vigilance towards obese patients during the current pandemic. It is therefore more important to properly screen obese patients if they develop signs and symptoms suspected to be from COVID19. Physicians and healthcare works need to pay special attention to treat such cases. [7]. This is what the current study has elaborated by results that a huge number of obese patients have undergone ventilation and certainly death. Meanwhile, multiple factors were included. In contrast to it, another research work had included over eight thousand cases with one hundred plus hospitals, including twenty six percent cases with hypertensive history and fourteen percent cases with diabetes, approximately twenty one percent smokers, sixteen percent had cardiovascular cases and two percent had history of chronic obstructive pulmonary disease [8]. This study had mentioned also asthma cases which were left in the previously mentioned study. Another multi-centered study only shows data of urban-population admitted to the tertiary care hospitals, the focus was on underweight, overweight and obese patients and extent of illness due to viral respiratory infections [11]. However, the objective of current study was not only to focus the urban setting but also to include rural hospitalized COVID19-patients.

Obese patients with least physical mobility and exercise habits have been proven more susceptible to get admitted at hospital due to influenza and could be proved as a channel for disease widespread [13]. Similarly, apart from hypertensive and diabetic history, obese patients are also at more risk to develop severe illness and eventually death due to the currently prevailing COVID19 infection [14].

5. CONCLUSION

Based on all the above facts, it can aptly be concluded that the currently going pandemic has case fatality 1.8%, (n=127). As per the gender i.e. males are more liable to develop COVID-19 related hospitalizations than females and eventually more deaths. Similarly, urban patients have more prevalence than the rural patients. Pragmatically, obesity can be stated one of the attributing factors among COVID-19 affected mortality cases. Accordingly, ample mortality count was observed among obese patients, whereas, the second highest count was among overweight patients. The data aptly shows the frequency of mortality is highly dependent on patients' BMI. The chances of deaths due to COVID-19 become more with increased BMI.

Logically, in light of all the above mentioned facts, it can be concluded that the outcome by this pandemic could be proved more dreadful and life threatening, if the people have any of the above mentioned factors, specially, increased BMI than the normal values. At one side, it can exacerbate the COVID-19 related respiratory complications due to which a patient has to undergo invasive mechanical ventilation and at the other side, it could lead to death.

So, it is therefore suggested that, the global community shall be motivated enough to curb their weight and reach to the normal BMI, so as to reduce the risk of severity and mortality due to covid19 throughout the globe. Also there is utmost need to vaccinate the obese people as soon as possible to reduce the risk of Covid-19 mortality among them.

CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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