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Association Between Body Mass Index and Clinical Outcomes in Diabetic Patients Hospitalized with COVID-19

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Abstract

Objective: Diabetes mellitus increases the risk of severe coronavirus disease 2019 (COVID-19). The prognostic value of body mass index (BMI) in diabetic patients with COVID-19 remains uncertain. We investigated the association between BMI and clinical outcomes in hospitalized diabetic patients.

Materials and Methods: This retrospective cohort study included 925 adults with diabetes hospitalized for confirmed COVID-19 at Shahid Sadoughi Hospital, Yazd, Iran, from March 2020 to March 2021. Patients were grouped by BMI (<20, 20–24.9, 25–29.9, 30–34.9, and ≥35 kg/m²). Univariable and multivariable logistic regression assessed factors associated with in-hospital mortality.

Results: Mortality differed across BMI groups ($P< 0.001$), peaking at 21.3% in the 25–29.9 kg/m² group. Compared with BMI 20–24.9 kg/m², mortality odds were lower for BMI 30–34.9 kg/m² (adjusted OR= 0.15, 95% CI: 0.05–0.49; $P= 0.002$) and BMI <20 kg/m² (adjusted OR= 0.16, 95% CI: 0.04–0.73; $P=0.018$). Male sex (adjusted OR= 1.84, 95% CI: 1.15–2.94; $P= 0.012$), hypertension (adjusted OR= 2.07, 95% CI: 1.28–3.32; $P= 0.003$), higher LDH (adjusted OR= 1.009, 95% CI: 1.007–1.011; $P< 0.001$), and higher ESR (adjusted OR= 1.076, 95% CI: 1.055–1.096; $P< 0.001$) were associated with higher mortality, whereas higher oxygen saturation was associated with lower mortality (adjusted OR= 0.95, 95% CI: 0.91–0.997; $P= 0.036$).

Conclusion: BMI was non-uniformly associated with in-hospital mortality in diabetic patients with COVID-19. Clinical and inflammatory markers were also independent predictors. Prospective multicenter studies are warranted.

Keywords: COVID-19, Diabetes mellitus, Body mass index, Mortality

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Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has posed a major global health challenge since its emergence in late 2019. Although most infected individuals experience mild disease, older adults and patients with chronic comorbidities are at substantially increased risk of hospitalization, intensive care unit (ICU) admission, respiratory failure and death (1,2). Diabetes mellitus, affecting more than 530 million adults worldwide, is one of the most common chronic diseases associated with poor COVID-19 outcomes and frequently coexists with overweight and obesity (3-5). As the prevalence of both diabetes and obesity continues to rise worldwide, identifying prognostic factors in this high-risk population has become increasingly important (3,6).

Body mass index (BMI), the most widely used measure of obesity, has been extensively investigated as a predictor of COVID-19 severity. Large cohort studies and several systematic reviews and meta-analyses have consistently demonstrated that overweight and obesity are associated with increased risks of hospitalization, invasive mechanical ventilation, ICU admission and mortality among patients with COVID-19 (7,8). Likewise, diabetes has been identified as an independent predictor of severe disease and death (9). However, findings regarding the prognostic significance of different BMI categories have not been entirely consistent across studies, suggesting that the relationship between BMI and COVID-19 outcomes may vary according to patient characteristics and underlying metabolic status (10).

Several biological mechanisms may explain the adverse interaction between obesity, diabetes, and COVID-19. Obesity promotes chronic low-grade systemic inflammation through increased secretion of pro-inflammatory cytokines, including interleukin-6 (IL-6) and tumor necrosis factor-alpha (TNF-α), while impairing both innate and adaptive immune responses. It is also associated with endothelial dysfunction, a prothrombotic state, reduced respiratory compliance and impaired pulmonary mechanics. Diabetes further aggravates these abnormalities through chronic hyperglycemia, oxidative stress, immune dysregulation, endothelial injury and microvascular dysfunction, thereby increasing susceptibility to severe SARS-CoV-2 infection and adverse clinical outcomes (11-14).

Despite extensive evidence linking obesity and diabetes to severe COVID-19, the independent prognostic role of BMI specifically among patients with diabetes remains insufficiently characterized. Most previous studies have evaluated heterogeneous populations in which diabetes was considered primarily as a confounding factor rather than the population of interest. Furthermore, data from Middle Eastern populations remain limited despite the high regional prevalence of both obesity and diabetes. Consequently, it remains uncertain whether BMI independently predicts adverse clinical outcomes among hospitalized diabetic patients with COVID-19 (15).

Therefore, this retrospective observational cohort study aimed to evaluate the association between BMI categories and clinical outcomes, including in-hospital mortality, ICU admission and length of hospital stays, among hospitalized patients with diabetes and COVID-19. In addition, we sought to determine whether BMI independently predicts in-hospital mortality after adjustment for important demographic, clinical and laboratory confounding factors.

Material and methods

Study design and setting

This retrospective observational cohort study was conducted at Shahid Sadoughi Hospital, a tertiary referral center affiliated with Shahid Sadoughi University of Medical Sciences, Yazd, Iran. The study included adult patients with diabetes mellitus who were hospitalized with confirmed COVID-19 between March 20, 2020 and March 19, 2021. The study was conducted in accordance with the Declaration

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of Helsinki. Because of the retrospective design, all patient information was anonymized before analysis to ensure confidentiality.

Study population

A census sampling strategy was used, and all eligible hospitalized diabetic patients during the study period were evaluated for inclusion. Eligible participants were adults (≥ 18 years) with a documented diagnosis of diabetes mellitus before admission and confirmed COVID-19 infection. COVID-19 was diagnosed by infectious disease, internal medicine, or pulmonary specialists based on compatible clinical manifestations together with a positive reverse transcription-polymerase chain reaction (RT-PCR) test or characteristic chest computed tomography (CT) findings. Hospitalization was indicated for patients with moderate-to-severe COVID-19 requiring inpatient management because of respiratory involvement, oxygen desaturation, or significant comorbidities. Patients were excluded if they had incomplete medical records, missing height or weight measurements preventing BMI calculation, unavailable information regarding the primary outcome (in-hospital mortality), duplicate records, or an uncertain diagnosis of COVID-19.

Data collection

Clinical data were retrospectively extracted from electronic and paper medical records using a standardized data collection form. The collected variables included demographic characteristics (age and sex), smoking status, anthropometric measurements (height, weight, and body mass index), diabetes treatment (insulin therapy versus non-insulin treatment), vaccination status (none, one dose, or two doses), peripheral oxygen saturation (SpO2) at admission, laboratory findings including white blood cell (WBC) count, neutrophil percentage, lymphocyte percentage, erythrocyte sedimentation rate (ESR) and lactate dehydrogenase (LDH). Comorbidities extracted from medical records included hypertension (HTN), coronary artery disease (CAD), chronic lung disease (CLD), cerebrovascular disease, malignancy and liver disease. The primary outcome was in-hospital mortality. Secondary outcomes included intensive care unit (ICU) admission and length of hospital stay.

Body mass index classification

Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in meters (kg/m²). According to the predefined study protocol, patients were categorized into five BMI groups:

- BMI< 20 kg/m²
- BMI 20.0–24.9 kg/m²
- BMI 25.0–29.9 kg/m²
- BMI 30.0–34.9 kg/m²
- BMI≥ 35.0 kg/m²

The BMI category of 20.0–24.9 kg/m² served as the reference group in logistic regression analyses.

Missing data

Medical records were reviewed for completeness before statistical analysis. Patients with missing BMI values or unavailable primary outcome data were excluded. Because the remaining variables contained minimal missing data, complete-case analysis was performed and no statistical imputation was applied.

Statistical analysis

Statistical analyses were performed using IBM SPSS version 26 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD), whereas categorical variables are presented as frequency and percentage. Comparisons among BMI categories were performed using one-way analysis of variance (ANOVA) for continuous variables and the Chi-square test or Fisher's exact test, as appropriate, for categorical variables. To evaluate the association between BMI category and in-hospital mortality, univariate binary logistic regression analysis was first performed to estimate crude odds ratios (ORs) and

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corresponding 95% confidence intervals (95% CIs). Subsequently, multivariable binary logistic regression analysis was conducted to identify independent predictors of in-hospital mortality. The multivariable model included BMI category together with clinically relevant covariates, including age, sex, hypertension, coronary artery disease, chronic lung disease, oxygen saturation at admission (SpO2), lactate dehydrogenase (LDH), erythrocyte sedimentation rate (ESR) and diabetes treatment. Adjusted odds ratios (aORs) with 95% confidence intervals were reported. Model calibration was evaluated using the Hosmer–Lemeshow goodness-of-fit test. All statistical tests were two-sided and a *P*-value< 0.05 was considered statistically significant.

Ethical considerations

This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences (Ethics Code: IR.SSU.MEDICINE.REC.1400.351).

Results

A total of 925 patients with diabetes mellitus who were hospitalized with confirmed COVID-19 were included in the study. Participants were categorized into five BMI groups: BMI< 20 kg/m² (n= 76), BMI 20–24.9 kg/m² (n= 279), BMI 25–29.9 kg/m² (n= 394), BMI 30–34.9 kg/m² (n= 153) and BMI≥ 35 kg/m² (n= 23).

Baseline characteristics

The baseline demographic, clinical and laboratory characteristics of the study population according to BMI category are summarized in Table 1. The mean age of participants ranged from 55.83 (± 17.16) to 61.71 (± 15.21) years and did not differ significantly across BMI categories (*P*= 0.406). Likewise, no statistically significant differences were observed regarding sex distribution, smoking status, insulin therapy, oxygen saturation at admission, WBC count, ESR, hypertension, coronary artery disease, cerebrovascular disease, malignancy, liver disease, or vaccination status (all *P*> 0.05). Among laboratory parameters, serum LDH levels differed significantly across BMI groups (*P*= 0.002), with the highest mean value observed in patients with BMI 25–29.9 kg/m² (521.50 (± 148.51) U/L). Chronic lung disease was also significantly more prevalent in patients with higher BMI categories (*P*= 0.032). No significant differences were observed in neutrophil or lymphocyte percentages between BMI groups.

Clinical outcomes according to BMI

Clinical outcomes across BMI categories are presented in Table 2. A statistically significant association was observed between BMI category and in-hospital mortality (*P*< 0.001). The highest mortality rate occurred in patients with BMI 25–29.9 kg/m² (21.3%), followed by those with BMI 20–24.9 kg/m² (18.6%). In contrast, markedly lower mortality rates were observed among patients with BMI< 20 kg/m² (2.7%), BMI 30–34.9 kg/m² (2.6%) and BMI≥ 35 kg/m² (4.3%). No significant differences were found among BMI categories regarding ICU admission (*P*= 0.309) or length of hospital stay (*P*= 0.190). Given the limited number of patients in the BMI≥ 35 kg/m² group (n= 23), findings related to this subgroup should be interpreted with caution.

Univariate logistic regression analysis

The association between BMI categories and in-hospital mortality was further evaluated using univariate logistic regression, with BMI 20–24.9 kg/m² serving as the reference category (Table 3).

Patients with BMI 30–34.9 kg/m² had significantly lower odds of in-hospital mortality (OR= 0.12, 95% CI: 0.04–0.33, *P*< 0.001). Similarly, patients with BMI < 20 kg/m² had significantly reduced odds of mortality (OR= 0.12, 95% CI: 0.03–0.50, *P*= 0.004). Although patients with BMI 25–29.9 kg/m² demonstrated higher odds of mortality than the reference group (OR= 1.18, 95% CI: 0.80–1.74), this association was not statistically significant (*P*= 0.394). Likewise, no significant association was observed for

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patients with BMI≥ 35 kg/m² (OR= 0.20, 95% CI: 0.03–1.51, *P*= 0.118).

Multivariable logistic regression analysis

To determine whether BMI independently predicted in-hospital mortality, a multivariable logistic regression model was constructed adjusting for age, sex, hypertension and coronary artery disease and chronic lung disease, oxygen saturation at admission, LDH, ESR and diabetes treatment (Table 4). After adjustment, BMI remained independently associated with mortality. Compared with patients with BMI 20–24.9 kg/m², those with BMI 30–34.9 kg/m² had significantly lower odds of in-hospital mortality (adjusted OR= 0.15, 95% CI: 0.05–0.49, *P*= 0.002), as did patients with BMI <20 kg/m² (adjusted OR= 0.16, 95% CI: 0.04–0.73, *P*= 0.018). Although patients with BMI 25–29.9 kg/m² had higher adjusted odds of mortality (adjusted OR= 1.55, 95% CI: 0.96–2.52), this association did not reach statistical significance (*P*= 0.075). Likewise, no significant association was observed for patients with BMI≥ 35 kg/m² (adjusted OR= 0.20, 95% CI: 0.02–1.82, *P*= 0.155).

Table 1. Baseline demographic, clinical and laboratory characteristics of patients according to body mass index (BMI) category

Variable	BMI< 20 (n= 76)	BMI 20–24.9 (n= 279)	BMI 25–29.9 (n= 394)	BMI 30–34.9 (n= 153)	BMI≥ 35 (n= 23)	*P*-value
Age (years), mean ± SD	61.71 (± 15.21)	60.88 (± 14.20)	60.95 (± 14.77)	60.71 (± 19.99)	55.83 (± 17.16)	0.406
Female sex, n (%)	27 (35.5)	134 (48.0)	195 (49.5)	76 (49.7)	12 (52.2)	0.247
Current smoker, n (%)	9 (11.8)	26 (9.3)	55 (14.0)	18 (11.8)	1 (4.4)	0.325
Insulin therapy, n (%)	33 (43.4)	102 (36.6)	150 (38.1)	60 (39.2)	8 (34.8)	0.848
SpO2 at admission (%), mean ± SD	92.88 (± 4.61)	91.71 (± 5.64)	92.08 (± 5.71)	92.13 (± 5.26)	90.43 (± 5.16)	0.275
Neutrophil (%), mean ± SD	73.25 (± 11.16)	73.88 (± 11.22)	74.74 (± 10.33)	71.17 (± 10.38)	70.49 (± 9.34)	0.491*
Lymphocyte (%), mean ± SD	26.75 (± 11.16)	26.11 (± 11.06)	25.26 (± 10.33)	28.83 (± 10.38)	29.51 (± 9.34)	0.491
WBC (×10³/µL), mean ± SD	11.36 (± 4.26)	11.66 (± 4.26)	11.62 (± 3.80)	10.96 (± 4.05)	10.61 (± 2.83)	0.077
ESR (mm/h), mean ± SD	47.50 ± 11.63	49.50 ± 11.13	49.10 ± 12.03	46.37 ± 11.70	47.94 ± 11.23	0.381
LDH (U/L), mean ± SD	439.70 (± 140.68)	457.70 (± 140.28)	521.50 (± 148.51)	432.24 (± 139.90)	469.25 (± 138.86)	0.002
Hypertension, n (%)	57 (75.0)	187 (67.0)	271 (68.8)	103 (67.3)	16 (69.6)	0.755
Coronary artery disease, n (%)	4 (5.3)	17 (6.1)	21 (5.3)	11 (7.2)	2 (8.7)	0.898
Chronic lung disease, n (%)	3 (3.9)	14 (5.0)	36 (9.1)	17 (11.1)	4 (17.4)	0.032
Cerebrovascular disease, n (%)	5 (6.6)	13 (4.7)	23 (5.8)	6 (3.9)	2 (8.7)	0.526
Malignancy, n (%)	2 (2.6)	13 (4.7)	20 (5.1)	5 (3.3)	1 (4.3)	0.770
Liver disease, n (%)	7 (9.2)	18 (6.5)	24 (6.1)	6 (3.9)	1 (4.3)	0.828
Vaccination status, n (%)						0.719
None	19 (25.0)	83 (29.7)	115 (29.2)	44 (28.8)	8 (34.8)	
One dose	31 (40.8)	103 (36.9)	166 (42.1)	57 (37.3)	6 (26.1)	
Two doses	26 (34.2)	93 (33.3)	113 (28.7)	52 (34.0)	9 (39.1)	
In-hospital mortality, n (%)	2 (2.7)	52 (18.6)	84 (21.3)	4 (2.6)	1 (4.3)	<0.001
ICU admission, n (%)	9 (11.8)	59 (21.1)	89 (22.6)	30 (19.6)	4 (17.4)	0.309
Length of hospital stay (days), mean ± SD	7.32 (± 2.61)	7.12 (± 2.11)	7.20 (± 2.48)	6.98 (± 2.69)	5.91 (± 3.53)	0.190

BMI: Body Mass Index, SpO_2: Peripheral Oxygen Saturation, WBC: white blood cell count, ESR: erythrocyte sedimentation rate, LDH: lactate dehydrogenase, ICU: intensive care unit, CAD: coronary artery disease, CLD:chronic lung disease.
Notes: Data are presented as mean ± standard deviation (SD) for continuous variables and number (percentage) for categorical variables. Comparisons among BMI categories were performed using one-way analysis of variance (ANOVA) for continuous variables and the Chi-square test or Fisher's exact test, as appropriate, for categorical variables. A two-sided *P*-value <0.05 was considered statistically significant.

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Table 2. Clinical outcomes of hospitalized diabetic patients with COVID-19 according to body mass index (BMI) category

Outcome	BMI< 20	BMI 20–24.9	BMI 25–29.9	BMI 30–34.9	BMI≥ 35	*P*-value
Mortality (%)	2.6	18.6	21.3	2.6	4.3	< 0.001
ICU admission (%)	11.8	21.1	22.6	19.6	17.4	0.309
Length of stay (Mean±SD)	7.32 (± 2.61)	7.12 (± 2.11)	7.20 (± 2.48)	6.98 (±2.69)	5.91 (± 3.53)	0.19

BMI: body mass index, ICU: intensive care unit.

Notes: Data are presented as percentage (%) or mean ± standard deviation (SD). Comparisons among BMI categories were performed using the Chi-square test for categorical variables and one-way analysis of variance (ANOVA) for continuous variables. A two-sided *P*-value< 0.05 was considered statistically significant.

Table 3. Univariate logistic regression analysis of the association between BMI categories and in-hospital mortality among hospitalized diabetic patients with COVID-19

BMI category	Crude OR	95% CI	*P*-value
20–24.9	Reference		
25–29.9	1.18	0.80–1.74	0.394
30–34.9	0.12	0.04–0.33	< 0.001
≥35	0.20	0.03–1.51	0.118
<20	0.12	0.03–0.50	0.004

OR: odds ratio, CI: confidence interval, BMI: body mass index.

Notes: Odds ratios (ORs), 95% confidence intervals (CIs) and *P* values were obtained from univariate binary logistic regression analysis. The BMI category of 20–24.9 kg/m² was used as the reference group.

Table 4: Multivariable logistic regression analysis of factors associated with in-hospital mortality among hospitalized diabetic patients with COVID-19

Variable	Adjusted OR	95% CI	*P*-value
BMI 20–24.9	Reference		
BMI 25–29.9	1.55	0.96–2.52	0.075
BMI 30–34.9	0.15	0.05–0.49	0.002
BMI ≥35	0.20	0.02–1.82	0.155
BMI <20	0.16	0.04–0.73	0.018
Male sex	1.84	1.15–2.94	0.012
Hypertension	2.07	1.28–3.32	0.003
Age	1.00	0.98–1.02	0.945
CAD	1.68	0.53–5.36	0.378
CLD	1.58	0.59–4.18	0.361
SpO_2	0.95	0.91–0.997	0.036
LDH	1.009	1.007–1.011	<0.001
ESR	1.076	1.055–1.096	<0.001
DM treatment	1.05	0.66–1.68	0.846

Notes: Adjusted odds ratios (aORs), 95% confidence intervals (CIs) and *P* values were obtained using multivariable binary logistic regression. The model was adjusted for age, sex, hypertension, coronary artery disease, chronic lung disease, oxygen saturation at admission (SpO2), lactate dehydrogenase (LDH), erythrocyte sedimentation rate (ESR) and diabetes treatment. The BMI category of 20–24.9 kg/m² was used as the reference group. A two-sided *P*-value< 0.05 was considered statistically significant. Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; BMI, body mass index; CAD, coronary artery disease; CLD, chronic lung disease; SpO2, peripheral oxygen saturation; LDH, lactate dehydrogenase; ESR, erythrocyte sedimentation rate.

Among the covariates included in the adjusted model, male sex (adjusted OR= 1.84, 95% CI: 1.15–2.94, *P*= 0.012), hypertension (adjusted OR= 2.07, 95% CI: 1.28–3.32, *P*= 0.003), higher LDH levels (adjusted OR= 1.009 per unit increase, 95% CI: 1.007–1.011, *P*< 0.001) and higher ESR (adjusted OR= 1.076 per unit increase, 95% CI: 1.055–1.096, *P*< 0.001) were independently associated with increased in-hospital mortality. Conversely, higher oxygen saturation at admission was associated with a lower risk of mortality (adjusted OR= 0.95, 95% CI: 0.91–0.997, *P*= 0.036). Age,

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coronary artery disease, chronic lung disease and diabetes treatment were not independently associated with mortality after adjustment.

Discussion

In this retrospective cohort study of 925 hospitalized patients with diabetes and COVID-19, we investigated the association between BMI categories and clinical outcomes, particularly in-hospital mortality. The principal finding was that mortality differed significantly across BMI categories in the unadjusted analysis, with the highest mortality observed among patients with BMI 25–29.9 kg/m². However, after adjustment for important clinical and demographic factors, only patients with BMI< 20 kg/m² and BMI 30–34.9 kg/m² showed significantly lower odds of in-hospital mortality compared with the reference group (BMI 20–24.9 kg/m²), whereas the associations for BMI 25–29.9 kg/m² and BMI≥ 35 kg/m² were not statistically significant. In addition, male sex, hypertension, elevated LDH, elevated ESR and lower oxygen saturation at admission were independently associated with increased mortality.

The relationship between BMI and COVID-19 outcomes has been extensively investigated, although the findings remain inconsistent, particularly among patients with diabetes. Several large cohort studies and meta-analyses have reported obesity as an independent risk factor for severe COVID-19, ICU admission, mechanical ventilation and mortality. Obesity has been linked to impaired pulmonary mechanics, chronic low-grade inflammation, immune dysregulation, endothelial dysfunction and a prothrombotic state, all of which may contribute to worse outcomes following SARS-CoV-2 infection. Conversely, other studies have reported a weaker or non-significant association after adjustment for age, metabolic disorders and other comorbidities, suggesting that obesity alone may not fully explain disease severity (10,16).

Our findings differ somewhat from studies reporting a linear increase in mortality with increasing BMI. In the present cohort, the highest crude mortality was observed among overweight patients (BMI 25–29.9 kg/m²), whereas mortality was considerably lower in patients with BMI 30–34.9 kg/m². Moreover, after multivariable adjustment, overweight was no longer significantly associated with mortality, while patients with BMI 30–34.9 kg/m² demonstrated significantly lower odds of death than the reference group. Although this finding may appear unexpected, several explanations should be considered (17).

First, BMI is an imperfect indicator of adiposity because it does not distinguish between lean body mass and fat mass or reflect visceral fat distribution, which has been shown to correlate more strongly with adverse metabolic and inflammatory profiles. Consequently, patients with similar BMI values may differ substantially in metabolic health and body composition (18,19).

Second, diabetic patients frequently present with multiple coexisting conditions that may influence prognosis independently of BMI. In our multivariable model, hypertension remained an independent predictor of mortality, suggesting that underlying cardiometabolic disease may contribute more substantially to adverse outcomes than BMI itself. Likewise, male sex was associated with an approximately 84% increase in the odds of death, consistent with previous reports describing sex-related differences in immune response and COVID-19 severity (20,21).

Third, the relatively small number of patients in the extreme BMI categories, particularly the BMI≥ 35 kg/m² group (n= 23), limits the precision of the estimated effect sizes. The wide confidence intervals observed for this group indicate limited statistical power and therefore these findings should be interpreted cautiously. The unequal distribution of patients across BMI categories may also have influenced the observed mortality pattern (22).

Inflammatory biomarkers were important predictors of mortality in the adjusted analysis. Elevated LDH was independently associated with increased mortality, consistent with

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previous studies identifying LDH as a marker of tissue injury and severe pulmonary involvement in COVID-19. (23,24) Similarly, higher ESR independently predicted mortality, reflecting the contribution of systemic inflammation to disease progression. Although neutrophil percentage differed numerically across BMI categories, it was not independently evaluated in the regression model; therefore, its clinical significance should be interpreted cautiously. These findings collectively support the concept that inflammatory activity, rather than BMI alone, plays a major role in determining prognosis among hospitalized diabetic patients (15,25).

Another clinically relevant finding was the protective association of higher oxygen saturation at hospital admission. Patients with better baseline oxygenation had lower odds of in-hospital mortality, emphasizing the importance of respiratory status at presentation as a determinant of subsequent clinical outcomes.

The discrepancies between our findings and previous reports may reflect differences in study populations, ethnicity, prevalence of diabetes, healthcare systems, timing during the pandemic, circulating viral variants, treatment protocols and adjustment for confounding variables. Unlike many earlier studies that evaluated mixed populations of diabetic and non-diabetic patients, our study specifically focused on hospitalized patients with pre-existing diabetes, a group characterized by substantial metabolic heterogeneity and a high burden of comorbidities.

This study has several strengths. It included a relatively large cohort of hospitalized diabetic patients and evaluated BMI using predefined categories while simultaneously adjusting for important demographic, clinical, and laboratory variables through multivariable logistic regression. These analyses provide a more comprehensive assessment of the independent association between BMI and mortality than unadjusted comparisons alone.

Nevertheless, several limitations should be acknowledged. First, the retrospective single-center design limits the generalizability of the findings and may introduce selection bias. Second, the distribution of patients across BMI categories was markedly unequal, with very few patients in the BMI≥ 35 kg/m² category, reducing statistical power for this subgroup. Third, BMI was used as the sole measure of obesity; therefore, body fat distribution, waist circumference and visceral adiposity could not be evaluated. Fourth, residual confounding from unmeasured variables, including glycemic control before admission, duration of diabetes, diabetes type, medications and socioeconomic factors, cannot be excluded. Finally, because the study population consisted exclusively of hospitalized patients, the findings may not apply to patients with milder COVID-19 managed in outpatient settings.

Conclusion

Among hospitalized patients with diabetes and COVID-19, BMI category was associated with in-hospital mortality in the unadjusted analysis, although this relationship was not uniform across all BMI categories after adjustment for potential confounders. Patients with BMI 30–34.9 kg/m² and those with BMI< 20 kg/m² demonstrated lower adjusted odds of mortality than the reference group, whereas no significant association was observed for BMI 25–29.9 kg/m² or BMI≥ 35 kg/m². Independent predictors of mortality included male sex, hypertension, lower oxygen saturation at admission and elevated LDH and ESR levels. These findings suggest that the prognosis of hospitalized diabetic patients with COVID-19 is influenced by multiple clinical and inflammatory factors in addition to BMI. Given the limited number of patients in the highest BMI category and the retrospective single-center design, further large prospective multicenter studies are required to clarify the independent prognostic role of BMI and other measures of adiposity in this high-risk population.

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Conflict of Interest

The authors declare that they have no conflicts of interest relevant to this study.

Authors' contributions

A. E-M: Contributed to data collection, data analysis, literature review and manuscript editing.

A. Gh: Contributed to study design, data interpretation, supervision of the study, manuscript editing and final approval.

All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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