In-Hospital 30-Day Survival Among Young Adults With Coronavirus Disease 2019: A Cohort Study

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Background. Our objective was to characterize young adult patients hospitalized with coronavirus disease 2019 (COVID-19) and identify predictors of survival at 30 days.

Methods. This retrospective cohort study took place at 12 acute care hospitals in the New York City area. Patients aged 18–39 hospitalized with confirmed COVID-19 between March 1 and April 27, 2020 were included in the study. Demographic, clinical, and outcome data were extracted from electronic health record reports.

Results. A total of 1013 patients were included in the study (median age, 33 years; interquartile range [IQR], 28–36; 52% female). At the study end point, 940 (92.8%) patients were discharged alive, 18 (1.8%) remained hospitalized, 5 (0.5%) were transferred to another acute care facility, and 50 (4.9%) died. The most common comorbidities in hospitalized young adult patients were obesity (51.2%), diabetes mellitus (14.8%), and hypertension (13%). Multivariable analysis revealed that obesity (adjusted hazard ratio [aHR], 2.71; 95% confidence interval [CI], 1.28–5.73; \( P = .002 \)) and Charlson comorbidity index score (aHR, 1.20; 95% CI, 1.07–1.35; \( P = .002 \)) were independent predictors of in-hospital 30-day mortality.

Conclusions. Obesity was identified as the strongest negative predictor of 30-day in-hospital survival in young adults with COVID-19.

Keywords. coronavirus disease 2019 (COVID-19); mortality; severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2); young adults.
The most common comorbidities in this group were obesity (51.2%), diabetes mellitus (14.8%), and hypertension (13%). The median length of stay was 3.85 days (IQR, 2.17–7.18) for all patients: 3.67 days (IQR, 2.13–6.88) for patients discharged alive and 11.84 days (IQR, 4.31–18.93) for those who died. The most prevalent age group was 32 to 39. The most common comorbidities for hospitalized patients were obesity (51.2%), diabetes mellitus (14.8%), and hypertension (13%). The median score on the CCI, which does not include obesity, asthma, or hypertension, was zero.

Patients Who Received Invasive Mechanical Ventilation

There were 105 (10.3%) patients who received treatment with invasive mechanical ventilation (median age, 34.5; IQR, 30–37; 31% female). For these patients, the median length of stay was 4.8 days (IQR, 3–9.7) compared to 3.3 days (IQR, 2–6.8) for those who did not receive invasive mechanical ventilation. The most common comorbidities in this group were obesity (56.2%), diabetes mellitus (31.4%), and hypertension (25.7%). Median score on the CCI was 1. Obese patients were not more likely to receive invasive mechanical ventilation, with 11.28% (59 of 523) of these patients requiring ventilation compared to 8.82% (38 of 431) of non-obese patients (P < .210). Eight of the patients who received treatment with invasive mechanical ventilation did not have a recorded body mass index and were left out of this analysis.
There were 119 patients in our study within this age group (median age, 22 years [IQR, 21–23]; 69% female). Median length of stay for these patients was 3 days (IQR, 1.9–4.9). Only 7 required invasive mechanical ventilation and, of those, 4 died. Two of the 7 who required invasive mechanical ventilation had no prior medical history except for obesity, whereas the remaining 5 patients all had comorbidities, including Down’s syndrome, congestive heart failure, end-stage kidney disease, and obstructive sleep apnea. The median BMI was 39.8 (IQR, 24.7–34.8) for all

| Variables                         | Total n = 1013 | Died n = 50 | Alive n = 963 |
|-----------------------------------|---------------|-------------|---------------|
| Demographic Information          |               |             |               |
| Age, median, IQR (range)         | 33 (28–36)    | 35 (30–38)  | 32 (28–36)    |
| Age, n (%)                        |               |             |               |
| 18–24                             | 119 (11.7)    | 4 (3.4)     | 115 (96.6)    |
| 25–31                             | 329 (32.5)    | 12 (3.7)    | 317 (96.4)    |
| 32–39                             | 565 (55.8)    | 34 (6.0)    | 531 (94.0)    |
| Female, n (%)                     | 527 (52)      | 15 (2.9)    | 512 (97.2)    |
| Male, n (%)                       | 486 (48)      | 35 (7.2)    | 451 (92.8)    |
| Race, n (%)                       |               |             |               |
| African American                  | 215 (21.2)    | 14 (6.5)    | 201 (93.5)    |
| Asian                             | 82 (8.1)      | 2 (2.4)     | 80 (97.6)     |
| White                             | 263 (26)      | 9 (3.4)     | 254 (96.6)    |
| Other/Multiracial                 | 416 (41.1)    | 24 (5.8)    | 392 (94.2)    |
| Unknown/Declined                  | 37 (3.7)      | 1 (2.7)     | 36 (97.3)     |
| Ethnicity, n (%)                  |               |             |               |
| Hispanic                          | 334 (33)      | 19 (5.7)    | 315 (94.3)    |
| Non-Hispanic                      | 623 (61.5)    | 25 (4.5)    | 598 (95.5)    |
| Unknown/Declined                  | 56 (5.5)      | 3 (5.4)     | 53 (94.6)     |
| Insurance, n (%)                  |               |             |               |
| Commercial                        | 405 (40)      | 16 (4.0)    | 389 (96.1)    |
| Medicaid                          | 516 (50.9)    | 27 (5.2)    | 489 (94.8)    |
| Medicare                          | 41 (4)        | 4 (9.8)     | 37 (90.2)     |
| Self-pay                          | 33 (3.6)      | 3 (9.1)     | 30 (90.9)     |
| Other                             | 18 (1.8)      | 0 (0.0)     | 18 (100.0)    |
| Comorbidities                     |               |             |               |
| Cancer, n (%)                     | 5 (.5)        | 3 (60.0)    | 2 (40.0)      |
| Cardiovascular Disease, n (%)     |               |             |               |
| Hypertension                      | 132 (13)      | 13 (9.9)    | 119 (90.2)    |
| Coronary artery disease           | 2 (.2)        | 0 (0.0)     | 2 (100.0)     |
| Congestive heart failure          | 9 (.9)        | 4 (44.4)    | 5 (55.6)      |
| Chronic liver disease             | 21 (2.1)      | 1 (4.8)     | 20 (95.2)     |
| Chronic Respiratory Disease, n (%)|               |             |               |
| Asthma                            | 122 (12)      | 6 (4.9)     | 116 (95.1)    |
| Chronic Obstructive Pulmonary Disease | 3 (3) | 1 (33.3) | 2 (66.7) |
| Diabetes mellitus                 | 150 (15)      | 8 (12.0)    | 132 (88.0)    |
| End-stage kidney disease, n (%)   | 23 (2.3)      | 2 (8.7)     | 21 (91.3)     |
| BMI, median, IQR, n = 954         | 30.9 (26.6–36.7) | 33.7 (28.3–40.6) | 30.7 (26.6–36.6) |
| Obesity, n (%), n = 954           |               |             |               |
| Normal (BMI <25.0)                | 163 (16.1)    | 5 (3.1)     | 158 (96.9)    |
| Overweight (BMI 25.0–29.9)        | 272 (26.9)    | 9 (3.3)     | 263 (96.7)    |
| Obese (BMI 30.0–39.9)             | 368 (36.3)    | 20 (5.4)    | 348 (94.6)    |
| Severe obese (BMI ≥40.0)          | 151 (15)      | 12 (8.0)    | 139 (92.1)    |
| Charlson comorbidity index, median (IQR) | 0 (1.0) | 1 (2.0) | 0 (1.0) |
| Smoking Status, n (%)             |               |             |               |
| Never                             | 881 (87)      | 34 (3.86)   | 847 (96.1)    |
| Former                            | 47 (4.6)      | 3 (6.4)     | 44 (93.6)     |
| Active                            | 39 (3.8)      | 2 (5.1)     | 37 (94.9)     |
| Unknown                           | 46 (4.5)      | 11 (23.9)   | 35 (76.1)     |

Abbreviations: BMI, body mass index; IQR, interquartile range.
patients in this age group, 33.0 (IQR, 23.4–49.0) for those requiring invasive mechanical ventilation, and 24.0 (IQR, 21.1–40.5) for those who died.

Predictors of Survival

Obesity and CCI were both negatively associated with in-hospital 30-day survival (Table 2). The strongest predictor of mortality in this age group was obesity (Figures 1 and 2). Patients who were obese, compared to those who were not, were 2.7 times more likely to expire within 30 days. Mortality risk increased by 20% for each additional point on the CCI. Among covariates examined sex, insurance type, asthma, hypertension, and smoking status were eliminated from the final model as these were not associated with increased mortality risk. The hazard ratio for other race varied over time and was significant only in patients with a hospital stay over 20 days.

DISCUSSION

This is the first study to report on predictors of survival in young adults, and its findings are significantly strengthened by our large number of participants. As expected, the overwhelming majority (95%) of hospitalized patients in this age group were alive at the study end point. Obesity, diabetes mellitus, and hypertension were the most common comorbidities in hospitalized patients; these findings echo reports for hospitalized patients of all age groups and support the findings from study in young adults [17, 23]. Body mass index and comorbidity burden (as measured by the CCI) were identified as predictors of in-hospital survival in young adults with COVID-19.

Obesity emerged as the most significant predictor of mortality in this age group. Obesity does not show a decreased prevalence by age in America, where approximately 40% of adults in all age groups are obese [28]. With the exception of 1 patient, with cachexia secondary to metastatic choriocarcinoma, all of the college-aged (18–24) patients in our cohort who died or required invasive mechanical ventilation were obese or morbidly obese. Our findings are supported by a recent study detailing the differential effect of obesity on risk of mortality based on age [29]. That study found that obesity was independently associated with mortality in those younger than 50 with an adjusted odds ratio of 5.1. For those with age above 50, however, the strength of association was weaker, with an adjusted odds ratio of 1.6.

We analyzed data only for patients admitted with COVID-19 and were unable to assess for predictors of infection or severe disease in young adults outside of the hospital. However, of the 954 people in our study with a recorded BMI, 519 (54.4%) were obese. This is higher than the national average and average in the NYC metropolitan area and suggests either a higher susceptibility to infections or a higher likelihood of severe disease requiring hospitalization. Further study will assess obesity as a predictor of severe disease and out-of-hospital survival in those with COVID-19.

The reason that obesity is associated with mortality in young adults is likely multifactorial. Obesity is associated with several additional chronic medical problems, such as diabetes and chronic kidney disease. However, we adjusted for these and other medical conditions in our analysis using the CCI. Obese persons are known to have reduced lung volumes and hypoventilation, which makes them at greater risk for complications from respiratory illnesses [30]. In addition, there is emerging evidence that patients with COVID-19 suffer from a hypercoagulable state that may act synergistically with the hypercoagulable state seen in obesity, which can lead to an increased risk of potentially fatal conditions such as pulmonary embolism, stroke, and arterial thrombosis [31].

Limitations

Several limitations should be noted. First, this cohort comprised only patients within the New York metropolitan area. Data were extracted from the EHR database and do not include the level of granularity that would be possible with a manual chart review. Of note, smoking status was limited given the inability to capture e-cigarette and vaping usage among this younger cohort. Evidence-based treatment regimens were developing and changing rapidly, and thus data collection of these regimens was not possible. Despite these limitations, the results are based on a large and diverse number of patients and thus significantly contribute to the existing literature.

CONCLUSIONS

Obesity may represent the most significant barrier to survival in young adults hospitalized with COVID-19. Given these findings and our understanding of obesity as an almost entirely preventable disease, public health recommendations to improve population-level health should include food policy changes in addition to existing diet and lifestyle recommendations. In this

Table 2. In-Hospital 30-Day Mortality Risk Assessment Using an Extended Cox Model

| Factor                      | aHR (95% CI)   | P Value |
|-----------------------------|---------------|---------|
| Age                         | 1.05 (0.98–1.13) | .148    |
| Charlson comorbidity index  | 1.20 (1.07–1.35) | .002    |
| Obesity                     | 2.71 (1.28–5.73) | .009    |
| Asian, compared with white  | 0.36 (0.043–2.98) | .342    |
| Black, compared with white  | 2.0 (0.81–4.90) | .136    |
| Other/multiracial, compared with white | 1.05 (0.32–3.48) | .934    |
| Hispanic, compared with non-Hispanic | 1.14 (0.42–3.10) | .801    |

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval.

*All variables were used in multivariate analysis.


study, the impact of obesity on in-hospital survival in young adults was similar in magnitude to the previously reported impact on survival of age over 65 in patients of all ages [10].

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Figure 1. Unadjusted Kaplan-Meier curve for survival by obesity status.

![Unadjusted Kaplan-Meier curve for survival by obesity status.](image)

| Factor                        | HR  | 95% CI | P Value |
|-------------------------------|-----|--------|---------|
| Age                           | 1.05| 0.98–1.13 | .148    |
| Charlson comorbidity index    | 1.2 | 1.07–1.35 | .002    |
| Obesity                       |     |        |         |
| Not obese (ref.)              |     |        |         |
| Obese (BMI > 30)              | 2.71| 1.28–5.73 | .009    |
| Race                          |     |        |         |
| White (ref.)                  |     |        |         |
| Asian                         | 0.36| 0.04–2.98 | .342    |
| Black                         | 2.00| 0.81–4.90 | .136    |
| Other*                        | 1.05| 0.32–3.48 | .934    |
| Ethnicity                     |     |        |         |
| Not Hispanic/Latino (ref.)    |     |        |         |
| Hispanic/Latino               | 1.14| 0.42–3.10 | .801    |

*Time varying covariate; day 5 estimate.

Figure 2. Forest plot: in-hospital 30-day mortality. BMI, body mass index; HR, hazard ratio.
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