Impact of Body Mass Index on Mortality in Hospitalized Patients With Coronary Artery Disease

Analysis for RCOP NIS IM-6

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## Preamble:

* **Reference Paper:** [Sreenivasan et al. 2022](https://doi.org/10.1016/j.amjcard.2022.04.011)
* **Study Objective**: Examine the impact of body mass index (BMI) on in-hospital mortality among patients with coronary artery disease (CAD).
* **Data Source**: Cross-sectional analysis of the National Inpatient Sample (NIS) from 2018 to 2020.
* **Patient Selection**: Included all hospitalized patients diagnosed with CAD.
* **BMI Categories**:
  + Underweight: BMI ≤19.9 kg/m²
  + Normal Weight: BMI 20.0 to 24.9 kg/m²
  + Overweight: BMI 25.0 to 29.9 kg/m²
  + Class I Obesity: BMI 30.0 to 34.9 kg/m²
  + Class II Obesity: BMI 35.0 to 39.9 kg/m²
  + Class III Obesity: BMI ≥40.0 kg/m²
* **Primary Outcome**: In-hospital all-cause mortality.
* **Statistical Analysis**: Multiple logistic regression to determine the independent association of BMI categories with in-hospital mortality, adjusted for:
  + Demographics: Age, gender, race
  + Medical History: Previous coronary artery bypass graft, myocardial infarction, percutaneous coronary intervention
  + Comorbidities: Atrial fibrillation, cerebrovascular disease, heart failure, peripheral vascular disease, dementia, tobacco use disorder, chronic obstructive pulmonary disease, valvular heart disease, liver disease, diabetes mellitus, hypertension, chronic kidney disease, dialysis dependence, anemia, hyperlipidemia, and any cancer.
* **Software:** All analyses were performed using R Version 4.4.1 (R Foundation for Statistical Computing, Vienna, Austria)

This analysis aims to provide insights into how different BMI categories affect the mortality risk of hospitalized CAD patients, offering valuable information for clinical management and patient care strategies.

## Baseline Table:

| **Characteristic** | **Overall**, N = 3,540,4251 | **Normal weight (BMI 20.0-24.9kg/m²)**, N = 256,0001 | **Class I obesity (BMI 30.0-34.9kg/m²)**, N = 836,9801 | **Class II obesity (BMI 35.0-39.9kg/m²)**, N = 692,2151 | **Class III obesity (BMI ≥40.0kg/m²)**, N = 1,038,7701 | **Overweight (BMI 25.0-29.9kg/m²)**, N = 338,6501 | **Underweight (BMI ≤19.9kg/m²)**, N = 377,8101 | **p-value**2 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Age, y | 69 (12) | 76 (11) | 69 (11) | 67 (11) | 64 (11) | 72 (11) | 76 (11) | <0.001 |
| Sex |  |  |  |  |  |  |  | <0.001 |
| Female | 1,553,895 (44%) | 96,515 (38%) | 308,290 (37%) | 288,125 (42%) | 547,540 (53%) | 125,705 (37%) | 187,720 (50%) |  |
| Male | 1,986,530 (56%) | 159,485 (62%) | 528,690 (63%) | 404,090 (58%) | 491,230 (47%) | 212,945 (63%) | 190,090 (50%) |  |
| Race |  |  |  |  |  |  |  | <0.001 |
| White | 2,652,535 (75%) | 188,155 (73%) | 640,975 (77%) | 526,895 (76%) | 769,670 (74%) | 249,600 (74%) | 277,240 (73%) |  |
| Asian or Pacific Islander | 51,535 (1.5%) | 7,910 (3.1%) | 10,460 (1.2%) | 6,270 (0.9%) | 6,760 (0.7%) | 6,755 (2.0%) | 13,380 (3.5%) |  |
| Black | 488,170 (14%) | 33,320 (13%) | 97,335 (12%) | 90,405 (13%) | 170,310 (16%) | 40,960 (12%) | 55,840 (15%) |  |
| Hispanic | 256,575 (7.2%) | 18,890 (7.4%) | 66,495 (7.9%) | 51,440 (7.4%) | 67,390 (6.5%) | 31,410 (9.3%) | 20,950 (5.5%) |  |
| Native American | 18,070 (0.5%) | 1,075 (0.4%) | 4,140 (0.5%) | 3,480 (0.5%) | 6,320 (0.6%) | 1,360 (0.4%) | 1,695 (0.4%) |  |
| Other | 73,540 (2.1%) | 6,650 (2.6%) | 17,575 (2.1%) | 13,725 (2.0%) | 18,320 (1.8%) | 8,565 (2.5%) | 8,705 (2.3%) |  |
| Income quartile by ZIP |  |  |  |  |  |  |  | <0.001 |
| $1 - $51,999 | 1,129,445 (32%) | 76,940 (30%) | 251,940 (30%) | 216,475 (31%) | 361,195 (35%) | 102,985 (30%) | 119,910 (32%) |  |
| $52,000 - $65,999 | 991,430 (28%) | 67,295 (26%) | 232,265 (28%) | 198,995 (29%) | 302,500 (29%) | 91,180 (27%) | 99,195 (26%) |  |
| $66,000 - $87,999 | 828,610 (23%) | 59,720 (23%) | 202,980 (24%) | 165,115 (24%) | 235,555 (23%) | 80,285 (24%) | 84,955 (22%) |  |
| $88,000 or more | 590,940 (17%) | 52,045 (20%) | 149,795 (18%) | 111,630 (16%) | 139,520 (13%) | 64,200 (19%) | 73,750 (20%) |  |
| Healthcare payer |  |  |  |  |  |  |  | <0.001 |
| Medicaid | 306,770 (8.7%) | 14,435 (5.6%) | 62,805 (7.5%) | 60,895 (8.8%) | 122,385 (12%) | 22,185 (6.6%) | 24,065 (6.4%) |  |
| Medicare | 2,480,960 (70%) | 210,350 (82%) | 575,250 (69%) | 455,100 (66%) | 671,365 (65%) | 255,605 (75%) | 313,290 (83%) |  |
| No charge | 6,890 (0.2%) | 275 (0.1%) | 2,045 (0.2%) | 1,375 (0.2%) | 2,240 (0.2%) | 565 (0.2%) | 390 (0.1%) |  |
| Other | 80,665 (2.3%) | 5,145 (2.0%) | 20,915 (2.5%) | 17,285 (2.5%) | 22,645 (2.2%) | 7,905 (2.3%) | 6,770 (1.8%) |  |
| Private | 591,730 (17%) | 22,920 (9.0%) | 157,345 (19%) | 140,505 (20%) | 195,520 (19%) | 46,300 (14%) | 29,140 (7.7%) |  |
| Self-pay | 73,410 (2.1%) | 2,875 (1.1%) | 18,620 (2.2%) | 17,055 (2.5%) | 24,615 (2.4%) | 6,090 (1.8%) | 4,155 (1.1%) |  |
| Hypertension | 3,204,925 (91%) | 218,475 (85%) | 767,460 (92%) | 640,865 (93%) | 964,675 (93%) | 304,235 (90%) | 309,215 (82%) | <0.001 |
| Diabetes mellitus | 2,001,830 (57%) | 96,875 (38%) | 479,180 (57%) | 436,405 (63%) | 715,345 (69%) | 173,155 (51%) | 100,870 (27%) | <0.001 |
| Chronic kidney disease | 1,301,220 (37%) | 94,635 (37%) | 292,155 (35%) | 249,305 (36%) | 419,095 (40%) | 125,125 (37%) | 120,905 (32%) | <0.001 |
| Dialysis dependence | 173,560 (4.9%) | 15,935 (6.2%) | 40,280 (4.8%) | 31,990 (4.6%) | 45,895 (4.4%) | 19,395 (5.7%) | 20,065 (5.3%) | <0.001 |
| Liver disease | 211,915 (6.0%) | 17,955 (7.0%) | 46,245 (5.5%) | 38,600 (5.6%) | 64,585 (6.2%) | 22,560 (6.7%) | 21,970 (5.8%) | <0.001 |
| Cancer | 193,960 (5.5%) | 29,270 (11%) | 40,985 (4.9%) | 27,895 (4.0%) | 34,400 (3.3%) | 25,665 (7.6%) | 35,745 (9.5%) | <0.001 |
| COPD | 1,358,760 (38%) | 87,505 (34%) | 274,545 (33%) | 249,195 (36%) | 461,595 (44%) | 107,995 (32%) | 177,925 (47%) | <0.001 |
| Anemia | 254,170 (7.2%) | 26,510 (10%) | 51,015 (6.1%) | 40,400 (5.8%) | 71,255 (6.9%) | 26,510 (7.8%) | 38,480 (10%) | <0.001 |
| Peripheral vascular disease | 559,235 (16%) | 51,350 (20%) | 136,985 (16%) | 100,170 (14%) | 122,055 (12%) | 61,650 (18%) | 87,025 (23%) | <0.001 |
| Atrial fibrillation | 976,495 (28%) | 74,645 (29%) | 222,765 (27%) | 185,100 (27%) | 295,715 (28%) | 94,115 (28%) | 104,155 (28%) | <0.001 |
| Prior MI | 856,140 (24%) | 60,070 (23%) | 213,585 (26%) | 172,880 (25%) | 236,135 (23%) | 82,775 (24%) | 90,695 (24%) | <0.001 |
| Prior PCI | 885,250 (25%) | 60,315 (24%) | 236,870 (28%) | 189,850 (27%) | 235,995 (23%) | 89,355 (26%) | 72,865 (19%) | <0.001 |
| Prior CABG | 618,950 (17%) | 55,940 (22%) | 164,445 (20%) | 126,135 (18%) | 139,640 (13%) | 72,285 (21%) | 60,505 (16%) | <0.001 |
| Cerebrovascular disease | 333,925 (9.4%) | 28,800 (11%) | 84,830 (10%) | 61,125 (8.8%) | 78,175 (7.5%) | 37,830 (11%) | 43,165 (11%) | <0.001 |
| Dementia | 261,580 (7.4%) | 49,150 (19%) | 43,335 (5.2%) | 25,905 (3.7%) | 28,705 (2.8%) | 36,085 (11%) | 78,400 (21%) | <0.001 |
| Heart failure | 1,837,020 (52%) | 120,885 (47%) | 391,175 (47%) | 350,380 (51%) | 636,345 (61%) | 158,430 (47%) | 179,805 (48%) | <0.001 |
| Tobbacco use disorder | 25,280 (0.7%) | 1,565 (0.6%) | 6,245 (0.7%) | 5,170 (0.7%) | 6,970 (0.7%) | 2,390 (0.7%) | 2,940 (0.8%) | <0.001 |
| Hyperlipidemia | 2,473,065 (70%) | 155,090 (61%) | 634,970 (76%) | 515,090 (74%) | 716,070 (69%) | 243,250 (72%) | 208,595 (55%) | <0.001 |
| Length of stay (days) | 5.8 (6.0) | 7.3 (7.0) | 5.2 (5.3) | 5.1 (5.1) | 5.8 (6.0) | 6.2 (6.5) | 7.1 (7.5) | <0.001 |
| 1Mean (SD); n (%) | | | | | | | | |
| 2Wilcoxon rank-sum test for complex survey samples; chi-squared test with Rao & Scott's second-order correction | | | | | | | | |

## Outcomes Table:

| **Characteristic** | **Overall**, N = 3,540,4251 | **Normal weight (BMI 20.0-24.9kg/m²)**, N = 256,0001 | **Class I obesity (BMI 30.0-34.9kg/m²)**, N = 836,9801 | **Class II obesity (BMI 35.0-39.9kg/m²)**, N = 692,2151 | **Class III obesity (BMI ≥40.0kg/m²)**, N = 1,038,7701 | **Overweight (BMI 25.0-29.9kg/m²)**, N = 338,6501 | **Underweight (BMI ≤19.9kg/m²)**, N = 377,8101 | **p-value**2 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| All-cause mortality | 103,530 (2.9%) | 13,185 (5.2%) | 15,555 (1.9%) | 12,590 (1.8%) | 25,990 (2.5%) | 10,625 (3.1%) | 25,585 (6.8%) | <0.001 |
| 1n (%) | | | | | | | | |
| 2chi-squared test with Rao & Scott's second-order correction | | | | | | | | |

## Multivariable Logistic Regression:

### All-Cause Mortality:

| **Characteristic** | **OR**1 | **95% CI**1 | **p-value** |
| --- | --- | --- | --- |
| Body mass index (BMI) |  |  |  |
| Normal weight (BMI 20.0-24.9kg/m²) | — | — |  |
| Class I obesity (BMI 30.0-34.9kg/m²) | 0.50 | 0.47, 0.53 | <0.001 |
| Class II obesity (BMI 35.0-39.9kg/m²) | 0.52 | 0.49, 0.55 | <0.001 |
| Class III obesity (BMI ≥40.0kg/m²) | 0.71 | 0.68, 0.76 | <0.001 |
| Overweight (BMI 25.0-29.9kg/m²) | 0.72 | 0.68, 0.76 | <0.001 |
| Underweight (BMI ≤19.9kg/m²) | 1.36 | 1.29, 1.43 | <0.001 |
| Age, y | 1.03 | 1.03, 1.03 | <0.001 |
| Sex |  |  |  |
| Female | — | — |  |
| Male | 1.15 | 1.11, 1.18 | <0.001 |
| Race |  |  |  |
| White | — | — |  |
| Asian or Pacific Islander | 1.25 | 1.13, 1.38 | <0.001 |
| Black | 0.97 | 0.93, 1.02 | 0.2 |
| Hispanic | 1.08 | 1.01, 1.15 | 0.022 |
| Native American | 1.12 | 0.92, 1.37 | 0.3 |
| Other | 1.13 | 1.03, 1.25 | 0.009 |
| Prior CABG |  |  |  |
| No | — | — |  |
| Yes | 0.91 | 0.87, 0.94 | <0.001 |
| Prior MI |  |  |  |
| No | — | — |  |
| Yes | 0.87 | 0.83, 0.90 | <0.001 |
| Prior PCI |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.76, 0.82 | <0.001 |
| Atrial fibrillation |  |  |  |
| No | — | — |  |
| Yes | 1.26 | 1.22, 1.30 | <0.001 |
| Cerebrovascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.36 | 1.30, 1.42 | <0.001 |
| Heart failure |  |  |  |
| No | — | — |  |
| Yes | 1.58 | 1.53, 1.63 | <0.001 |
| Peripheral vascular disease |  |  |  |
| No | — | — |  |
| Yes | 1.03 | 0.99, 1.07 | 0.14 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 1.19 | 1.13, 1.24 | <0.001 |
| Tobbacco use disorder |  |  |  |
| No | — | — |  |
| Yes | 0.87 | 0.71, 1.06 | 0.2 |
| COPD |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.96, 1.02 | 0.5 |
| Valvular heart disease |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.89, 0.96 | <0.001 |
| Liver disease |  |  |  |
| No | — | — |  |
| Yes | 2.97 | 2.84, 3.10 | <0.001 |
| Diabetes mellitus |  |  |  |
| No | — | — |  |
| Yes | 0.99 | 0.96, 1.02 | 0.5 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 0.68 | 0.65, 0.71 | <0.001 |
| Chronic kidney disease |  |  |  |
| No | — | — |  |
| Yes | 1.21 | 1.17, 1.25 | <0.001 |
| Dialysis dependence |  |  |  |
| No | — | — |  |
| Yes | 1.43 | 1.35, 1.52 | <0.001 |
| Anemia |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.74, 0.83 | <0.001 |
| Hyperlipidemia |  |  |  |
| No | — | — |  |
| Yes | 0.68 | 0.66, 0.70 | <0.001 |
| Cancer |  |  |  |
| No | — | — |  |
| Yes | 1.27 | 1.21, 1.34 | <0.001 |
| 1OR = Odds Ratio, CI = Confidence Interval | | | |