Impact of Socioeconomic Status on 30-Day Readmissions Following Acute COPD Exacerbations

RCOP NRD A13

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## Preamble:

* **Reference Studies:**
  + [Liu et al., 2024](https://www.journalofsurgicalresearch.com/article/S0022-4804(24)00023-4/fulltext)
  + [Lange et al., 2025](https://doi.org/10.4037/ajcc2025261)
  + [Brlecic et al., 2025](https://www.jtcvs.org/article/S0022-5223(25)00033-9/abstract)
* **Study Objective:**
* To evaluate the impact of socioeconomic status (SES) on 30-day all-cause readmission among adult patients hospitalized with acute exacerbations of chronic obstructive pulmonary disease (AECOPD). Secondary objectives included characterizing comorbid conditions, resource utilization, and identifying predictors of readmission within this population using a nationally representative dataset.
* **Data Source:**
* This retrospective cohort study used data from the 2016–2017 Nationwide Readmissions Database (NRD), developed by the Healthcare Cost and Utilization Project (HCUP). The NRD is a nationally representative, all-payer database of U.S. hospitalizations that allows linkage of patients across hospital stays within a calendar year. Survey weights, stratification, and clustering variables support complex sampling design for national estimates.
* **Cohort Definition:**
* Patients were eligible for inclusion if they met all of the following criteria:
  + Adults aged ≥18 years
  + AECOPD diagnosis:
    - Either a principal diagnosis of AECOPD based on specific ICD-10-CM codes:
      * J410, J411, J418, J42, J430, J431, J432, J438, J439, J440, J441, J449
    - Or a principal diagnosis of respiratory failure (e.g., J9600, R0603) plus a secondary diagnosis of AECOPD
  + ZIP-based income quartile (ZIPINC\_QRTL) not missing
  + Non-elective admission
  + Index discharge by the end of November to allow for a complete 30-day follow-up period
  + Complete data on LOS and NRD\_DAYSTOEVENT, required to compute discharge dates
* **SES Quartile Definition (ZIPINC\_QRTL):**
  + Socioeconomic status was defined using the HCUP ZIP-based median household income quartile variable. This categorizes patients by the median income of their home ZIP code into four quartiles:
    - 1 = 0–25th percentile
    - 2 = 26th–50th percentile
    - 3 = 51st–75th percentile
    - 4 = 76th–100th percentile
* **Outcomes of Interest:**
  + Primary Outcome:
    - 30-day all-cause readmission (Yes/No), flagged using NRD linkage variables
  + Secondary Outcomes (index admission):
    - In-hospital mortality (DIED)
    - Length of stay (LOS, in days)
    - Total hospitalization charges (TOTCHG), inflation-adjusted to 2017 USD
    - Non-home discharge
  + Readmission Characteristics:
    - In-hospital mortality
    - Length of stay (LOS, in days)
    - Total hospitalization charges (inflation-adjusted to 2017 USD)
* **Outcome Definitions:**
  + Readmission:
    - Defined using HCUP NRD’s methodology. Readmissions were identified only among patients with qualifying index events.
    - Trauma-related hospitalizations were excluded only from the readmission pool to avoid unrelated admissions.
  + Mortality:
    - In-hospital death recorded during index or readmission (DIED = 1)
  + LOS:
    - Reported in days; modeled as count outcome
  + Charge:
    - Derived from HCUP’s TOTCHG variable and adjusted to 2017 dollars using Consumer Price Index (CPI) data
* **Covariates and Variable Construction:**
  + Demographic & Socioeconomic Factors:
    - Age (continuous)
    - Sex (FEMALE; ref = Male)
    - Primary expected payer (Insurance; Medicare, Medicaid, Private, Other)
    - Weekend admission (AWEEKEND)
  + Clinical Comorbidities:
    - Derived from Elixhauser or Charlson comorbidity groups:
      * Diabetes
      * Congestive heart failure
      * Renal failure
      * Hypertension
      * Obesity
      * Myocardial infarction
      * Depression
      * Dementia
      * Solid tumor without metastasis
      * Alcohol abuse
    - Additional Conditions:
      * Asthma — identified using ICD-10-CM codes from secondary diagnoses
    - Acute Severity Markers:
      * Mechanical ventilation – identified using procedure codes (5A1935Z, 5A1945Z, 5A1955Z)
      * Acute kidney injury (AKI) – identified using secondary diagnosis codes (N17\*)
  + Hospital & Admission Characteristics:
    - Hospital bed size (Small, Medium, Large)
    - Urban/rural teaching status (Metropolitan, teaching vs non-teaching, etc.)
    - Non-home discharge (e.g., SNF, hospice, other facilities, or death)
    - Length of stay (LOS) – continuous variable (in days)
* **Statistical Methods:**
  + Survey Design and Weighting:
    - All analyses accounted for NRD’s complex survey design using weights (DISCWT), strata (NRD\_STRATUM), and clustering (HOSP\_NRD). Survey-adjusted methods were implemented via survey and srvyr packages.
  + Descriptive Analyses:
    - Summary of baseline characteristics and index admission outcomes across SES quartiles
    - P-values from design-based statistical tests (Rao–Scott adjusted chi-square for categorical variables; design-based Kruskal–Wallis test for continuous variables).
  + Multivariable Regression:
    - A survey-weighted logistic regression modeled predictors of 30-day readmission.
    - The model included demographic, clinical, hospital-level, and index-stay factors.
    - Results were exponentiated to yield odds ratios (ORs) with 95% confidence intervals.
  + Readmission Characteristics:
    - A sub-analysis among patients with 30-day readmissions summarized readmission hospitalization characteristics descriptively using weighted survey statistics.
* **Software:** All analyses were conducted in R Statistical Language (Version 4.5.0; R Foundation for Statistical Computing, Vienna, Austria).

## Descriptive Analyses

### Baseline Characteristics by Socioeconomic Status

| **Characteristic** | **Overall** N = 1,637,432*1* | **1st SES quartile** N = 617,394*1* | **2nd SES quartile** N = 470,827*1* | **3rd SES quartile** N = 345,526*1* | **4th SES quartile** N = 203,686*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- |
| Age (years) | 68 (12) | 66 (12) | 68 (12) | 69 (12) | 72 (12) | <0.001 |
| Sex |  |  |  |  |  | 0.14 |
| Male | 701,615 (43%) | 263,139 (43%) | 202,800 (43%) | 148,622 (43%) | 87,054 (43%) |  |
| Female | 935,817 (57%) | 354,254 (57%) | 268,027 (57%) | 196,904 (57%) | 116,632 (57%) |  |
| Primary Expected Payer |  |  |  |  |  | <0.001 |
| Private | 164,807 (10%) | 50,870 (8.2%) | 47,999 (10%) | 41,078 (12%) | 24,860 (12%) |  |
| Medicaid | 217,611 (13%) | 107,633 (17%) | 57,810 (12%) | 35,630 (10%) | 16,537 (8.1%) |  |
| Medicare | 1,171,165 (72%) | 419,377 (68%) | 340,645 (72%) | 254,910 (74%) | 156,233 (77%) |  |
| Other | 81,991 (5.0%) | 38,750 (6.3%) | 23,793 (5.1%) | 13,566 (3.9%) | 5,883 (2.9%) |  |
| Admission Day |  |  |  |  |  | 0.3 |
| Monday-Friday | 1,211,723 (74%) | 456,528 (74%) | 348,298 (74%) | 255,610 (74%) | 151,287 (74%) |  |
| Saturday-Sunday | 425,709 (26%) | 160,865 (26%) | 122,529 (26%) | 89,916 (26%) | 52,399 (26%) |  |
| Hospital Bed Size |  |  |  |  |  | <0.001 |
| Small | 342,701 (21%) | 104,520 (17%) | 108,868 (23%) | 80,564 (23%) | 48,749 (24%) |  |
| Large | 801,662 (49%) | 335,433 (54%) | 227,639 (48%) | 156,783 (45%) | 81,807 (40%) |  |
| Medium | 493,069 (30%) | 177,441 (29%) | 134,320 (29%) | 108,179 (31%) | 73,129 (36%) |  |
| Hospital Location and Teaching Status |  |  |  |  |  | <0.001 |
| Metropolitan, non-teaching | 497,581 (30%) | 153,753 (25%) | 152,607 (32%) | 122,148 (35%) | 69,072 (34%) |  |
| Metropolitan, teaching | 887,021 (54%) | 317,923 (51%) | 233,894 (50%) | 202,930 (59%) | 132,274 (65%) |  |
| Non-metropolitan | 252,831 (15%) | 145,717 (24%) | 84,326 (18%) | 20,447 (5.9%) | 2,340 (1.1%) |  |
| Diabetes | 523,462 (32%) | 210,473 (34%) | 149,322 (32%) | 104,815 (30%) | 58,852 (29%) | <0.001 |
| Hypertension | 1,179,476 (72%) | 451,241 (73%) | 334,315 (71%) | 245,694 (71%) | 148,225 (73%) | <0.001 |
| Renal Failure | 276,914 (17%) | 98,657 (16%) | 79,659 (17%) | 60,855 (18%) | 37,742 (19%) | <0.001 |
| Obesity | 335,747 (21%) | 132,114 (21%) | 97,510 (21%) | 69,164 (20%) | 36,958 (18%) | <0.001 |
| Congestive Heart Failure | 545,901 (33%) | 207,911 (34%) | 154,966 (33%) | 113,742 (33%) | 69,282 (34%) | <0.001 |
| Myocardial Infarction | 158,095 (9.7%) | 58,127 (9.4%) | 44,951 (9.5%) | 34,154 (9.9%) | 20,863 (10%) | <0.001 |
| Asthma | 255,625 (16%) | 100,409 (16%) | 67,593 (14%) | 53,227 (15%) | 34,396 (17%) | <0.001 |
| Depression | 299,096 (18%) | 107,521 (17%) | 87,423 (19%) | 65,802 (19%) | 38,349 (19%) | <0.001 |
| Dementia | 92,863 (5.7%) | 31,692 (5.1%) | 25,798 (5.5%) | 20,361 (5.9%) | 15,012 (7.4%) | <0.001 |
| Solid Tumor (No Metastasis) | 72,341 (4.4%) | 25,188 (4.1%) | 20,929 (4.4%) | 15,994 (4.6%) | 10,230 (5.0%) | <0.001 |
| Alcohol Abuse | 85,518 (5.2%) | 34,655 (5.6%) | 23,496 (5.0%) | 17,287 (5.0%) | 10,080 (4.9%) | <0.001 |
| Mechanical Ventilation | 106,235 (6.5%) | 43,278 (7.0%) | 30,506 (6.5%) | 21,082 (6.1%) | 11,369 (5.6%) | <0.001 |
| Acute Kidney Injury | 195,873 (12%) | 72,741 (12%) | 55,007 (12%) | 42,030 (12%) | 26,095 (13%) | <0.001 |
| *1*Mean (SD); n (%) | | | | | | |
| *2*Design-based KruskalWallis test; Pearson's X^2: Rao & Scott adjustment | | | | | | |

### Outcomes of Index Hospitalizations

| **Characteristic** | **Overall** N = 1,637,432*1* | **1st SES quartile** N = 617,394*1* | **2nd SES quartile** N = 470,827*1* | **3rd SES quartile** N = 345,526*1* | **4th SES quartile** N = 203,686*1* | **p-value***2* |
| --- | --- | --- | --- | --- | --- | --- |
| 30-Day Readmission | 264,536 (16%) | 106,774 (17%) | 74,532 (16%) | 52,589 (15%) | 30,641 (15%) | <0.001 |
| In-Hospital Mortality | 38,699 (2.4%) | 12,911 (2.1%) | 11,226 (2.4%) | 8,763 (2.5%) | 5,799 (2.8%) | <0.001 |
| Length of Stay (days) | 4.8 (5.0) | 4.7 (5.0) | 4.7 (4.8) | 4.8 (5.1) | 5.0 (5.4) | <0.001 |
| Inflation-Adjusted Total Charges ($) | 41,728 (63,934) | 41,513 (60,361) | 40,082 (58,346) | 42,119 (67,517) | 45,550 (78,815) | 0.001 |
| Discharged to Non-Home Setting | 319,008 (19%) | 112,556 (18%) | 92,319 (20%) | 69,619 (20%) | 44,514 (22%) | <0.001 |
| *1*n (%); Mean (SD) | | | | | | |
| *2*Pearson's X^2: Rao & Scott adjustment; Design-based KruskalWallis test | | | | | | |

## Readmission Hospitalization Characteristics

### In-Hospital Mortality Among Readmitted Patients

Readmission hospitalizations resulted in:

1. Deaths (n): 11964
2. Death Rate (%): 4.55%
3. Death Rate (95% CI): 4.4% to 4.7%

### Resource Utilization During Readmission

Readmission hospitalizations resulted in:

1. Mean Length of Stay (days): 5.44
2. Mean Length of Stay (95% CI): 5.39 to 5.48
3. Mean Charge ($): 49918
4. Mean Charge (95% CI): 48769 to 51067

## Multivariable Analyses

### Multivariable Predictors of 30-Day Readmission

| **Characteristic** | **OR** | **95% CI** | **p-value** |
| --- | --- | --- | --- |
| Socioeconomic Status Quartile |  |  |  |
| 1st SES quartile | — | — |  |
| 2nd SES quartile | 0.92 | 0.90, 0.94 | <0.001 |
| 3rd SES quartile | 0.88 | 0.86, 0.90 | <0.001 |
| 4th SES quartile | 0.88 | 0.85, 0.90 | <0.001 |
| Age (years) | 0.99 | 0.99, 0.99 | <0.001 |
| Sex |  |  |  |
| Male | — | — |  |
| Female | 0.90 | 0.88, 0.91 | <0.001 |
| Primary Expected Payer |  |  |  |
| Private | — | — |  |
| Medicaid | 1.70 | 1.64, 1.76 | <0.001 |
| Medicare | 1.52 | 1.47, 1.56 | <0.001 |
| Other | 1.09 | 1.04, 1.14 | <0.001 |
| Admission Day |  |  |  |
| Monday-Friday | — | — |  |
| Saturday-Sunday | 1.03 | 1.01, 1.04 | <0.001 |
| Hospital Bed Size |  |  |  |
| Small | — | — |  |
| Large | 1.06 | 1.03, 1.09 | <0.001 |
| Medium | 1.06 | 1.03, 1.09 | <0.001 |
| Hospital Location and Teaching Status |  |  |  |
| Metropolitan, non-teaching | — | — |  |
| Metropolitan, teaching | 1.00 | 0.98, 1.03 | 0.7 |
| Non-metropolitan | 0.87 | 0.84, 0.89 | <0.001 |
| Diabetes |  |  |  |
| No | — | — |  |
| Yes | 1.13 | 1.11, 1.15 | <0.001 |
| Hypertension |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 1.03, 1.06 | <0.001 |
| Renal Failure |  |  |  |
| No | — | — |  |
| Yes | 1.21 | 1.18, 1.23 | <0.001 |
| Obesity |  |  |  |
| No | — | — |  |
| Yes | 0.94 | 0.93, 0.96 | <0.001 |
| Congestive Heart Failure |  |  |  |
| No | — | — |  |
| Yes | 1.44 | 1.42, 1.46 | <0.001 |
| Myocardial Infarction |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 1.04, 1.09 | <0.001 |
| Asthma |  |  |  |
| No | — | — |  |
| Yes | 0.95 | 0.93, 0.97 | <0.001 |
| Depression |  |  |  |
| No | — | — |  |
| Yes | 1.06 | 1.04, 1.08 | <0.001 |
| Dementia |  |  |  |
| No | — | — |  |
| Yes | 0.98 | 0.95, 1.01 | 0.2 |
| Solid Tumor (No Metastasis) |  |  |  |
| No | — | — |  |
| Yes | 1.28 | 1.24, 1.32 | <0.001 |
| Alcohol Abuse |  |  |  |
| No | — | — |  |
| Yes | 1.13 | 1.09, 1.16 | <0.001 |
| Mechanical Ventilation |  |  |  |
| No | — | — |  |
| Yes | 0.79 | 0.76, 0.81 | <0.001 |
| Acute Kidney Injury |  |  |  |
| No | — | — |  |
| Yes | 0.93 | 0.91, 0.95 | <0.001 |
| Length of Stay (days) | 1.01 | 1.01, 1.01 | <0.001 |
| Discharged to Non-Home Setting |  |  |  |
| No | — | — |  |
| Yes | 1.04 | 1.02, 1.06 | <0.001 |
| Abbreviations: CI = Confidence Interval, OR = Odds Ratio | | | |