Supplemental Material

Appendix A1. Data transformations

We differentiate between primary diagnosis and secondary (“other”) diagnoses. We define primary diagnosis as the first listed diagnosis, or “the condition established after study to be chiefly responsible for occasioning the admission of the patient to the hospital for care” (1). Secondary diagnoses are all diagnoses listed in positions 2 – 30 on the medical record. An increasing number of positions are allotted for diagnoses in these data collection years by states reporting to HCUP: 15 positions per hospitalization during 2006-2008, 25 positions during 2009 – 2013, and 30 positions during 2014 - 2016. Across the years, only 1.36% of the diagnoses occur in position 16 and higher; as such, the inclusion of these additional positions across years likely has little effect on the analysis of patterns.

To identify discharges with obesity as the primary or secondary diagnosis, we use the International Classification of Diseases, 9th Revision (ICD-9) codes of 278.00 and 278.01 and the ICD, 10th Revision (ICD-10) codes of E66.8, E66.9, E66.0, E66.01, and E66.09. To identify the conditions that most frequently co-occur with the secondary diagnosis of obesity, we use the Clinical Classifications Software (CCS) tool to cluster ICD-9 or ICD-10 diagnoses into distinct, clinically meaningful categories. Following Trasande (2009), we combine CCS categories 49 and 50 (diabetes mellitus with and without complications) for this analysis, as well as all pregnancy-related conditions (categories 181–196). We account for the 2015 shift from the ICD-9 to ICD-10 coding system in all models by including an indicator variable to account for a potential discontinuity caused by this change.

We use weights and study design variables (strata and clusters) in all analyses to account for the sample stratification and obtain national estimates. In accordance with recommendations in the HCUP data documentation, we use the trend weight (TRENDWT) for years 2006 - 2011, and the regular discharge weight (DISCWT) for years 2012 – 2016 (2).

HCUP data provide the total charges for each hospitalization. Charges are the amount that hospitals billed for services, but do not reflect the specific amounts that hospitals received in payment (3). Costs represent actual expenses incurred in the production of hospital services and are obtained using the formula:

Total Cost = Total Charge x Cost-to-Charge Ratio

Cost-to-charge ratios are provided by the Agency for Healthcare Research and Quality (3). Following AHRQ recommendations, we use hospital-specific all-payer inpatient cost-to-charge ratio (APICC), when available, and otherwise use the weighted group average (GAPICC).

In the cases when both measures of cost-to-charge ratios (APICC and GAPICC) are missing (3% of our sample), we follow the User Guide for National Inpatient Sample (NIS) Cost-to-Charge Ratios in creating a new discharge weight for cost estimates only (1):

New Discharge Weight = Original discharge weight x

(Total weight of original cases / Total weights, after excluding cases with missing cost)

We report all total charges and costs in 2016 medical price equivalents, using the Personal Consumption Expenditures: Health care index (PCE). PCE index is preferred to Consumer Price Index (CPI) because it reflects the price level of health care expenditures (4). PCE is also preferred to the more commonly used Medical care CPI (MCPI), because the latter is appropriate only for out-of-pocket expenditures (4).

References

1. NIS Description of Data Elements. Healthcare Cost and Utilization Project (HCUP). August 2018. Agency for Healthcare Research and Quality, Rockville, MD. <www.hcup-us.ahrq.gov/db/nation/nis/nisdde.jsp>. Accessed May 25, 2019

2. HCUP NIS Trend Weights. Healthcare Cost and Utilization Project (HCUP). May 2015. Agency for Healthcare Research and Quality, Rockville, MD. <www.hcup-us.ahrq.gov/db/nation/nis/trendwghts.jsp>. Accessed May 21, 2019

3. Cost-to-Charge Ratio Files. Healthcare Cost and Utilization Project (HCUP). September 2018. Agency for Healthcare Research and Quality, Rockville, MD. <www.hcup-us.ahrq.gov/db/state/costtocharge.jsp>. Accessed May 25, 2019

4. Dunn A, Grosse SD, Zuvekas SH. Adjusting health expenditures for inflation: a review of measures for health services research in the United States. Health Serv Res 2018;53:175-196

Appendix Table A2. Mean and Median Length of Stay, Charges and Costs For Hospitalizations Among Children and Youth Ages 2 – 19, 2006 - 2016

|  |  |  |  |
| --- | --- | --- | --- |
|  | Length of Stay | Charges | Costs |
|  | Mean | Median | Mean | Median | Mean | Median |
| All hospitalizations | 3.8 | 2 | 29,333 | 14,219 | 9,192 | 4,472 |
|  - By sex |  |  |  |  |  |  |
|  -Males | 4.2 | 2 | 34,433 | 16,038 | 10,838 | 5,105 |
|  -Females | 3.6 | 2 | 25,736 | 13,208 | 8,047 | 4,154 |
|  - By primary condition |  |  |  |  |  |  |
|  -Pregnancy-related conditions  | 2.7 | 2 | 14,266 | 11,113 | 4,277 | 3,517 |
|  -MHSA: Mood disorders  | 6.8 | 5 | 18,081 | 12,122 | 5,626 | 3,792 |
|  -Asthma  | 2.2 | 2 | 14,382 | 9,849 | 4,335 | 3,111 |
|  -Diabetes  | 2.4 | 2 | 16,538 | 12,129 | 5,194 | 3,997 |
|  -Appendicitis  | 2.8 | 2 | 31,441 | 25,253 | 9,463 | 7,845 |
|  -Biliary tract disease  | 3.2 | 2 | 35,962 | 27,512 | 10,576 | 8,407 |
|  -Skin and subc. tissue infections | 2.7 | 2 | 14,676 | 10,413 | 4,480 | 3,369 |
|  -Pneumonia  | 3.4 | 2 | 23,153 | 11,004 | 7,207 | 3,580 |
|  -MHSA: Schizophrenia  | 10.5 | 7 | 28,593 | 16,634 | 9,190 | 5,154 |
|  -Epilepsy, convulsions  | 2.6 | 2 | 24,825 | 13,660 | 7,665 | 4,175 |
|  -Pancreatic disorders  | 5.1 | 3 | 36,617 | 19,916 | 11,280 | 6,315 |
|  -Other bone disease  | 4.1 | 4 | 113,466 | 88,166 | 37,485 | 32,375 |
|  -Other nervous system disorders | 4.4 | 3 | 51,554 | 29,334 | 16,293 | 9,562 |
|  -Fracture of lower limb  | 3.3 | 2 | 44,349 | 28,749 | 13,320 | 9,384 |

SOURCE: Authors’ analysis of data from the National Inpatient Sample (NIS), 2006-2016.

Appendix Table A3. Length of Stay, Charges and Costs For Hospitalizations Among Children and Youth Ages 2 – 19 With A Diagnosis of Obesity, 2006 - 2016 – Using Percent Incremental Difference

|  |  |  |  |
| --- | --- | --- | --- |
|  | % Increment (95% CI) in length of stay (days) associated with diagnosis of obesity | % Increment (95% CI) in total charges associated with diagnosis of obesity | % Increment (95% CI) in total costs associated with diagnosis of obesity |
| Obesity as a primary diagnosis | -61% (-67,-55)\*\*\* | +54% (47, 61)\*\*\* | +51% (42, 60)\*\*\* |
|  - By sex |  |  |  |
|  -Males | -59% (-76,-43) \*\*\* | +37% (29, 46) \*\*\*^^^ | +34%(24, 45)\*\*\*^^^ |
|  -Females | -62% (-67,-57) \*\*\* | +59% (52, 67) \*\*\*^^^ | +56% (47, 65)\*\*\*^^^ |
| Obesity as a secondary diagnosis | +19% (17, 21)\*\*\* | +11% (9, 13)\*\*\* | +14% (12,16)\*\*\* |
|  - By sex |  |  |  |
|  -Males | +19% (17,23) \*\*\* | +14% (11, 17) \*\*\*^^ | +18% (15, 21) \*\*\*^^^ |
|  -Females | +19% (17,21) \*\*\* | +9% (7, 11) \*\*\*^^ | +12% (10, 14) \*\*\*^^^ |
|  - By primary condition |  |  |  |
|  -Pregnancy-related conditions  | +17% (15,18)\*\*\* | +17% (14,19)\*\*\* | +21% (19,23)\*\*\* |
|  -MHSA: Mood disorders  | +8% (5,11)\*\*\* | +9% (6,13)\*\*\* | +11% (8,15)\*\*\* |
|  -Asthma  | +14% (11,16)\*\*\* | +18% (14,23)\*\*\* | +21% (17,25)\*\*\* |
|  -Diabetes  | +18% (15,22)\*\*\* | +9% (4,14)\*\*\* | +13% (8,18)\*\*\* |
|  -Appendicitis  | +10% (7,13)\*\*\* | +10% (7,13)\*\*\* | +10% (7,13)\*\*\* |
|  -Biliary tract disease  | -3% (-6,0.4) | -2% (-5,2) | -2 % (-5,1) |
|  -Skin and subc. tissue infections | +17% (14,20)\*\*\* | +20% (16,24)\*\*\* | +24% (19,28)\*\*\* |
|  -Pneumonia  | +14% (9,20)\*\*\* | +27% (19,36)\*\*\* | +31% (23,38)\*\*\* |
|  -MHSA: Schizophrenia  | +9% (-0.1,17) | +4% (-4,11) | +5% (-4,13) |
|  -Epilepsy, convulsions  | +8% (0.6,15)\* | +6% (-3,15) | +8% (-1,16) |
|  -Pancreatic disorders  | +8% (2,14)\* | +14% (7,21)\*\*\* | +14% (7,21)\*\*\* |
|  -Other bone disease  | -20% (-26,-14)\*\*\* | -41% (-48,35)\*\*\* | -39% (-45,-33)\*\*\* |
|  -Other nervous system disorders | -2% (-11,7) | -15% (-24,-7)\*\*\* | -12% (-20,-4)\*\* |
|  -Fracture of lower limb  | +26% (19,33)\*\*\* | +14% (7,21)\*\*\* | +17% (11,23)\*\*\* |
| Observations | 4041963 | 3975469 | 3903598 |

SOURCE: Authors’ analysis of data from the National Inpatient Sample (NIS), 2006-2016.

NOTES: CI is confidence interval. \* *p* < 0.05, \*\* *p* < 0.01, \*\*\* *p* < 0.001 (stat.difference from zero) ^ *p* < 0.05, ^^ *p* < 0.01, ^^^ *p* < 0.001 (stat. difference of interaction)

Each model includes race / ethnicity, sex, age group, hospital region, median income for patient’s zip code, payer type, location and teaching status, year, ICD change as controls.