Supplemental Online Content

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This supplemental material has been provided by the authors to give readers additional information about their work.
**eMethods: Calculation of Star Ratings**

CMS calculates star ratings for each contract on the basis of 30-35 measures of enrollee satisfaction and quality outcomes. Each of these individual measures comes from HEDIS, CAHPS, HOS and other data reported by plans. Star ratings range from 2-5 stars in 0.5-star increments. While we could not calculate our stratified star ratings following the exact methodologies that CMS uses due to limitations in our data, we approximated their approach based on the 2015-star ratings. We first calculated ten individual measures from HEDIS data, five individual measures from the HOS, and six measures from CAHPS. Many of the CAHPS and HOS measures are indices which we also calculated following CMS methods. Finally, we also calculated disenrollment rates using the MBSF. Included measures are listed in Table S1. We could not calculate improvement measures as we did not have enough years of the HOS and CAHPS data, however the measures we did calculate account for ~70% of all measures used by CMS.

Next, we collapsed these individual measures from 2015 and 2016 to the contract level, and used cut-points used by CMS in 2015 to give each individual measure an assigned star value of 1-5. We aggregated these measures to the domain level, weighting each measure following CMS methods, and then aggregated to an overall Part C star rating. We first calculated these ratings for all enrollees in each contract. We then repeated the approach only including enrollees in each of our six stratified groups (high SES, either low income or low education, both low income and low education, white, black, and Hispanic). Similar to CMS, we then rounded our ratings to the nearest half-star increment. The approximated overall star rating we calculated was highly correlated to the official star rating CMS assigned to each contract (correlation coefficient=0.89, mean difference 0.1 stars).

As we combined data from across multiple years, we included a contract in our analysis if they had at least 50 enrollees we could calculate measures for across either year. If a contract only had one year of data in either 2015 or 2016, we would only include that year in our calculation if the sample allowed. We required a contract to have individual measures successfully calculated for at least 75% of component measures to be assigned a star rating for any comparison.
**eFigure 1:** Stratified star ratings by decile of low SES, black, and Hispanic

**Notes:** The y-axis represents the calculated star rating stratified by group. The x-axis for each panel is the decile of concentration for each stratified group.
**Notes:** The y-axis represents the simulated star rating stratified by group. The x-axis for each panel is the official star rating.
### eTable 1: List of quality measures included in stratified star rating calculation

| Measure                                      | Source    | Included in Analysis | Reason for Exclusion                                      |
|----------------------------------------------|-----------|----------------------|-----------------------------------------------------------|
| Measure: C01 - Colorectal Cancer Screening   | HEDIS     | Yes                  |                                                           |
| Measure: C02 - Cardiovascular Care – Cholesterol Screening | HEDIS     | No                   | Data not included in our HEDIS files                      |
| Measure: C03 - Diabetes Care – Cholesterol Screening | HEDIS     | No                   | Data not included in our HEDIS files                      |
| Measure: C04 - Annual Flu Vaccine            | CAHPS     | No                   | Data not included in our CAHPS files                      |
| Measure: C05 - Improving or Maintaining Physical Health | HOS       | Yes                  |                                                           |
| Measure: C06 - Improving or Maintaining Mental Health | HOS       | Yes                  |                                                           |
| Measure: C07 - Monitoring Physical Activity  | HOS       | Yes                  |                                                           |
| Measure: C08 - Adult BMI Assessment          | HEDIS     | Yes                  |                                                           |
| Measure: C09 - Special Needs Plan (SNP) Care Management | Plan reporting | No | Plan reported data not available to researchers          |
| Measure: C10 - Care for Older Adults – Medication Review | HEDIS     | No                   | Data not included in our HEDIS files                      |
| Measure: C11 - Care for Older Adults – Functional Status Assessment | HEDIS     | No                   | Data not included in our HEDIS files                      |
| Measure: C12 - Care for Older Adults – Pain Assessment | HEDIS | No | Data not included in our HEDIS files |
| Measure: C13 - Osteoporosis Management in Women who had a Fracture | HEDIS | Yes | |
| Measure: C14 – Diabetes Care – Eye Exam | HEDIS | Yes | |
| Measure: C15 – Diabetes Care – Kidney Disease Monitoring | HEDIS | Yes | |
| Measure: C16 - Diabetes Care – Blood Sugar Controlled | HEDIS | Yes | |
| Measure: C17 - Diabetes Care – Cholesterol Controlled | HEDIS | Yes | |
| Measure: C18 - Controlling Blood Pressure | HEDIS | Yes | |
| Measure: C19 – Rheumatoid Arthritis Management | HEDIS | Yes | |
| Measure: C20 – Improving Bladder Control | HOS | Yes | |
| Measure: C21 - Reducing the Risk of Falling | HOS | Yes | |
| Measure: C22 – Plan All-Cause Readmissions | HEDIS | Yes | |
| Measure: C23 - Getting Needed Care | CAHPS | Yes | |
| Measure: C24 - Getting Appointments and Care Quickly | CAHPS | Yes | |
| Measure: C25 - Customer Service | CAHPS | Yes | |
| Measure: C26 - Rating of Health Care Quality | CAHPS | Yes | |
| Measure: C27 - Rating of Health Plan | CAHPS | Yes | |
| Measure: C28 - Care Coordination | CAHPS | Yes | |
| Measure: C29 - Complaints about the Health Plan | CMS | No | CMS data source not available to researchers |
| Measure: C30 - Members Choosing to Leave the Plan | MBSF | Yes | |
| Measure: C31 - Health Plan Quality Improvement | CMS | No | Not possible with our methodology |
| Measure: C32 - Plan Makes Timely Decisions about Appeals | CMS | No | CMS data source not available to |
| Measure: C33 - Reviewing Appeals Decisions | CMS | No | CMS data source not available to researchers |
### eTable 2: Distributions of contract level concentration of stratified groups

| Decile | Low Income and Low Education Mean | Black Median | Hispanic Median |
|--------|-----------------------------------|--------------|-----------------|
| 1      | 8.8%                              | 18.9%        | 24.0%           |
| 2      | 8.3%                              | 14.3%        | 15.9%           |
| 3      | 4.5%                              | 7.3%         | 6.2%            |
| 4      | 5.9%                              | 9.6%         | 10.9%           |
| 5      | 7.3%                              | 12.5%        | 11.0%           |
| 6      | 9.0%                              | 15.7%        | 14.4%           |
| 7      | 10.4%                             | 19.6%        | 17.0%           |
| 8      | 12.1%                             | 25.5%        | 22.5%           |
| 9      | 14.7%                             | 35.7%        | 28.2%           |
| 10     | 19.2%                             | 55.2%        | 42.4%           |

| Decile | Low Income and Low Education Median | Black Lower Bound | Black Upper Bound | Hispanic Lower Bound | Hispanic Upper Bound |
|--------|------------------------------------|------------------|------------------|----------------------|----------------------|
| 1      | 2.3%                               | 3.0%             | 4.2%             | 2.7%                 | 3.6%                 |
| 2      | 3.5%                               | 3.9%             | 4.3%             | 4.4%                 | 5.1%                 |
| 3      | 4.0%                               | 5.1%             | 6.2%             | 6.2%                 | 5.1%                 |
| 4      | 5.3%                               | 6.6%             | 8.3%             | 9.1%                 | 11.5%                |
| 5      | 6.6%                               | 8.3%             | 11.0%            | 13.5%                | 15.9%                |
| 6      | 8.3%                               | 9.6%             | 14.4%            | 18.2%                | 20.9%                |
| 7      | 9.7%                               | 11.0%            | 17.0%            | 22.1%                | 24.0%                |
| 8      | 11.1%                              | 13.5%            | 22.5%            | 28.1%                | 34.7%                |
| 9      | 13.5%                              | 16.3%            | 28.2%            | 41.5%                | 47.5%                |
| 10     | 16.4%                              | 21.9%            | 55.2%            | 82.8%                | 91.5%                |
**eTable 3: Agreement between self-report and CMS race/ethnicity variables**

|                | HOS and MBSF | HOS and RTI | CAHPS and MBSF | CAHPS and RTI |
|----------------|--------------|-------------|----------------|--------------|
|                | Sensitivity  | Specificity | Sensitivity    | Specificity  |
| White          | 97.4         | 64.6        | 87.1           | 73.2         |
| Black          | 96.0         | 91.2        | 95.5           | 91.7         |
| Hispanic       | 29.0         | 97.1        | 85.8           | 95.0         |

**Notes:** The MBSF race is the race recorded for each enrollee in CMS data which comes originally from the social security administration. The RTI race code applies a predictive algorithm to classify enrollees in race/ethnicity categories. Both are available in the Master Beneficiary Summary File. In both the MBSF variables, Hispanic is considered an exclusive race category. In the HOS and the CAHPS, Hispanic ethnicity is asked as a separate question from race. For this table, we coded the HOS and CAHPS variables in the same way as the MBSF, considering someone to be Hispanic, or any other race non-Hispanic. We then compared the self-report as a gold standard to the two MBSF variables.
### eTable 4: Enrollees and Contracts Remaining After Exclusion Criteria

| Enrollees                        | Contracts |
|----------------------------------|-----------|
|                                  | All Enrollees | High SES Enrollees | Both Low Income and Education | White | Black | Hispanic | N of contracts | % Contracts | 2-2.5 Stars | 3 Stars | 3.5 Stars | 4 Stars | 4.5 to 5 Stars |
| 50+ High SES and Low SES         | 67%        | 55%              | 93%                      | 58%   | 8%    | 89%      | 264             | 58%        | 81%        | 93%     | 61%      | 58%     | 39%       |
| 50+ White and Black Enrollees    | 85%        | 82%              | 91%                      | 84%   | 9%    | 81%      | 357             | 78%        | 89%        | 90%     | 73%      | 87%     | 78%       |
| 50+ White and Hispanic Enrollees | 83%        | 80%              | 88%                      | 81%   | 8%    | 83%      | 333             | 73%        | 78%        | 81%     | 79%      | 81%     | 72%       |

**Notes:** This table presents the percent of enrollees and contracts of different official star ratings that are included in each of our analyses. To ensure the stability of our estimates, we required that at least 50 enrollees of a type were included for each comparison. Each percentage in the enrollee columns are the percent of all enrollees of that type sampled in the HOS or CAHPS that are included in the sample after each exclusion. The contract columns represent the % of all MA contracts of a given star rating that are included in that sample.
### Table 5: Comparison of response rates

#### Individual Level Response Rates by Enrollee Characteristic

| Source | Overall | Not Low Income | Low Income | White | Black | Hispanic |
|--------|---------|----------------|------------|-------|-------|----------|
| CAHPS  | 38.6    | 41.8           | 32.5       | 43.2  | 34.2  | 30.8     |
| HOS    | 43.9    | 45.0           | 41.4       | 44.9  | 40.7  | 38.3     |

#### Contract Level Response Rates by Overall Rating

| Source | Overall | 2-2.5 | 3  | 3.5 | 4  | 4.5-5 | Unrated |
|--------|---------|-------|----|-----|----|-------|---------|
| CAHPS  | 38.2    | 39.5  | 35 | 39.7| 40.1| 46.2  | 32.8    |
| HOS    | 43.5    | 43.7  | 41.2| 43.9| 45  | 46.8  | 41.8    |

#### Contract Level Response Rates by Decile of Enrollment

| Decile of: | 1 | 2 | 3 | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|------------|---|---|---|----|----|----|----|----|----|----|
| Low SES    | CAHPS | 41% | 38% | 39% | 37% | 38% | 35% | 35% | 33% | 34% | 35% |
|            | HOS   | 45% | 44% | 44% | 45% | 47% | 41% | 42% | 42% | 42% | 43% |
| Black      | CAHPS | 43% | 41% | 39% | 38% | 38% | 36% | 35% | 36% | 36% | 34% |
|            | HOS   | 46% | 46% | 44% | 45% | 43% | 43% | 43% | 42% | 43% | 40% |
| Hispanic   | CAHPS | 43% | 43% | 39% | 39% | 38% | 36% | 36% | 35% | 34% | 34% |
|            | HOS   | 46% | 47% | 45% | 44% | 43% | 42% | 40% | 42% | 42% | 44% |
**eTable 6: Within Contract Differences in Individual Measures**

| Measure                                                      | Difference from White | p-value | Hispanic | p-value |
|--------------------------------------------------------------|-----------------------|---------|----------|---------|
| Rheumatoid Arthritis Management                             | 0.5%                  | 0.641   | 2.7%     | 0.021   |
| Diabetes Care – Kidney Disease Monitoring                   | 0.8%                  | 0.003   | 1.0%     | 0.001   |
| Diabetes Care – Eye Exam                                    | 1.8%                  | 0.004   | 4.2%     | 0       |
| Plan All-Cause Readmissions                                 | 0.5%                  | 0.078   | -1.5%    | 0       |
| Improving Bladder Control                                   | 0.0%                  | 0.984   | 3.1%     | 0       |
| Colorectal Cancer Screening                                 | 3.8%                  | 0       | 3.2%     | 0       |
| Adult BMI Assessment                                         | 0.5%                  | 0.238   | 1.5%     | 0       |
| Monitoring Physical Activity                                 | 6.6%                  | 0       | 7.5%     | 0       |
| Osteoporosis Management in Women who had a Fracture          | 0.6%                  | 0.805   | 5.0%     | 0.017   |
| Diabetes Care – Blood Sugar Controlled                      | -0.5%                 | 0.112   | 1.5%     | 0       |
| Diabetes Care – Cholesterol Controlled                      | -2.3%                 | 0       | -2.8%    | 0       |
| Controlling Blood Pressure                                   | -8.2%                 | 0       | 0.6%     | 0.419   |
| Getting Needed Care                                         | -2.9%                 | 0       | -1.2%    | 0       |
| Getting Appointments and Care Quickly                       | -3.4%                 | 0       | -3.0%    | 0       |
| Rating of Health Plan                                       | 6.7%                  | 0       | 26.4%    | 0       |
| Rating of Health Care Quality                               | -24.0%                | 0       | -3.4%    | 0.032   |
| Care Coordination                                            | 0.2%                  | 0.199   | -1.3%    | 0       |
| Customer Service                                            | -0.1%                 | 0.794   | -1.0%    | 0.001   |
| Members Choosing to Leave the Plan                          | 0.7%                  | 0       | 1.2%     | 0       |
| Reducing the Risk of Falling                                | 1.6%                  | 0       | 2.9%     | 0       |
| Improving or Maintaining Physical Health                    | 3.6%                  | 0.011   | 4.4%     | 0.008   |
| Improving or Maintaining Mental Health                      | 0.8%                  | 0.577   | -3.0%    | 0.073   |

**Notes:** This table displays within contract differences in outcomes for each of the measures included in the study. The Black column shows the difference in outcome for Black enrollees from White enrollees, and the Hispanic column shows the difference between the outcomes for Hispanic enrollees and White enrollees.
### eTable 7: Average Number of Observations included in Calculation by Measure and Race/Ethnicity

| Variable                                         | White          | Black          | Hispanic       |
|--------------------------------------------------|----------------|----------------|----------------|
|                                                  | Mean Sample Size | Std. Dev. | Mean Sample Size | Std. Dev. | Mean Sample Size | Std. Dev. | M in | M ax | M in | M ax |
| Rheumatoid Arthritis Management                  | 72.7           | 26.3          | 17            | 5           | 1               | 67.3       | 15.7  | 5   | 5   | 85   |
| Diabetes Care – Kidney Disease Monitoring         | 139.1          | 82.9          | 53            | 5           | 1               | 91.2       | 35.7  | 5   | 2   | 20   |
| Diabetes Care – Eye Exam                         | 128.3          | 71.9          | 53            | 5           | 1               | 89.8       | 34.9  | 5   | 2   | 20   |
| Plan All-Cause Readmissions                       | 294.5          | 214.2         | 174           | 3           | 2               | 124.0      | 99.3  | 5   | 1   | 79   |
| Improving Bladder Control                        | 242.4          | 147.5         | 15            | 4           | 2               | 98.3       | 48.3  | 5   | 1   | 28   |
| Colorectal Cancer Screening                      | 209.6          | 343.6         | 25            | 5           | 1               | 105.7      | 66.8  | 5   | 1   | 39   |
| Adult BMI Assessment                              | 168.1          | 233.6         | 23            | 5           | 1               | 96.4       | 50.8  | 5   | 1   | 25   |
| Monitoring Physical Activity                     | 615.8          | 414.1         | 39            | 5           | 2               | 185.2      | 145.0 | 5   | 1   | 89   |
| Diabetes Care – Blood Sugar Controlled           | 139.2          | 78.7          | 56            | 5           | 2               | 92.0       | 42.0  | 5   | 1   | 25   |
| Diabetes Care – Cholesterol Controlled           | 139.2          | 78.7          | 56            | 5           | 2               | 92.0       | 42.0  | 5   | 1   | 25   |
| Controlling Blood Pressure                        | 153.1          | 96.2          | 65            | 5           | 1               | 108.2      | 59.6  | 5   | 1   | 29   |
| Getting Needed Care                              | 350.2          | 306.1         | 24            | 5           | 1               | 114.3      | 91.6  | 5   | 1   | 68   |
| Getting Appointments and Care Quickly            | 447.7          | 402.8         | 33            | 5           | 5               | 145.7      | 144.5 | 5   | 1   | 12   |
| Rating of Health Plan                            | 482.1          | 438.4         | 35            | 5           | 1               | 152.6      | 150.3 | 5   | 1   | 13   |
| Rating of Health Care Quality                    | 487.4          | 446.0         | 36            | 5           | 2               | 154.4      | 154.1 | 5   | 1   | 13   |
| Members Choosing to Leave the Plan               | 2135.9         | 152.2         | 12            | 5           | 2               | 527.6      | 575.8 | 5   | 1   | 52   |
| Care Coordination                                | 422.6          | 380.3         | 31            | 5           | 2               | 143.9      | 137.6 | 5   | 1   | 11   |
| Customer Service                                 | 209.7          | 168.9         | 13            | 5           | 1               | 104.8      | 80.2  | 5   | 1   | 55   |
| Reducing the Risk of Falling                     | 289.7          | 182.2         | 19            | 5           | 2               | 127.0      | 79.2  | 5   | 1   | 48   |

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Notes: This table includes the mean, standard deviation, min and max of the number of observations included for each measure at the plan level, stratified by race/ethnicity.
### eTable 8: Reliability of Measures by Strata

| Variable                          | White Mean Reliability | Black Mean Reliability | Hispanic Mean Reliability | Low SES Mean Reliability | n <0.6 White | n <0.6 Black | n <0.6 Hispanic | n <0.6 Low SES |
|-----------------------------------|------------------------|------------------------|---------------------------|--------------------------|--------------|--------------|-----------------|----------------|
| Rheumatoid Arthritis Management  | 0.72                   | 0.67                   | 0.77                      | n/a                      | 0            | 0            | 0               | n/a            |
| Diabetes Care – Kidney Disease Monitoring | 0.67                   | 0.60                   | 0.82                      | 0.76                      | 62           | 50           | 0               | 29             |
| Diabetes Care – Eye Exam          | 0.88                   | 0.85                   | 0.87                      | 0.81                      | 0            | 0            | 0               | 0              |
| Plan All-Cause Readmissions       | 0.72                   | 0.63                   | 0.70                      | 0.57                      | 50           | 80           | 29              | 50             |
| Improving Bladder Control         | 0.66                   | 0.63                   | 0.69                      | 0.69                      | 95           | 37           | 18              | 21             |
| Colorectal Cancer Screening       | 0.90                   | 0.86                   | 0.88                      | 0.82                      | 0            | 0            | 0               | 0              |
| Adult BMI Assessment              | 0.94                   | 0.93                   | 0.91                      | 0.86                      | 0            | 0            | 0               | 0              |
| Monitoring Physical Activity      | 0.83                   | 0.67                   | 0.70                      | 0.76                      | 4            | 61           | 28              | 0              |
| Diabetes Care – Blood Sugar Controlled | 0.74                   | 0.70                   | 0.73                      | 0.67                      | 0            | 0            | 0               | 0              |
| Diabetes Care – Cholesterol Controlled | 0.89                   | 0.84                   | 0.88                      | 0.84                      | 0            | 0            | 0               | 0              |
| Controlling Blood Pressure        | 0.91                   | 0.89                   | 0.91                      | 0.89                      | 0            | 0            | 0               | 0              |
| Reducing the Risk of Falling      | 0.76                   | 0.65                   | 0.73                      | 0.67                      | 4            | 39           | 0               | 13             |
| Members Choosing to Leave the Plan | 0.99                   | 0.99                   | 0.98                      | 0.98                      | 0            | 0            | 0               | 0              |
| Care Coordination                 | 0.87                   | 0.65                   | 0.79                      | 0.70                      | 0            | 0            | 0               | 0              |
| Customer Service                  | 0.84                   | 0.66                   | 0.72                      | 0.61                      | 4            | 0            | 42              | 0              |
| Getting Needed Care              | 0.91                   | 0.72                   | 0.79                      | 0.72                      | 0            | 0            | 0               | 0              |
| Getting Appointments and Care Quickly | 0.91                   | 0.74                   | 0.78                      | 0.71                      | 0            | 0            | 0               | 0              |
| Rating of Health Plan            | 0.92                   | 0.76                   | 0.83                      | 0.75                      | 0            | 0            | 0               | 0              |
| Rating of Health Care Quality    | 0.90                   | 0.69                   | 0.80                      | 0.71                      | 0            | 0            | 0               | 0              |

**Notes:** This table includes the mean reliabilities for each measure by strata. It also includes the number of contracts with greater than 50 observations for that measure-strata that have a reliability under 0.6 which is a cutoff CMS uses to suppress unreliable measures. The reliabilities are interrater reliabilities calculated from a random effects model. There was no reliability
calculated for the low SES category as there were too few contracts that had at least 50 observations on that measure for that strata.