Supplemental File S4

Below are detailed results of two negative binomial-logit hurdle regression models examining the relationship between behavioral health conditions and potentially preventable hospitalizations for diabetes. Model 1 includes individual behavioral health conditions. Model 2 includes a count of behavioral health diagnoses.

A review of the findings for non-behavioral health variables follows the tables. The results related to the behavioral health variables are reviewed in the text of the manuscript.

Model 1: Adjusted odds ratios (aOR) and adjusted risk ratios (aRR) of potentially preventable hospitalizations for diabetes (PPH). Logit results examine findings regarding the presence or absence of any PPH, whereas the negative binomial results examine the findings regarding the increasing counts of PPHs in individuals with one or more PPH. The findings in this table are from Model 1, in which behavioral health variables are entered into the model individually.

|                      | Logit | Negative Binomial |
|----------------------|-------|-------------------|
|                      | aOR   | 95% Confidence Interval | p-value | aRR   | 95% Confidence Interval | p-value |
| Gender               |       |                   |        |       |                   |        |
| Male                 | 1.000 |                   |        | 1.000 |                   |        |
| Female               | 0.775 | 0.718 - 0.838     | <0.001 | 1.102 | 0.892 - 1.362     | 0.367   |
| Age Group            |       |                   |        |       |                   |        |
| 20-29                | 1.000 |                   |        | 1.000 |                   |        |
| 30-44                | 0.256 | 0.223 - 0.294     | <0.001 | 0.679 | 0.474 - 0.973     | 0.035   |
| 45-64                | 0.151 | 0.131 - 0.173     | <0.001 | 0.387 | 0.276 - 0.541     | <0.001  |
| Census Region        |       |                   |        |       |                   |        |
| Midwest              | 1.000 |                   |        | 1.000 |                   |        |
| Northeast            | 0.828 | 0.746 - 0.919     | <0.001 | 1.607 | 1.207 - 2.138     | 0.001   |
| South                | 0.943 | 0.851 - 1.045     | 0.260  | 1.269 | 0.950 - 1.694     | 0.106   |
| West                 | 0.868 | 0.787 - 0.957     | 0.005  | 1.060 | 0.803 - 1.401     | 0.679   |
| Federal Poverty Level (FPL) in County |       |                   |        |       |                   |        |
| <15% of Households Under FPL | 1.000 |                   |        | 1.000 |                   |        |
| >=15% of Households Under FPL | 1.136 | 1.037 - 1.244     | 0.006  | 1.079 | 0.840 - 1.386     | 0.552   |
| Urban-Rural Category |       |                   |        |       |                   |        |
| Large Central Metro  | 1.000 |                   |        | 1.000 |                   |        |
|                          | Logit       |                        | Negative Binomial |  |  |
|--------------------------|-------------|-----------------------|-------------------|---|---|
|                          | aOR | 95% Confidence Interval | p-value | aRR | 95% Confidence Interval | p-value |
| Large Fringe Metro       | 1.031 | 0.924 | 1.150 | 0.588 | 0.731 | 0.547 | 0.976 | 0.034 |
| Medium Metro             | 0.935 | 0.840 | 1.041 | 0.222 | 0.634 | 0.465 | 0.864 | 0.004 |
| Small Metro              | 0.927 | 0.799 | 1.076 | 0.320 | 0.805 | 0.551 | 1.176 | 0.262 |
| Micropolitan             | 0.800 | 0.677 | 0.946 | 0.009 | 0.474 | 0.299 | 0.751 | 0.001 |
| Noncore                  | 0.722 | 0.589 | 0.885 | 0.002 | 0.668 | 0.395 | 1.128 | 0.131 |
| COPD                     |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 0.940 | 0.808 | 1.095 | 0.427 | 1.241 | 0.836 | 1.843 | 0.284 |
| Asthma                   |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 0.868 | 0.759 | 0.993 | 0.039 | 0.940 | 0.680 | 1.298 | 0.706 |
| Chronic Pain/Pain-Related Condition |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 0.874 | 0.803 | 0.951 | 0.002 | 1.559 | 1.241 | 1.959 | <0.001 |
| Tobacco Use              |        |                        |        |     |        |        |        |     |
| No Diagnosis or Prescription | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis or Prescription | 2.173 | 1.974 | 2.391 | <0.001 | 1.475 | 1.179 | 1.844 | 0.001 |
| Renal Failure/Chronic Kidney Disease |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 8.918 | 7.883 | 10.090 | <0.001 | 1.228 | 0.920 | 1.638 | 0.164 |
| Chronic Heart Condition  |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 1.967 | 1.807 | 2.140 | <0.001 | 2.264 | 1.815 | 2.823 | <0.001 |
| Cancer                   |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 0.849 | 0.747 | 0.965 | 0.012 | 0.791 | 0.556 | 1.125 | 0.193 |
| Chronic Hypertension     |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 1.325 | 1.204 | 1.457 | <0.001 | 1.660 | 1.220 | 2.260 | 0.001 |
| Chronic Cerebrovascular Disease |        |                        |        |     |        |        |        |     |
| No Diagnosis             | 1.000 |           | 1.000 |  |  |  |  |  |
| Had Diagnosis            | 1.465 | 1.291 | 1.663 | <0.001 | 1.031 | 0.749 | 1.418 | 0.852 |
|                         | Logit                          |                       | Negative Binomial                |                       |
|-------------------------|--------------------------------|-----------------------|---------------------------------|-----------------------|
|                         | aOR | 95% Confidence Interval | p-value | aRR | 95% Confidence Interval | p-value |
| **Obesity**             |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.203 | 1.109 | 1.304 | <0.001 | 0.870 | 0.697 | 1.085 | 0.217 |
| **Chronic Hyperlipidemia** |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 0.855 | 0.782 | 0.935 | 0.001 | 0.870 | 0.679 | 1.116 | 0.274 |
| **Alcohol Use Disorder** |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.768 | 1.448 | 2.158 | <0.001 | 0.990 | 0.648 | 1.512 | 0.964 |
| **Drug Use Disorder**   |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.982 | 1.608 | 2.443 | <0.001 | 2.238 | 1.563 | 3.202 | <0.001 |
| **Schizophrenia**       |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.611 | 1.294 | 2.005 | <0.001 | 1.414 | 0.942 | 2.121 | 0.095 |
| **Bipolar**             |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 0.988 | 0.778 | 1.254 | 0.922 | 1.342 | 0.780 | 2.307 | 0.288 |
| **Depression & Other Mood Disorders** |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.546 | 1.394 | 1.714 | <0.001 | 2.007 | 1.563 | 2.576 | <0.001 |
| **Anxiety**             |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.029 | 0.917 | 1.154 | 0.629 | 1.206 | 0.915 | 1.590 | 0.184 |
| **Adjustment Disorder** |     |                      |         |     |                      |         |
| No Diagnosis            | 1.000 |                      |         | 1.000 |                      |         |
| Had Diagnosis           | 1.160 | 0.973 | 1.382 | 0.098 | 1.279 | 0.886 | 1.847 | 0.189 |

**Abbreviations:**
aOR: Adjusted odds ratio
aRR: Adjusted risk ratio
COPD: Chronic obstructive pulmonary disease
FPL: Federal poverty level
PPH: Diabetes-related potentially preventable hospitalization
Model 2: Adjusted odds ratios (aOR) and adjusted risk ratios (aRR) of potentially preventable hospitalizations for diabetes (PPH) from the negative binomial-logit hurdle model containing behavioral health (BH) complexity level. Logit results examine findings regarding the presence or absence of any PPH, whereas the negative binomial results examine the findings regarding the increasing counts of PPHs in individuals with one or more PPH. Behavioral health complexity represents a simple count of each person’s behavioral health conditions, including both mental health conditions and substance use disorders.

|                      | Logit |                  |       | Negative Binomial |                  |       |
|----------------------|-------|------------------|-------|-------------------|------------------|-------|
|                      | aOR   | 95% Confidence Interval | p-value | aRR              | 95% Confidence Interval | p-value |
| **Gender**           |       |                   |       |                   |                   |       |
| Male                 | 1.000 (reference) |                   |       | 1.000 (reference) |                   |       |
| Female               | 0.747 0.692 0.806 | <0.001            |       | 1.119 0.911 1.375 | 0.285            |       |
| **Age Group**        |       |                   |       |                   |                   |       |
| 20-29                | 1.000 (reference) |                   |       | 1.000 (reference) |                   |       |
| 30-44                | 0.252 0.220 0.290 | <0.001            |       | 0.650 0.454 0.930 | 0.018            |       |
| 45-64                | 0.151 0.132 0.172 | <0.001            |       | 0.372 0.266 0.519 | <0.001          |       |
| **Census Region**    |       |                   |       |                   |                   |       |
| Midwest              | 1.000 (reference) |                   |       | 1.000 (reference) |                   |       |
| Northeast            | 0.830 0.748 0.921 | <0.001            |       | 1.604 1.205 2.134 | 0.001            |       |
| South                | 0.950 0.858 1.052 | 0.327             |       | 1.303 0.975 1.741 | 0.073            |       |
| West                 | 0.871 0.790 0.961 | 0.006             |       | 1.073 0.815 1.414 | 0.615            |       |
| **Federal Poverty Level (FPL) in County** |  |                   |       |                   |                   |       |
| <15% of Households Under FPL | 1.000 (reference) |                   |       | 1.000 (reference) |                   |       |
| >=15% of Households Under FPL | 1.136 1.037 1.244 | 0.006             |       | 1.086 0.847 1.393 | 0.515            |       |
| **Urban-Rural Category** |  |                   |       |                   |                   |       |
| Large Central Metro  | 1.000 (reference) |                   |       | 1.000 (reference) |                   |       |
| Large Fringe Metro   | 1.026 0.920 1.144 | 0.645             | 0.729 0.547 0.971 | 0.031            |       |
| Medium Metro         | 0.923 0.830 1.028 | 0.144             | 0.632 0.465 0.861 | 0.004            |       |
| Small Metro          | 0.914 0.788 1.060 | 0.235             | 0.806 0.551 1.179 | 0.266            |       |
| Micropolitan         | 0.792 0.671 0.936 | 0.006             | 0.504 0.319 0.797 | 0.003            |       |
| Noncore              | 0.710 0.579 0.871 | 0.001             | 0.670 0.387 1.160 | 0.153            |
| Condition                         | aOR  | 95% Confidence Interval | p-value | aRR  | 95% Confidence Interval | p-value |
|----------------------------------|------|-------------------------|---------|------|-------------------------|---------|
| **COPD**                         |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 0.942 | 0.810                   | 1.096   | 0.440 | 1.236 | 0.835                   | 1.829   | 0.290 |
| **Asthma**                       |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 0.855 | 0.748                   | 0.977   | 0.021 | 0.925 | 0.672                   | 1.274   | 0.634 |
| **Chronic Pain/Pain-Related Condition** |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 0.867 | 0.797                   | 0.942   | 0.001 | 1.581 | 1.261                   | 1.982   | <0.001 |
| **Tobacco Use**                  |      |                         |         |      |                         |         |
| No Diagnosis or Prescription     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis or Prescription    | 2.229 | 2.030                   | 2.447   | <0.001 | 1.541 | 1.239                   | 1.918   | <0.001 |
| **Renal Failure/Chronic Kidney Disease** |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 8.986 | 7.948                   | 10.160  | <0.001 | 1.235 | 0.930                   | 1.638   | 0.144 |
| **Chronic Heart Condition**      |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 1.959 | 1.801                   | 2.131   | <0.001 | 2.311 | 1.855                   | 2.880   | <0.001 |
| **Cancer**                       |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 0.846 | 0.745                   | 0.960   | 0.010 | 0.785 | 0.548                   | 1.125   | 0.187 |
| **Chronic Hypertension**         |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 1.333 | 1.212                   | 1.466   | <0.001 | 1.601 | 1.177                   | 2.176   | 0.003 |
| **Chronic Cerebrovascular Disease** |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 1.482 | 1.308                   | 1.679   | <0.001 | 1.019 | 0.748                   | 1.387   | 0.906 |
| **Obesity**                      |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Had Diagnosis                    | 1.185 | 1.093                   | 1.285   | <0.001 | 0.880 | 0.705                   | 1.099   | 0.260 |
| **Chronic Hyperlipidemia**       |      |                         |         |      |                         |         |
| No Diagnosis                     | 1.000 (reference) |                         |         | 1.000 (reference) |                         |         |
| Behavioral Health Complexity Level | Logit |         | Negative Binomial |         |
|-----------------------------------|-------|---------|--------------------|---------|
| Had Diagnosis                     | aOR   | 95% CI  | p-value            | aRR    | 95% CI  | p-value |
|                                  | 0.843 | 0.771   | 0.922 <0.001       | 0.910  | 0.711   | 1.164   | 0.454  |
| No BH Diagnoses                  | 1.000 (reference) |         | 1.000 (reference) |         |         |         |
| 1 BH Diagnosis                   | 1.566 | 1.424   | 1.721 <0.001       | 1.389  | 1.067   | 1.809   | 0.015  |
| 2 BH Diagnoses                   | 2.081 | 1.837   | 2.358 <0.001       | 2.203  | 1.641   | 2.958   | <0.001 |
| 3 BH Diagnoses                   | 2.536 | 2.096   | 3.069 <0.001       | 3.549  | 2.431   | 5.181   | <0.001 |
| >=4 BH Diagnoses                 | 3.339 | 2.581   | 4.319 <0.001       | 6.470  | 3.708   | 11.288  | <0.001 |

**Abbreviations:**
- aOR: Adjusted odds ratio
- aRR: Adjusted risk ratio
- COPD: Chronic obstructive pulmonary disease
- FPL: Federal poverty level
- PPH: Diabetes-related potentially preventable hospitalization
Relationships between Diabetes PPHs and Sociodemographic Covariates

In both adjusted and unadjusted analyses, males were more likely than females to experience at least one diabetes PPH (p<0.001 for both). In unadjusted analyses males were also more likely to experience higher counts of diabetes PPHs; however, in adjusted analyses there was no gender difference in the risk of increasing counts of diabetes PPHs in persons with at least one diabetes PPH (Model 1 p=0.367; Model 2 p=0.515). In all analyses, younger age was associated with both an increased likelihood of having at least one diabetes PPH and increased counts of diabetes PPHs (p<0.001 to p=0.035). Region was also associated with diabetes PPHs in both unadjusted and adjusted analyses (p<0.001). See Supplemental File S4 for detailed results.

In unadjusted and adjusted analyses, county-level poverty was associated with an increased likelihood of having at least one diabetes PPH (p=0.007 and p=0.006, respectively). County-level poverty was also associated with increasing counts of diabetes PPHs in unadjusted analyses (p=0.010) but this relationship was not significant in adjusted analyses (Model 1 p=0.552; Model 2 p=0.515). The risk of diabetes PPHs also varied by urban-rural category in both sets of analyses. Most notably, in adjusted analyses persons in micropolitan and non-core (i.e., rural) areas were less likely to have any diabetes PPHs, and those with at least one diabetes PPH in micropolitan areas were less likely to have increasing counts of PPHs (see Supplemental File S4).

Relationships between Diabetes PPHs and Physical Health Status Covariates

In unadjusted and adjusted analyses, chronic pain, tobacco use, chronic heart conditions, and chronic hypertension were associated with the likelihood of having at least one diabetes PPH and with increasing counts of diabetes PPHs (p<0.05 for all). In addition, in unadjusted analyses chronic renal failure, chronic cerebrovascular disease, and obesity were associated with
increasing counts of PPHs. They were also associated with an increased likelihood of having at least one diabetes PPH in both unadjusted and adjusted analyses (p<0.05 for all). On the other hand, these three conditions were not significantly associated with increasing counts of diabetes PPHs in those with at least one diabetes PPH in adjusted analyses (p≥0.05 for all).

In unadjusted analyses, neither asthma nor cancer were associated with an increased likelihood of having at least one diabetes PPH (p=0.186 and p=0.737, respectively), nor were they associated with increasing counts of diabetes PPHs in unadjusted (p=0.374 for both) or adjusted (p≥0.05 for all) analyses. Conversely, in adjusted analyses, the relationships between these conditions and having at least one diabetes PPH were significant (p<0.05 for all). Further, in unadjusted analyses chronic hyperlipidemia had a protective effect, significantly reducing the likelihood of having any or increasing counts of diabetes PPHs (p<0.05 for all), but in adjusted analyses only the relationship between chronic hyperlipidemia and reduced odds of having at least one PPH.