UNDERSTANDING HEALTH CONDITIONS ACROSS THE U.S.

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Executive Summary

Why are some communities healthier than others? Which factors are most important in keeping a population healthy: economics, healthy behaviors, or access to quality care? How does the importance of these factors change when measuring different health conditions? These are all fundamental questions for policymakers and social scientists to consider in order to understand the health of everyday Americans. The recently released Blue Cross Blue Shield Health Index provides a unique and valuable way to try to answer key questions surrounding health.

Using data on more than 24 million BCBS members in 2015[1], the BCBS Health Index provides county-level health indicators and allows for the objective measurement of specific health conditions that drive overall health in each county. This study provides new insights into the relationships between population health and various demographic, socioeconomic, behavioral and health system factors measured at the county level (for a complete list of these factors, see Appendix 1). Specifically, this study looks at 10 major health conditions that impact the overall health of the commercially insured population as measured by the BCBS Health Index.

Moody's analysis of the relationship between county-level factors and the 10 major health conditions reveals three broad groupings:

» **Group 1: Physical health conditions** are well explained by county population characteristics—in particular socioeconomic, demographic and behavioral factors—and are related to these characteristics in expected ways. Conditions in Group 1 are **high cholesterol, coronary artery disease, hypertension, chronic obstructive pulmonary disease,** and **diabetes**. For example, diabetes strongly correlates with unemployment, lower educational attainment, and obesity.

» **Group 2: Mental health conditions** are not related to other conditions and are harder to explain using county population characteristics. Conditions in Group 2 are **hyperactivity** and **depression/anxiety/ affective disorder**. In addition, these conditions can often have the opposite relationship to socioeconomic and demographic factors from those in Group 1, which may be due to treatment and diagnosis effects. For example, depression is actually more prevalent in places with higher educational attainment, which may be because more educated patients are more likely to seek treatment.

» **Group 3: Unique health conditions** fall somewhere in between Groups 1 and 2, driven by a mix of environment, genetics and treatment/diagnosis effects unique to each condition. Conditions in Group 3 are **breast cancer, lung cancer,** and **substance abuse disorder**. By their nature, these conditions defy easy generalization because each condition has its own particular reasons for why it does not behave like either a physical or a mental health condition.

These three condition groupings are crucial for understanding variations in community health and assessing which conditions in particular are likely to contribute to poor health. Physical health conditions tend to cluster together, are strongly associated with overall health as measured by the Health Index, and have a larger adverse effect on population health in places with socioeconomic, demographic and behavioral challenges. In contrast, mental health conditions are more likely to have large effects in counties that have fewer socioeconomic, demographic and behavioral challenges. Finally, there is a set of conditions that do not fit into either of

[1] Note that BCBS Health Index data are currently available from 2012 to 2016 and incorporate as many as 40 million members.

The BCBS Health Index

The BCBS Health Index is a unique measurement of America's health that quantifies how a range of diseases and conditions impact longevity and quality of life.

The BCBS Health Index leverages 1.8 billion claims for more than 40 million commercially insured Americans under 65, excluding Medicare and Medicaid, over a four-year period.

The "health impact" of a specific condition is the degree to which it reduces optimal health. The Health Index reflects prevalence and severity for that condition as well as the years of life lost due to premature death and disability. For further information on the BCBS Health Index, go to https://www.bcbs.com/the-health-of-america/health-index.

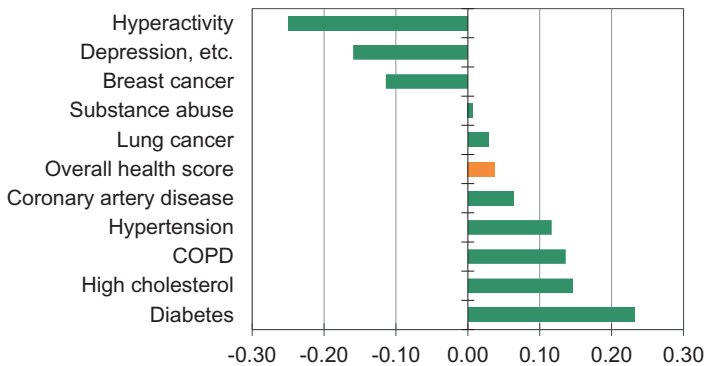## Chart E1: Taxonomy of Index Health Conditions

Conditions vary in important ways in terms of what drives them and how they relate to overall health
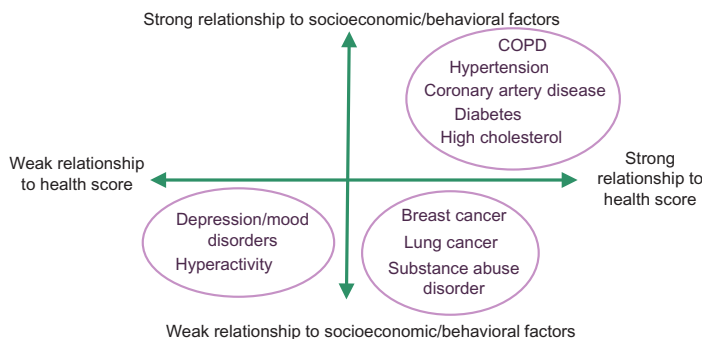
Sources: BCBS, Moody's Analytics

Chart E2: Education Has Mixed Effects

Effect of % population with college degree on condition z-score

Sources: BCBS, Moody's Analytics

these categories as a result of the unique ways they influence health.

Group 1: Physical health conditions

Five of the 10 conditions in this study are categorized as physical health conditions: high cholesterol, coronary artery disease, hypertension, COPD, and diabetes. One characteristic these conditions have in common is that they strongly correlate with overall population health as measured by the BCBS Health Index (see Chart E1). In other words, when a county is healthy overall, these five conditions have less impact on the health of the population (in terms of a reduced averaged number of years lived under optimal health). When a county is unhealthy overall, these conditions tend to have more impact on the health of the population.

The strong relationship between these conditions and overall health is important to highlight because demographic, socioeconomic and behavior factors are highly predictive of overall health. In total, these factors explain 74% of the county-by-county variation in the Health Index Score. As a result, these factors also explain much of the county-by-county variation in the impact of these health conditions.

Population characteristics tend to affect these health conditions in ways one typically expects when evaluating community health. For example, physical health conditions have less of an impact on places with greater levels of education and higher labor market participation.

Behavioral factors also drive these five conditions. There are adverse health impacts of these conditions in communities where

physical inactivity is greater, where preventable hospital stays are more common, and—for some conditions—where smoking and obesity are more prevalent. Health system factors, such as the presence of primary care physicians or the level of Medicaid support, are the least important in evaluating physical health conditions, but still cause a substantial amount of variation among counties.

In short, the five physical health conditions align with the typical view of population health. These conditions are more common in areas with lower overall BCBS Health Index scores and are more strongly associated with socioeconomic, demographic and behavioral factors.

Group 2: Mental health conditions

Mental health conditions studied in the report are hyperactivity and depression/anxiety/affective disorder. These conditions have little correlation with overall health. Counties with low overall BCBS Health Indexes and high levels of other conditions are no more likely to have hyperactivity and depression than healthy counties. Mental health conditions lack a relationship with other conditions and the BCBS Health Index at the county level because they can be less obvious to diagnose and treat than physical health conditions.

As a result, county-to-county variation in these mental health conditions is more difficult to explain using county population characteristics. Socioeconomic, demographic and behavior factors have modest to small effects on these conditions in the BCBS Health

Index. Further, these characteristics often have an opposite relationship to the BCBS Health Index and physical health conditions. For example, more educated counties are more affected by depression and hyperactivity than less educated ones (see Chart E2).[2] Additionally, larger minority populations have fewer depression diagnoses. It is unlikely that minority populations and those with lower socioeconomic standings have fewer mental health conditions; these groups, for a variety of reasons, are less likely to be diagnosed and treated.

The relationship between mental health conditions with overall health suggests that they should be considered differently from physical health conditions. For instance, patients with higher socioeconomic status are more likely to receive a diagnosis of having a mental health condition. It appears that this diagnosis practice confounds the relationship between various population characteristics and mental health. Further, policies that attempt to address mental health conditions by changing socioeconomic and behavioral outcomes will have less success reducing the effects of these conditions as measured by the BCBS Health Index.

Group 3: Unique health conditions

Unique health conditions are the third group of health conditions examined in

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2 A Z-score shows how many standard deviations away from the mean an observation is. For example, a score of one means an observation is one standard deviation from average for that variable, and a score of negative two is negative two standard deviations.

this report. Unique conditions exist between the conditions in Groups 1 and 2, and each possess distinctive features. Group 3 comprises breast cancer, lung cancer, and substance abuse disorder. These conditions are somewhat correlated with overall health and are modestly related to socioeconomic and demographic factors, as well as genetics. Beyond those generalizations, however, these conditions each require individual attention and discussion.

Breast cancer and substance abuse disorder are likely to be affected by the treatment and diagnosis similar to mental health conditions. For example, results in this report will show that breast cancer is related to higher education levels. Socioeconomic and demographic factors do a poor job of explaining county-level variations in the level of substance abuse disorder.

Breast cancer and lung cancer are among the conditions least affected by health system and behavioral factors. It is difficult to explain variations in these health conditions at the county level because the prevalence for these conditions within the general population is low, and as a result, there is simply less variation in the data to explain their impact on health.

Altogether, unique health conditions are somewhat driven by socioeconomic, demographic and behavioral factors. However, each condition also has distinctive features—including treatment effects, low prevalence and genetics—that potentially qualify them for a different analysis method than that of other conditions.

In sum, the findings in this report show that demographic, behavioral and structural factors impact health conditions in different ways and that greater insight into these differences is critical to understanding county-level population health using the BCBS Health Index.

Understanding Health Conditions Across the U.S.

Why are some communities healthier than others? Which factors are most important in keeping a population healthy: economics, healthy behaviors or access to quality care? How does the importance of these factors change when measuring different health conditions? These are all fundamental questions for policymakers and social scientists to consider in order to understand the health of everyday Americans. The recently released Blue Cross Blue Shield Health Index provides a unique and valuable way to try to answer key questions surrounding health.

Using data on more than 24 million BCBS members in 2015[1], the BCBS Health Index provides county-level health indicators and allows for the objective measurement of specific health conditions that drive overall health in each county. This study provides new insights into the relationships between population health and various demographic, socioeconomic, behavioral and health system factors measured at the county level (for a complete list of these factors, see Appendix 1). Specifically, this study looks at 10 major health conditions that impact the overall health of the commercially insured population as measured by the BCBS Health Index.

Physical health conditions are well explained by county population characteristics—in particular socioeconomic, demographic and behavioral factors—and are related to these characteristics in expected ways. Conditions in Group 1 are high cholesterol, coronary artery disease, hypertension, chronic obstructive pulmonary disease, and diabetes. For example, diabetes strongly correlates with unemployment, lower educational attainment, and obesity.

The second group, mental health conditions, are those not related to other conditions and are harder to explain using county population characteristics. Conditions in Group 2 are hyperactivity and depression/anxiety/affective disorder. In addition, these conditions can often have the opposite relationship to socioeconomic and demographic factors from those in Group 1, which may be due to treatment and diagnosis effects. For example, depression is actually more prevalent in places with higher educational attainment, which may be due to more educated patients being more likely to seek treatment.

Finally, a third group of unique health conditions fall somewhere in between Groups 1 and 2, driven by a mix of environment, genetics and treatment/diagnosis effects unique to each condition. Conditions in Group 3 are breast cancer, lung cancer, and substance abuse disorder. By their nature, these conditions defy easy generalization because each condition has its own particular reasons for why it does not behave like either a physical or a mental health condition.

Each group of conditions varies differently across the country. A place with low socioeconomic status and a low physical health will not necessarily be greatly affected by mental health conditions or idiosyncratic health conditions. In addition to providing a variety of insights into what kinds of socioeconomic, demographic, behavioral and health system factors matter most for each condition, the results of this analysis suggest that the question of why some places appear healthier than others depends crucially on what kinds of conditions are being examined.

What drives health: Background and a review of the literature

The health of a population is driven by a variety of factors that can be grouped into three broad categories: socioeconomics and demographics, behaviors, and other health system factors. In some instances, the line between these groups is blurred and subjective since some factors could be grouped into more than one category. To determine which measures to include in an analysis, it is important to discuss why and how they are expected to be related to overall health and specific conditions. In addition, it is important to understand the complex relationships between these factors and health, and how that presents a challenge to measuring the effects of individual factors.

Socioeconomic and demographic factors.

Socioeconomic factors broadly include economic decisions and outcomes. Important examples include educational attainment, income, and labor force participation. In this analysis, socioeconomics are grouped with demographic factors such as race, ethnicity and age, because of their strong correlation across geographies, and because

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1 Note that BCBS Health Index data are currently available from 2012 to 2016 and incorporate as many as 40 million members.

some factors contain both demographic and economic components, such as the share of children in families with single mothers.

The relationship between health and socioeconomic and demographic factors is both deep and complex. Perhaps the simplest and most direct relationship is between age and health: As age increases, health deteriorates and mortality rates increase. Younger populations will therefore have higher overall BCBS Health Indexes. However, even here there is nuance, as some conditions could plausibly have a greater effect on younger workers, which in this analysis includes substance abuse disorder and hyperactivity.

The relationship between socioeconomic status and health is multifaceted. As Nobel laureate Angus Deaton and coauthors explained, the "link between social status and health is complex, perhaps too complex for a single explanation".[2] The causality between health and socioeconomic factors such as income and labor force participation may be complex, but the correlation is obvious: The gap in life expectancy between the richest 1% and the poorest 1% is 14.6 years for men and 10.1 years for women.[3] Complexity emerges because the relationship goes both ways. Previous analysis of the BCBS Health Index helped to demonstrate that economics impacts health, and health impacts economics.[4] Those with lower incomes have less money to spend on preventive healthcare and on health-improving goods and services such as healthy food and gym memberships. Simultaneously, however, unhealthy workers are likely to have more absenteeism, accumulate fewer skills, be out of the labor force, and have lower productivity. Tracking individual workers over time, one study found that permanent health problems reduce

wages and hours worked for both men and women.[5]

Education is another factor that will have a strong and complex relationship with health. First, it is another pathway through which health affects incomes, as those with poor health are less likely to attend school, and less schooling translates into lower lifetime earnings. For example, evidence shows that children with some diagnosed health conditions are less likely to stay in school and more likely to end up on social assistance later in life.[6] In addition, education likely exhibits an independent effect on health and is also a good proxy for difficult-to-measure factors such as innate cognitive and noncognitive ability that drive both health and income.

Race and ethnicity are also important demographic factors related to health. In one dataset, 9% of Hispanics and 14% of African Americans are reported by a physician as having fair or poor health compared with 7% of whites. Racial and ethnic differences can be driven by behavioral and socioeconomic factors. For example, research has shown that African American individuals have on average six years less life expectancy than whites, though only about one-third of this difference can be explained by combined socioeconomic and behavioral differences.[7] Thus, because of additional difficult-to-measure factors, race and ethnicity remain important correlates of health even after controlling for socioeconomic and behavioral influences and should be included in any analysis of the determinants of health.

The local social and economic environment is another socioeconomic factor that drives health. For example, residents in urban areas may be more or less unhealthy for a variety of reasons, some of which we can measure directly and others we cannot.

Some urban areas may have higher crime rates that drive worse health outcomes, whereas other urban areas may have more pollution due to a greater density of people and machinery. On the other hand, in some places worse health may be associated with rural or less urban areas, for example due to less walkability. It would be difficult to measure every way in which urban areas differ from rural and suburban, especially since the relevant difference may vary from city to city. To capture and control for these differences, population density can be used as a proxy for various unmeasured urban factors.

The county-level socioeconomic and demographic variables used in this analysis include the following:

- » % of members in each age group (17 and younger, 18 to 34, 35 to 44, 45 to 54, 55 to 64, 65 and older)
- » % of county population younger than 19
- » % of county population 65 and older
- » % African American
- » % Hispanic
- » % with a college degree
- » % of children with a single mother
- » log of average annual pay
- » labor force participation rate
- » log of population density
- » 10-year growth in income per capita

Behavioral factors.

The link between certain behaviors and health outcomes is obvious. Smoking, inactivity, obesity, and substance abuse disorder are important contributors to mortality in the U.S. In 2005, tobacco use was responsible for an estimated one out of five deaths, and inactivity and obesity were each responsible for one out of 10. Diet is another major contributor to mortality, and alcohol use contributes via cardiovascular disease, cancer, liver cirrhosis, pancreatitis, automotive and other accidents, and violence.[8]

Another important consideration is the ability and willingness to self-manage health

2 Cutler, David, Angus Deaton, and Adriana Lleras-Muney, "The Determinants of Mortality," *The Journal of Economic Perspectives* 20, no. 3 (2006): 97-120.

3 Chetty, Raj, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler, "The Association Between Income and Life Expectancy in the United States, 2001-2014," *Jama* 315, no. 16 (2016): 1750-1766.

4 White, Daniel, Adam Ozimek, Michael Brisson, and Sarah Crane, "Healthy People, Healthy Economies," Moody's Analytics. July 2016.

5 Pelkowski, Jodi Messer, and Mark C. Berger, "The Impact of Health on Employment, Wages, and Hours Worked Over the Life Cycle," *The Quarterly Review of Economics and Finance* 44, no. 1 (2004): 102-121.

6 Currie, Janet, Mark Stabile, Phongsack Manivong, and Leslie L. Roos, "Child Health and Young Adult Outcomes," *Journal of Human Resources* 45, no. 3 (2010): 517-548.

7 Barghaus, Katherine M., David M. Cutler, Roland G. Fryer Jr, and Edward L. Glaeser, "An Empirical Examination of Racial Differences in Health," Unpublished Manuscript, Harvard University (2008).

8 Danaei, Goodarz, Eric L. Ding, Dariush Mozaffarian, Ben Taylor, Jürgen Rehm, Christopher JL Murray, and Majid Ezzati, "The Preventable Causes of Death in the United States: Comparative Risk Assessment of Dietary, Lifestyle, and Metabolic Risk Factors," *PLoS Med* 6, no. 4 (2009): e1000058.

conditions, including following through on the prescribed treatments and other recommendations of health professionals. Treatment of health conditions often requires consistent self-management and also judgment, and not all patients have the same ability and willingness to comply. The important health consequences of an inability to adhere to a prescribed treatment regimen have been documented for HIV and diabetes patients, for example.[9]

In addition, many hospital admissions are for conditions that can be better treated in inpatient or outpatient settings, and therefore can often be prevented with better self-management of health conditions and treatment. The importance of unnecessary hospital admissions can be seen in past research that has shown that preventable hospital stays are related to overall county health levels.[10] While the incidence of preventable hospital stays is also likely related somewhat to supply-side factors, research has shown that 71% of the variation in emergency room visits is explained by person-specific factors rather than healthcare supply, suggesting it is appropriate to categorize it as behavioral.[11]

The behavioral variables used in this analysis include the following:
- » physical inactivity
- » preventable hospital stays
- » smoking
- » obesity

Health system factors.

Two populations with otherwise equal socioeconomic, demographic and behavioral conditions may still end up with different BCBS Health Indexes as a result of factors related to the healthcare system. These include supply, demand and quality. Importantly, the BCBS Health Index is driven by the di-

agnosis and treatment of health conditions. As a result, only those who seek and receive treatment will show up as sick, while undiagnosed health conditions will not be reflected in the index. This implies that the supply and demand of healthcare, by affecting the level of diagnosis and treatment, can play a large role in determining the BCBS Health Index.

Places where individuals on average have greater healthcare demand and where the supply of healthcare induces more treatment and diagnoses may show up as having worse BCBS Health Indexes. For example, in some places, people may seek more regular tests and screenings. This in turn could lead to greater diagnoses despite no difference in health. This is important as research has shown that there are significant differences in healthcare utilization across the country that are not driven by differences in health. Only 47% of the difference in healthcare utilization in the U.S. is due to patient-specific factors, and the rest is due to place-specific factors.[12]

In addition, healthcare quality can affect health outcomes as well. For example, in one study, Raj Chetty and his coauthors found a statistically significant relationship between hospital quality and health.[13] They proxy hospital quality using a measure based on risk-adjusted 30-day mortality rates for acute myocardial infarction, congestive heart failure, and pneumonia patients, and find this is negatively correlated with life expectancy.[14]

Finally, the details of insurance coverage can affect healthcare utilization and therefore the BCBS Health Index. An area where the covered population has more generous insurance policies, for example lower co-pays and deductibles, may utilize more healthcare and therefore have greater diagnoses. As a result, a more generous health insurance plan could actually lower

the BCBS Health Index. For example, past Moody's Analytics research has shown that BCBS members who work in the government have lower BCBS Health Indexes than their private sector counterparts, likely reflecting the more generous levels of healthcare coverage in the public sector.

Medicaid coverage levels could also affect BCBS Health Indexes, with more generous state Medicaid programs taking greater shares of low-income workers out of the private health insurance market and leaving the private market pool healthier overall.

The health system factors used in this analysis include:
- » % of doctors who are generalists
- » % of Medicare enrollees with more than one primary care visit per year
- » Level of diabetic screening
- » State Medicaid income cutoff
- » 30-day risk-adjusted hospital mortality rate
- » % of BCBS members who work in government

The interrelationship between socioeconomic, demographic, behavioral and health system factors is not straightforward. In many cases the line between each group is blurred, with a variable in one group operating as the mechanism through which a variable in another group affects health. Behavioral differences, for example, can be how differences in socioeconomic status translate to health.

For example, more education, in addition to generally resulting in better economic outcomes, is associated with less smoking, drinking, drug use, and obesity and more exercise and physical activity. Whether this reflects the effect of education on health or behavior on health is an open question. In addition, more education is related to greater use of preventive care and better chronic disease management. One study found that "the better educated have healthier behaviors along virtually every margin," and that controlling for healthy behaviors reduces the effect of education on health by 30%.[15]

9 Goldman, Dana P., and James P. Smith, "Can Patient Self-Management Help Explain the SES Health Gradient?" *Proceedings of the National Academy of Sciences* 99, no. 16 (2002): 10929-10934.

10 Remington, Patrick L., Bridget B. Catlin, and Keith P. Gennuso, "The County Health Rankings: Rationale and Methods," *Population health metrics* 13, no. 1 (2015): 11.

11 Finkelstein, Amy, Matthew Gentzkow, and Heidi Williams, "Sources of Geographic Variation in Healthcare: Evidence From Patient Migration," *The Quarterly Journal of Economics* (2016): qjw023.

12 Ibid.

13 Chetty, Raj, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler, "The Association Between Income and Life Expectancy in the United States, 2001-2014." *Jama* 315, no. 16 (2016): 1750-1766.

14 Joynt, Karen E., E. John Orav, and Ashish K. Jha, "Association Between Hospital Conversions to For-Profit Status and Clinical and Economic Outcomes." Jama 312, no. 16 (2014): 1644-1652.
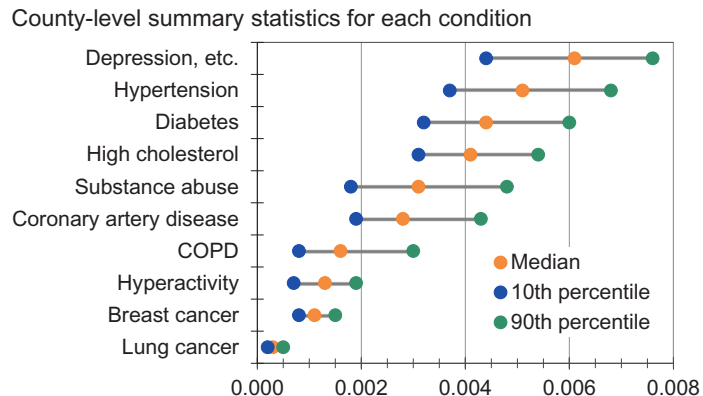
15 Cutler, David, Angus Deaton, and Adriana Lleras-Muney, "The Determinants of Mortality," *The Journal of Economic Perspectives* 20, no. 3 (2006): 97-120.

Chart 1: Depression Has the Biggest Impact
Condition score: % of lost quality adjusted yrs of life
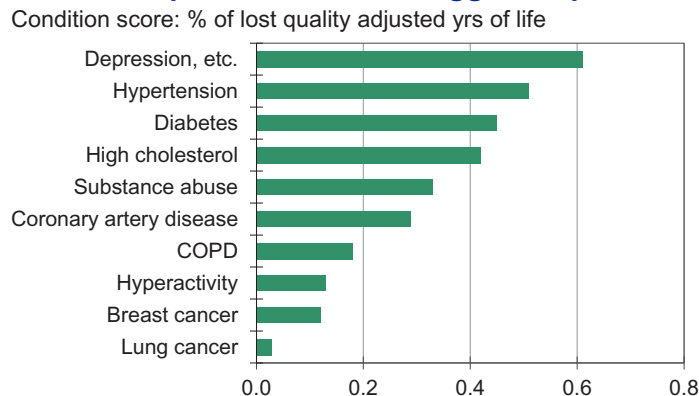
Sources: BCBS, Moody's Analytics

Chart 2: Wider Variation for Some Conditions
County-level summary statistics for each condition

Sources: BCBS, Moody's Analytics

With this complexity in mind, the approach taken in this analysis will lean toward inclusiveness, including both direct measures and plausible mechanisms. If a variable is operating as a proxy for other hard-to-measure factors that are not included, for example population density, then this will be included in the analysis.

How health conditions relate to overall health and each other

An important advantage of the BCBS Health Index over other measures of population health is that it not only includes a total overall BCBS Health Index, but also quantifies the conditions that drive that score. These condition scores measure how many quality years of life have been lost on average as a result of the condition. Table 1 shows the following descriptive statistics

for the overall BCBS Health Index and 10 of the most important condition scores: mean, 10th percentile, median, 90th percentile, and number of counties where data are available. These statistics show how the overall BCBS Health Index and the individual condition scores vary across counties.

For example, depression, anxiety and affective disorder conditions have the highest county average, at 0.0061 (see Chart 1), which means these conditions have the biggest impact on the overall BCBS Health Index. This indicates that across all of the counties in the data, the average BCBS members lose 0.61% of quality life years because of this condition.

The summary statistics also show that places across the country vary in how much they are affected by depression, anxiety and affective disorder (see Chart 2). The ef-

fects are 72% larger in the worst-performing counties than the best (0.0076/0.0044 = 1.72). Hypertension is the condition with the second largest impact on overall health, with an average impact of 0.0051, followed by diabetes at 0.0045.

Lung cancer has the lowest impact on overall BCBS Health Index, at 0.0003. The low score is due to the relative rarity of lung cancer and not its effect on those who have it. Comparing lung cancer to the conditions with the biggest impact on BCBS Health Index shows the importance of prevalence in determining overall impact. Among BCBS members, the prevalence of lung cancer is 0.1% compared with 12% for depression/anxiety/affective disorder and 17% for hypertension.

The low prevalence of lung cancer also leads to a smaller county-level sample size, with data only available in 2,239 counties compared with the 3,128 counties that the overall BCBS Health Index is available in. One reason for the low prevalence is that the risk of lung cancer is greatest for those who are outside of working age, with an average diagnosis age of 70, and therefore unlikely to be BCBS members but instead are covered by Medicare.[16]

Correlation to overall health.

It is not surprising that most individual condition scores are negatively correlated with the overall BCBS Health Index at the county level, as measured by the BCBS

Table 1: Summary Statistics by County
Weighted by member count

Variables	Mean	10th percentile	Median	90th percentile	Sample size
BCBS Health Index	0.924	0.908	0.925	0.938	3,128
Depression, etc.	0.006	0.004	0.006	0.008	3,128
Hypertension	0.005	0.004	0.005	0.007	3,128
Diabetes	0.005	0.003	0.004	0.006	3,125
High cholesterol	0.004	0.003	0.004	0.005	3,127
Substance abuse	0.003	0.002	0.003	0.005	3,098
Coronary artery disease	0.003	0.002	0.003	0.004	3,110
COPD	0.002	0.001	0.002	0.003	3,076
Hyperactivity	0.001	0.001	0.001	0.002	3,091
Breast cancer	0.001	0.001	0.001	0.002	3,108
Lung cancer	0.000	0.000	0.000	0.001	2,239

Sources: BCBS, Moody's Analytics

16https://www.cancer.org/cancer/non-small-cell-lung-cancer/about/key-statistics.html

Table 2: Overall BCBS Health Index and Individual Condition Correlations
Member weighted county-level correlations

	Overall health index	Substance abuse	Depres-sion, etc.	Hyper-tension	High cholesterol	Coronary artery disease	Diabetes	COPD	Hyper-activity	Breast cancer	Lung cancer
Overall health index	1.00	-0.47	-0.04	-0.69	-0.78	-0.74	-0.66	-0.69	0.04	-0.45	-0.50
Substance abuse	-0.47	1.00	0.34	0.21	0.27	0.24	0.14	0.42	0.09	0.13	0.20
Depression, etc.	-0.04	0.34	1.00	-0.28	-0.16	-0.24	-0.32	-0.15	0.44	0.11	-0.07
Hypertension	-0.69	0.21	-0.28	1.00	0.71	0.72	0.79	0.70	-0.13	0.14	0.40
High cholesterol	-0.78	0.27	-0.16	0.71	1.00	0.65	0.68	0.60	-0.15	0.42	0.44
Coronary artery disease	-0.74	0.24	-0.24	0.72	0.65	1.00	0.65	0.74	-0.19	0.25	0.54
Diabetes	-0.66	0.14	-0.32	0.79	0.68	0.65	1.00	0.62	-0.22	0.10	0.33
COPD	-0.69	0.42	-0.15	0.70	0.60	0.74	0.62	1.00	-0.24	0.09	0.49
Hyperactivity	0.04	0.09	0.44	-0.13	-0.15	-0.19	-0.22	-0.24	1.00	0.01	-0.14
Breast cancer	-0.45	0.13	0.11	0.14	0.42	0.25	0.10	0.09	0.01	1.00	0.35
Lung cancer	-0.50	0.20	-0.07	0.40	0.44	0.54	0.33	0.49	-0.14	0.35	1.00

Sources: BCBS, Moody's Analytics

Health Index, given that the BCBS Health Index is equal to 1 minus the sum of the condition scores. However, a look at which conditions are most strongly correlated and which are least correlated provides important information about conditions.

The conditions can be grouped into three categories: strongly correlated with overall health, modestly correlated, and uncorrelated (see Chart 3). This matters because the overall BCBS Health Index is the best measure we have for general, overall healthiness of a population. If a condition is strongly correlated with the overall BCBS Health Index, then that suggests it is driven in large part by a population's overall healthiness. If it is modestly correlated, that suggests overall population healthiness matters, but so do other factors. If it is uncorrelated, that

suggests healthiness is not what is determining how much a county is affected by that condition.

The strongest correlation with overall BCBS Health Index is high cholesterol, followed closely by coronary artery disease, hypertension, COPD, and diabetes. The modestly correlated group includes lung cancer and breast cancer, which have among the lowest prevalence rates. In addition, substance abuse disorder is also in the modestly correlated group despite a higher prevalence.

Depression and hyperactivity stand out from the other conditions in terms of their relationship to overall health and to other conditions. These two conditions have the lowest overall correlation with health, and are also the least correlated with the other conditions (see Table 2). The other eight conditions are always positively correlated with each other. In contrast, depression and hyperactivity are either slightly negatively correlated with other conditions or not correlated at all, providing further evidence

that factors other than underlying healthiness are driving them.

This suggests that underlying population healthiness is not driving depression and hyperactivity, and raises an important question: If not healthiness, what makes some places more prone to depression and hyperactivity? One thing that separates these conditions, and to a lesser extent substance abuse disorder, is that they are mental health conditions and, as a result, their diagnosis and treatment are not always as obvious as a physical illness. This suggests that the prevalence of these conditions will be driven less by underlying population health and more by the propensity of the underlying population to seek treatment.

Geographical variation.

The relationships between health and underlying socioeconomic, behavioral and health system variables can be most easily identified by examining how they vary across geographies. This makes the data instrumental in answering two important questions. Why are some populations healthier than others, and why do certain health conditions appear to affect populations differently?

To answer these questions, we used regression analysis to see how much of the overall BCBS Health Index and 10 of the most important condition scores can be explained by the three major categories of vari-
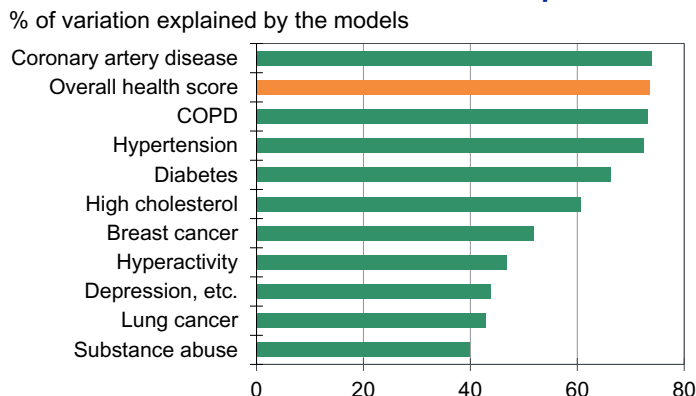
Chart 3: Only Some Conditions Track Health
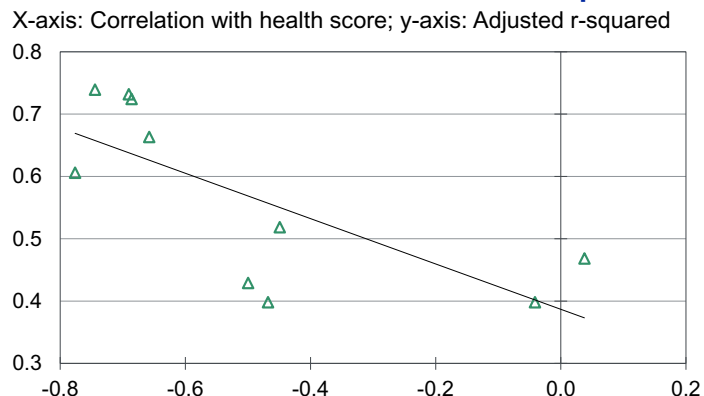Correlation with overall health score
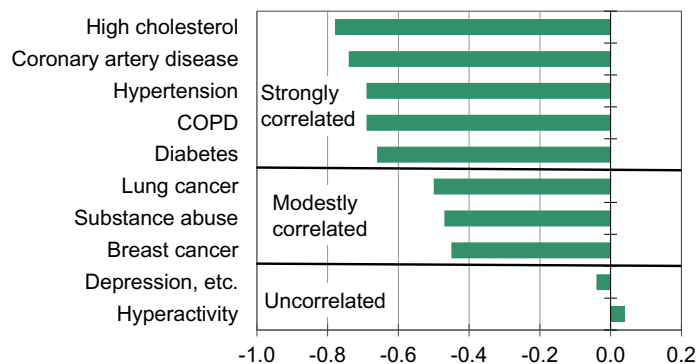
Sources: BCBS, Moody's Analytics

Chart 4: Overall Health Is Easier to Explain
% of variation explained by the models

Sources: BCBS, Moody's Analytics

Chart 5: Association w/ Health Better Explained
X-axis: Correlation with health score; y-axis: Adjusted r-squared

Sources: BLS, BCBS, Moody's Analytics

ables: socioeconomic and demographic (15 variables), behavioral (four variables), and health system factors (six variables).

The regression output (see Appendix 1) shows that in general, the BCBS Health Index has a higher ability to be explained by the data than the individual conditions. For example, the adjusted r-squared of 0.74 (see Chart 4) indicates that 74% of the variation in the county BCBS Health Index can be explained by the 25 variables included in the model (see Appendix 1).[17]

The one exception is coronary artery disease, which has an equal ability to be explained by the data as overall BCBS Health Index. The next highest are COPD, hypertension, diabetes and high cholesterol,

which all have an r-squared above 0.6. The five best-explained outcomes are also the most strongly correlated to the overall BCBS Health Index.

The variable that is least well explained is substance abuse disorder, which the model can explain only 40% of the variation in. In other words, the conditions that are most strongly related to overall healthiness as measured by the BCBS Health Index are also the ones that can be best explained by county-level factors (see Chart 5). The conditions that are not driven by healthiness—such as substance abuse disorder, depression, and hypertension—are more difficult to explain.

The models also do not explain lung cancer and breast cancer as well, which have relatively low prevalence rates. This suggests that rarer conditions tend to be harder to explain.

In general, there appear to be two main factors determining whether the county-level data can do a good job in explaining an outcome. The first is that outcomes that are strongly correlated with overall health are better explained. This suggests that there is some broader underlying healthiness that drives these conditions more than others. In addition, models also have a harder time explaining conditions with lower prevalence, such as breast cancer and lung cancer.

In addition to explaining health outcomes in combination with one another, these models can also tell us what kinds of factors appear to be most important for explaining health: socioeconomic/demographic, behavioral or health system factors. To do this, the models are rerun including only the variables from each explanatory group. The adjusted r-squareds on these models (see Table 3) tell us, for example, whether socioeconomic variables alone or behavioral variables alone can do a better job of explaining high cholesterol.

What drives outcomes?

Socioeconomic and demographic variables.

The socioeconomic and demographic variables are consistently the most important factors for explaining health, confirming much of what was found in previous analysis. For the overall BCBS Health Index, these variables alone can explain 64% of the variation compared with 74% using all of the variables. For coronary artery disease, socioeconomic and demographic factors can

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17 The adjusted r-squared is used throughout this analysis, which controls for the number of variables included in the regression.

Table 3: What Drives Conditions
Adjusted r-squared for each variable group

Outcome	Combined	Socioeconomic	Behavioral	Health system
Coronary artery disease	0.74	0.66	0.36	0.11
Overall health index	0.74	0.64	0.19	0.10
COPD	0.73	0.64	0.47	0.15
Hypertension	0.72	0.65	0.47	0.20
Diabetes	0.66	0.59	0.31	0.21
High cholesterol	0.61	0.56	0.13	0.06
Breast cancer	0.52	0.50	0.07	0.07
Hyperactivity	0.47	0.36	0.05	0.12
Depression, etc.	0.44	0.41	0.13	0.14
Lung cancer	0.43	0.41	0.08	0.02
Substance abuse	0.40	0.36	0.13	0.10

Sources: BCBS, Moody's Analytics

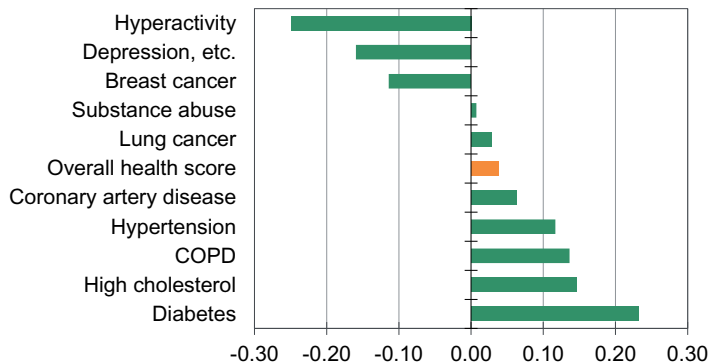## Chart 6: Seniors Have Better Behavioral Health
Effect of % BCBS members age 65 and older on condition z-score
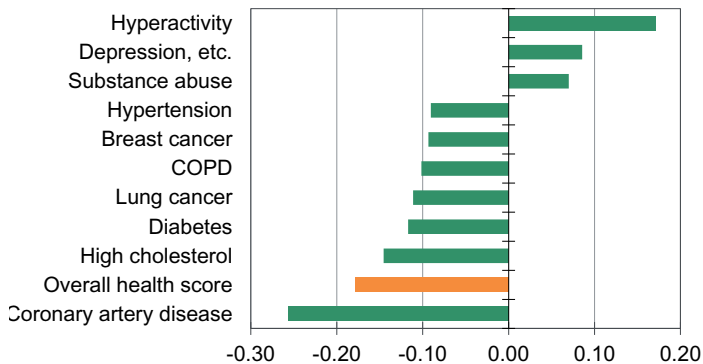
Sources: BCBS, Moody's Analytics

Chart 7: Education Has Mixed Effects
Effect of % population with college degree on condition z-score

Sources: BCBS, Moody's Analytics

explain 66% of the variation. Meanwhile, socioeconomic and demographic factors explain less than half of the variation in substance abuse disorder, depression, hyperactivity, and lung cancer.

Looking at individual coefficients and their statistical significance, it is clear that the age of the BCBS members is among the most important variables in explaining BCBS Health Index and condition impacts. In general, younger members mean higher BCBS Health Indexes and lower health conditions, while a greater share of older commercially insured members has the opposite effect. This result is not surprising given that as people age more of them will fall farther from ideal health.

However, the effect of aging on conditions is not consistent (see Chart 6). The share of the commercially insured population who are age 65 or older has a negative effect on seven out of 10 conditions and overall health. However, it has a positive effect on hyperactivity, depression, and substance abuse disorder. For substance abuse disorder, a greater share of members age 45 to 54 has the worst effect on conditions. This is consistent with recent research showing substance abuse disorder has increased mortality rates for middle-aged whites aged 45 to 54 in the U.S.[18]

Some socioeconomic and demographic variables also illustrate that differences in

the propensity to seek treatment clearly drive variation in BCBS Health Index, and that some conditions are not driven primarily by overall healthiness. For example, the percent of the population with a college degree is associated with better health for some conditions and worse health for others (see Chart 7). A one standard deviation increase in the share of the population with a college degree improves the diabetes impact score by 0.23 standard deviations but worsens the hyperactivity score by 0.25 standard deviations. It is unlikely that more education causes hyperactivity, depression or breast cancer, but instead leads to a higher likelihood that these conditions will be diagnosed. In other conditions, such as diabetes and COPD, any diagnosis effect is outweighed by strong association of greater education with living a healthier lifestyle.

Consistent with past research from Moody's Analytics and others, better health is associated with a strong economy, as measured by labor force participation, higher pay, and faster per capita income growth. Labor force participation is one of the strongest associations across any group, and is statistically significant for every condition except depression and hyperactivity, which again likely reflect diagnosis effects.

Having a job is a source of income, stability, meaning and social connections, all of which contribute to health. Health, in turn, makes it easier to be gainfully employed. And finally, this likely reflects unmeasured factors that contribute to health and employment, such as intelligence, conscientiousness and

ability. Overall, disentangling the causality is extremely difficult, but these results present one more datapoint illustrating a strong relationship between health and the economy. Importantly, these results also tell us the relationship is stronger for some conditions than others, and in some cases may be swamped by diagnosis effects.

Population density is another important factor in explaining health outcomes. Places with denser populations have consistently worse health outcomes, with the exceptions of depression and substance abuse disorder, again likely a result of diagnosis effects. The strongest effects are on high cholesterol and hyperactivity.

That dense urban areas have worse health outcomes even after controlling for a litany of socioeconomic, demographic, behavioral and health system factors points to the importance of continued research on the causes and consequences of urban health issues. What is more, the lower levels of substance abuse disorder and depression despite much greater concentrations of physical health problems suggest potential underdiagnoses rather than better health for these conditions.

Behavioral factors.

Behavioral factors proved to be the second most important variable in explaining health. However, health conditions vary markedly in how much they can be explained by behavioral variables. Behavioral factors are important drivers for hypertension, coronary artery disease, diabetes, and

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18 Case, Anne, and Angus Deaton, "Rising Morbidity and Mortality in Midlife Among White Non-Hispanic Americans in the 21st Century," *Proceedings of the National Academy of Sciences* 112, no. 49 (2015): 15078-15083.

COPD, which are four of the five conditions that are most strongly associated with the overall BCBS Health Index. In contrast, hyperactivity, breast cancer and lung cancer are not well explained by behavioral factors. The lack of importance of behavioral factors is one reason these conditions are overall more difficult to explain using regression. These results are likely underestimating the importance of behaviors for a few reasons.

One reason is likely the strong relationship between behavioral factors and other socioeconomic and demographic factors. Behavioral factors, like smoking, are often the mechanism through which other factors, such as low educational attainment, affect health.

Another reason is that, along with obesity and inactivity, smoking is imperfectly measured using the Center for Disease Control's Behavioral Risk Factor Surveillance System survey.[19] The survey utilizes a relatively small sample, which has required other researchers to aggregate from 1996-2008 to cover a significant share of counties, and further necessitated many to be imputed by Moody's Analytics using state averages.[20]

As a result, the behavioral data are likely measured with a significant amount of er-

19 The data for the Center for Disease Control's Behavioral Risk Factor Surveillance System were aggregated by Chetty et al., available at https://healthinequality.org/data/, and County Health Rankings, available at http://www.countyhealthrankings.org/.
20 Chetty, Raj, Michael Stepner, Sarah Abraham, Shelby Lin, Benjamin Scuderi, Nicholas Turner, Augustin Bergeron, and David Cutler, "The Association Between Income and Life Expectancy in the United States, 2001-2014." *Jama* 315, no. 16 (2016): 1750-1766.

ror and noise compared with, for example, average annual pay. That they are measured with less precision can compound the fact that behavioral factors are a mechanism for some better measured socioeconomic or demographic influences.

However, despite the measurement problems and limitations, behaviors appear to be a significant driver of some conditions. Behaviors alone can explain nearly half of the variation in COPD and hypertension and one-third of the variation in coronary artery disease and diabetes. In contrast, behavioral factors seem to matter little for explaining hyperactivity, breast cancer and lung cancer.

Health system factors.

Finally, health system factors proved the least important of the three groups in explaining health outcomes, but still made significant contributions to the overall predictive power of the models. These factors have the greatest effect on diabetes and hypertension. In particular, the share of commercially insured members working in government is significantly related to both, suggesting that government workers may either be more likely to be diagnosed for these conditions or more likely to remain in the workforce with these conditions.

Healthcare quality also appears to be a factor, with higher 30-day hospital mortality rates associated with worse outcomes for both hypertension and diabetes. A greater share of doctors who are generalists is also associated with lower diabetes scores, suggesting generalists and higher-quality hospitals may help with diabetes management. More generous state Medicaid programs are associated with better outcomes for several conditions, which is likely driven by Med-

icaid removing systematically fewer patients from the commercially insured universe.

Classifying conditions

Group 1: Physical health conditions

Five of the 10 conditions are categorized as physical health conditions: high cholesterol, coronary artery disease, hypertension, COPD and diabetes. One characteristic these conditions have in common is that they strongly correlate with overall population health as measured by the BCBS Health Index (see Chart 8). In other words, when a county is healthy overall, these five conditions have less impact on the health of the population. When a county is unhealthy overall, these conditions tend to have more impact on the health of the population.

The strong relationship between these conditions and overall health is important to highlight because demographic, socioeconomic, and behavioral factors are highly predictive of overall health. In total, these factors explain 74% of the county-by-county variation in the Health Index score. As a result, these factors also explain much of the county-by-county variation in the impact of these health conditions.
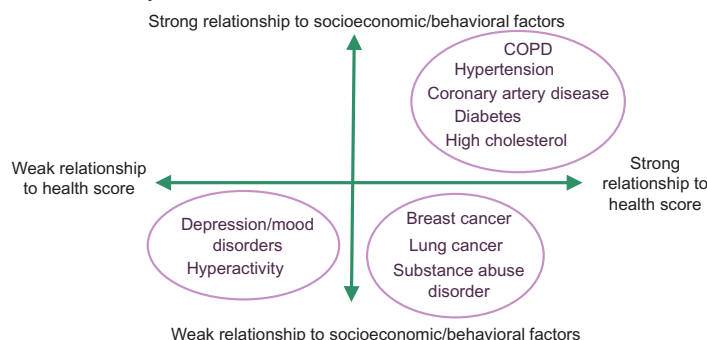
Population characteristics tend to affect these health conditions in ways one typically expects when evaluating community health. For example, physical health conditions have less of an impact on places with greater levels of education and higher labor market participation.

Behavioral factors also drive these five conditions. There are adverse health impacts of these conditions in communities where physical inactivity is greater, where preventable hospital stays are more common and, for some conditions, where smoking and obesity are more prevalent. Health system factors, such as the presence of primary care physicians or the level of Medicaid support are the least important in evaluating physical health conditions, but still cause a substantial amount of variation among counties.

In short, the five physical health conditions align with the typical view of population health. These conditions are more common in areas with lower overall BCBS Health

Chart 8: Taxonomy of Index Health Conditions
Conditions vary in important ways in terms of what drives them and how they relate to overall health

Strong relationship to socioeconomic/behavioral factors

COPD
Hypertension
Coronary artery disease
Diabetes
High cholesterol

Weak relationship to health score

Strong relationship to health score

Depression/mood disorders
Hyperactivity

Breast cancer
Lung cancer
Substance abuse disorder

Weak relationship to socioeconomic/behavioral factors

Sources: BCBS, Moody's Analytics

Index scores and are more strongly associated with socioeconomic, demographic and behavioral factors.

Group 2: Mental health conditions

Mental health conditions include hyperactivity and depression/anxiety/affective disorder. These conditions have little correlation with overall health. Counties with low overall BCBS Health Index and high levels of other conditions are no more likely to have hyperactivity and depression than healthy counties. Mental health conditions lack a relationship with other conditions and the BCBS Health Index at the county level because they can be less obvious to diagnosis and treat than physical health conditions.

As a result, county-to-county variation in these mental health conditions is more difficult to explain using county population characteristics. Socioeconomic, demographic and behavior factors have modest to small effects on these conditions in the BCBS Health Index. Further, these characteristics often have an opposite relationship to the BCBS Health Index and physical health conditions. For example, more educated counties are more affected by depression and hyperactivity than less educated ones (see Chart 7). Additionally, larger minority populations have fewer depression diagnoses. It is unlikely that minority populations and those with lower socioeconomic standings have fewer mental health conditions; these groups, for a variety of reasons, are less likely to be diagnosed and treated.

The relationship between mental health conditions with overall health suggests that they should be considered differently from physical health conditions. For instance, patients with higher socioeconomic status are more likely to receive a diagnosis of having a mental health condition. It appears that this diagnosis practice confounds the relationship between various population characteristics and mental health. Further, policies that attempt to address mental health conditions by changing socioeconomic and behavioral outcomes will have less success reducing the effects of these conditions as measured by the BCBS Health Index.

Group 3: Unique health conditions

Unique health conditions are the third group of health conditions. Unique conditions exist between the conditions in Groups 1 and 2, and each possess distinctive features. Group 3 comprises breast cancer, lung cancer, and substance use disorder. These conditions are somewhat correlated with overall health and are modestly related to socioeconomic and demographic factors, as well as genetics. Beyond those generalizations, however, these conditions each require individual attention and discussion.

Breast cancer and substance use disorder are likely to be affected by the treatment and diagnosis similar to mental health conditions. For example, breast cancer is related to higher education levels. Socioeconomic and demographic factors do a poor job of explaining county-level variations in the level of substance abuse disorder.

Breast cancer and lung cancer are among the conditions least affected by health system and behavioral factors. It is difficult to explain variations in these health conditions at the county level because the prevalence for these conditions within the general population is low, and as a result, there is simply less variation in the data to explain their impact on health.

Altogether, unique health conditions are somewhat driven by socioeconomic, demographic and behavioral factors. However, each condition also has distinctive features—including treatment effects, low prevalence and genetics—that potentially qualify them for a different analysis method than that of other conditions.

In sum, the findings in this report show that demographic, behavioral and structural factors impact health conditions in different ways and that greater insight into these differences is critical to understanding county-level population health using the BCBS Health Index.

Conclusions

Overall, the results present several deeper lessons about what influences health, and why the BCBS Health Index varies across the U.S. In general, socioeconomic and demographic variables are the best at

explaining the county-level variation in BCBS Health Indexes. For all conditions, these variables alone are able to explain a significant amount of the variation in outcomes.

Behavioral factors are the next most important in explaining variation, outranking health system factors in seven out of 10 conditions. However, while socioeconomic and demographic factors alone can explain a lot of every condition, there is a wide range in how important behavioral factors are. For some conditions, such as hyperactivity and breast cancer, behavioral factors can explain very little of the variation, while they can explain almost half the variation in hypertension and COPD. In general, behavioral factors appear to matter most for conditions that are driven by overall population healthiness, in particular those in the physical health conditions group.

Health system factors are the least important group, explaining on average about 12% of the variation, compared with 22% for behavioral variables and 52% for socioeconomic and demographic factors. While health system factors have proven to be a major driver of healthcare expenditures in previous research, they appear to be less important for driving health outcomes measured here. Nevertheless, for certain health conditions, health system factors do have significant impacts.

Looking at individual health conditions, the variation is easier to explain in some than in others. In general, those that have the strongest relationship with overall BCBS Health Index are easier to explain. This suggests there is an underlying latent healthiness that drives a variety of conditions, and that this healthiness is well-explained by socioeconomic, demographic, behavioral and health system factors. In general, healthy behaviors, more education, and better economic outcomes are associated with better overall healthiness. From a public health standpoint, improving these factors may therefore help reduce a variety of important conditions that are associated with general overall healthiness, including the physical health conditions of hypertension, high cholesterol, coronary artery disease, diabetes, and COPD.

In contrast, other conditions appear to be driven by factors less related to underlying population healthiness. In particular, the mental health conditions of depression/anxiety/affective disorder and hyperactivity are largely unrelated to other health conditions.

One reason for the difference is that treatment for mental health conditions can be perceived by patients as more optional than treatment for physical conditions. This may make the propensity to seek treatment more important for these conditions than the underlying healthiness of the population. Further evidence for this theory is that depression and hyperactivity are associated with higher levels of education, while the relationship is the opposite for most of the physical health conditions. It is unlikely that higher education is causing worse mental health outcomes, but it does plausibly make people more likely to seek treatment.

In addition, labor force participation is associated with better outcomes for every condition except depression and hyperactivity. This does not suggest that better labor market outcomes increase mental health issues, but that they may increase treatment for them.

That mental health conditions are not being diagnosed as much in the places with the greatest physical health problems suggests perhaps mental health is going underdiag-nosed in many places. Given that depression/anxiety/affective disorder has the largest impact of any condition on overall BCBS Health Index, understanding the nature of this lack of correlation is important for future work.

Although substance abuse disorder appears similar to mental health conditions in some ways, it also appears similar to physical health conditions in others. For example, it is modestly related to overall healthiness, lying on the spectrum between the mental health conditions and many of the physical conditions. The modest relationship suggests that healthiness plays some role but propensity to seek treatment is a factor as well. In addition, like many physical health conditions, substance abuse disorder is associated with lower levels of education and lower labor force participation. However, like other mental health conditions, a higher concentration of older BCBS members is associated with better outcomes. For these reasons, substance abuse disorder is categorized in the unique health conditions group.

Breast cancer and lung cancer are among the least affected by health system factors and behavioral factors, and as a result, the models overall have the hardest time explaining variations in these health conditions. Breast cancer and lung cancer are therefore included in the unique health conditions group as well. One major factor is that the prevalence for these conditions within the general population is low, and as a result, there is simply less variation in the index to explain.

For example, the average county prevalence rate for lung cancer is 0.1%, and the data are available in only 2,239 counties. By contrast, high cholesterol affects 16% of the population and the data are available in 3,127 counties. The difficulty in explaining breast cancer is likely driven in part by low prevalence, and in part by a diagnosis and treatment effect, as evidenced by higher education being associated with a worse score.

Overall, this analysis demonstrates the importance of the BCBS Health Index and detailed condition indexes in developing a better understanding of health across counties in the U.S. Overall healthiness matters for many conditions, and overall healthiness also varies greatly across the country. Much of the variation in health can be explained by socioeconomic, demographic, behavioral and, to a lesser extent, health system factors. However, other conditions, especially mental health conditions, appear to be less related to a population's healthiness and have more to do with factors like diagnosis effects and propensity to seek treatment, making the geographic variation in these conditions somewhat harder to explain.

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Appendix 1: Regression Results

Regression Results
Coefficients for overall BCBS Health Index and condition regression models

Socioeconomic and demographic											
% members 18 to 34		0.07		0.00		0.02	0.04	0.03			0.01
% members 35 to 44		0.11	0.08	-0.03		0.00	-0.01	0.03			0.01
% member 45 to 54		0.00				-0.04	-0.07		0.04		0.00
% members 55 to 64	-0.02	0.04			-0.13	-0.09		-0.03			
% members 65 and older											
% pop 19 and younger			0.03	0.04		0.00	-0.03	0.06	0.10		0.01
% pop 65 and older						-0.02			0.02	0.05	-0.01
% African American	0.03				-0.05	-0.07	-0.09		-0.16	-0.04	0.01
% Hispanic	0.06			-0.02	-0.05	0.03	-0.07		0.08		
% with college degree	0.04	0.01				0.15					
% children w/ single mother	-0.02				0.12		0.06	-0.04	-0.11	0.00	0.02
Log avg annual pay	0.02	-0.06	-0.05	0.04		0.03	0.01	-0.01	0.00	0.02	-0.01
Labor force participation			0.01						-0.05		
Log pop density		-0.07	-0.10								
Income per capita growth 10 yr	0.02	0.05		-0.07	-0.06	-0.04	0.00		0.04	-0.03	-0.01
Behavioral											
Physical inactivity	-0.19	-0.04	0.02	-0.23	-0.17	-0.21	-0.17	-0.14	-0.04	-0.02	-0.02
Preventable hospital stays	-0.16	-0.13	0.00	-0.10	0.03	-0.20	-0.02	-0.20	-0.06	-0.02	-0.05
Smoking	-0.09	-0.12	-0.02	0.00	0.02	-0.09	0.02	-0.07	-0.11	0.00	-0.03
Obesity	0.00	0.05	0.05	-0.03	-0.02	-0.04	-0.07	-0.03	0.03	0.02	-0.01
Health system factors											
% generalists	0.11	0.13	0.02	0.00	0.09	0.06	0.10	0.04	-0.08	0.02	-0.02
% Medicare enrollees w/ ≥1 p.c. visit	0.00	-0.03	0.03	-0.04	-0.11	-0.01	-0.03	-0.02	-0.14	-0.02	-0.02
Diabetic screening value	0.00	-0.05	-0.13	0.02	-0.13	0.04	0.06	0.01	-0.08	-0.02	-0.03
State Medicaid income cutoff	0.15	0.06	0.14	0.09	0.10	0.04	0.10	0.07	0.24	-0.02	0.01
30-day hospital mortality rate	-0.03	-0.02	0.06	-0.14	-0.10	-0.04	-0.09	-0.07	-0.04	0.00	-0.01
% members in govt	-0.23	-0.03	0.00	-0.10	-0.10	0.02	-0.16	-0.07	0.17	0.05	0.01
Adjusted r-squared	0.736	0.398	0.439	0.724	0.606	0.739	0.663	0.732	0.468	0.519	0.429
Sample	2,899	2,895	2,899	2,899	2,899	2,895	2,899	2,885	2,883	2,894	2,175

Notes: Blue color-coded numbers are positive and statistically significant, and red color-coded numbers are negative and statistically significant. BCBS Health Index multiplied by -1 to have a consistent sign with conditions. All variables are standardized to z-scores for comparability.

Appendix 2: Regression Analysis

Regression analysis is a statistical model that attempts to "explain" one outcome (the dependent variable) using one or more variables (the independent variables). This type of analysis produces several outputs. The coefficients tell you how much the dependent variable would be expected to increase if the independent variable increased by one unit. The p-values indicate whether these effects are statistically significant. Finally, an r-squared is a number between 0 and 100 that tells you what percent of the variation in the dependent variable can be "explained" by the independent variables.

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Moody's Analytics helps capital markets and credit risk management professionals worldwide respond to an evolving marketplace with confidence. With its team of economists, the company offers unique tools and best practices for measuring and managing risk through expertise and experience in credit analysis, economic research, and financial risk management. By offering leading-edge software and advisory services, as well as the proprietary credit research produced by Moody's Investors Service, Moody's Analytics integrates and customizes its offerings to address specific business challenges.

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BLUE CROSS BLUE SHIELD, THE HEALTH OF AMERICA REPORT

This is the sixteenth study of the Blue Cross Blue Shield: The Health of America Report series, a collaboration between BCBSA and Blue Health Intelligence, which uses a market-leading claims database to uncover key trends and insights into health care affordability and access to care.

Blue Cross Blue Shield Health Index[SM] Methodology

The Blue Cross Blue Shield Health Index[SM] is a unique measurement of the state of America's health powered by data from more than 40 million of our members. This first-of-its-kind resource identifies the health conditions with the greatest impact on commercially-insured Americans.

The BCBS Health Index is informed by data from Blue Cross Blue Shield Axis®, the BCBS companies' industry-leading data capability. It is also a result of collaboration with Blue Health Intelligence®, which provided analytical support, and consultation with the Institute for Health Metrics and Evaluation, an independent global health research center at the University of Washington in Seattle, that helped BCBS in defining condition categories and measuring their disabling affects.

Using blinded claims data from more than 40 million commercially insured members of BCBS companies, ICD-9 diagnoses were mapped to over 200 health condition categories. The impact of each condition was determined based on the years lost due to the risk of premature death and the disabling effects of illness or disease. These years of life lost were subtracted from the optimum life expectancy (OLE) of a given member assuming no health conditions and then divided by OLE to get an estimate of health between 0 and 1 with 1 corresponding to optimal health, defined as the absence of any currently known conditions or risks associated with potential adverse health impacts. A value less than one represents the proportion of future healthy life for that member based on his or her diagnosed condition(s). These individual level estimates are then aggregated to create a health score for the population.

The formal calculation is [OLE – (Mortality + Disability)] / OLE, where "OLE" is a person's optimum life expectancy derived from an actuarial life table, "mortality" is "years of life lost" due to risk of premature death, and "disability" is years of living with a disability.