

1 **Assessing area-level deprivation as a proxy for individual-level social risks**

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24 **Abstract**

25 **Introduction:** Concerns about the opportunity costs of social screening initiatives have led some
26 health care organizations to consider using social deprivation indices (area-level social risks) as
27 proxies for self-reported needs (individual-level social risks). Yet, little is known about the
28 effectiveness of such substitutions across different populations.

29
30 **Methods:** This paper explored how well the highest quartile (“cold spot”) of three different area-
31 level social risk measures—the Social Deprivation Index, Area Deprivation Index, and
32 Neighborhood Stress Score—correspond with six individual-level social risks and three risk
33 combinations among a national sample of Medicare Advantage members (N=77,503). Data were
34 derived from area-level measures and cross-sectional survey data collected between October
35 2019 – February 2020. Agreement between individual- and individual-level social risks,
36 sensitivity values, specificity values, positive predictive values (PPV), and negative predictive
37 values (NPV) were calculated for all measures in Summer/Fall 2022.

38
39 **Results:** Agreement between area and individual-level social risks ranged from 53-77%.
40 Sensitivity for each risk and risk category never exceeded 42%; specificity values ranged from
41 62-87%. PPVs ranged from 8-70% and NPVs ranged from 48-93%. There were modest
42 performance discrepancies across area-level measures.

43
44 **Conclusions:** These findings provide additional evidence that area-level deprivation indices may
45 be inconsistent indicators of individual-level social risks, supporting policy efforts to promote
46 individual-level social screening programs in health care settings.

47 **Introduction**

48 Social determinants of health (SDH), or the conditions in which people are born, grow, live,
49 work, and age,¹ profoundly impact health and health care outcomes as well as health care costs.^{2–}

50 ⁷ In response, United States (US) health care organizations including the Centers for Medicaid
51 and Medicare Services (CMS) have increasingly emphasized the importance of addressing
52 adverse SDH as a means of improving population health and health equity.⁸ Screening for
53 individual-level indicators of adverse SDH – such as food, housing, and transportation insecurity
54 – has emerged as a primary launch point for related interventions, e.g. providing social services
55 like food boxes and transportation or making referrals to community-based social service
56 organizations.⁹ While evidence suggests that social risk screening in health care settings is
57 increasing,¹⁰ concerns about the opportunity costs (e.g., financial resources, time) of universal
58 individual-level screening are likely to limit widespread adoption.¹¹ Unanswered questions
59 related to which populations should be screened, by whom, and with what frequency can
60 additionally complicate decisions about whether and how to implement screening programs.

61
62 Given the strong association between area-level indicators of SDH and morbidity and
63 mortality,¹² some payors and providers have considered using social deprivation indices to more
64 efficiently identify patients at high risk of social disadvantage, or as proxies for individual-level
65 social risk factors in data analysis.^{13–15} While this approach may be more time and cost-efficient
66 than individual-level screening, it subverts at least two key assumptions: 1) while intrinsically
67 tied to community and societal factors, individual-level social risks can arise independently (e.g.,
68 as a result of individual factors, interpersonal relationships, and organizations),¹⁶ and 2) using
69 aggregated area-level data may result in mis-categorizing an individual's risks, a concept in

70 epidemiology known as the *ecological fallacy*.¹⁷ At the time of publication, two studies had
71 previously examined the use of area-level data to estimate individual-level social risks.^{18,19}
72 Cottrell et al.¹⁸ found a modest association between self-reported risks and the Social
73 Deprivation Index (SDI); Miller-Rosales et al.¹⁹ reported similar findings using the
74 Neighborhood Deprivation Index (NDI). The authors concluded that neighborhood data was an
75 imperfect proxy for individual-level information. However, the generalizability of their findings
76 was limited both by the populations studied, which were disproportionately or exclusively
77 comprised of individuals with low income, and by the deprivation index that was used.^{18,19}

78

79 This study adds to knowledge in this field by leveraging the availability of a national sample of
80 Medicare Advantage (MA) members to examine how well three different area-level social risk
81 measures—the Social Deprivation Index (SDI), Area Deprivation Index (ADI), and
82 Neighborhood Stress Score (NSS)—correspond with individual-level social risks within this
83 population.

84

85 **Methods**

86 **Study Sample**

87 The study population was drawn from a national sample of MA members who responded to a
88 survey assessing health related social needs (HRSN) administered by Humana, Inc., a private-
89 health insurer, between October 16, 2019 – February 29, 2020. Households were eligible to
90 participate if they had at least one non-institutionalized adult enrolled in an individual MA plan
91 that was not contractually excluded from research (N=436,038). Among households with
92 multiple eligible individuals, only one was randomly selected to receive survey outreach. Ninety

93 percent (n=392,363) were successfully contacted to complete a survey. Text message, telephone,
94 and email outreach was conducted across all fifty states, though over 60% of MA members were
95 concentrated in urban areas and the southern U.S. The survey was made available using
96 interactive voice response (IVR) phone call, text messaging and email in both English and
97 Spanish. The HRSN survey contained adapted social risk domains included in the CMS
98 Accountable Health Communities HRSN Screening tool (see: Appendix A).²⁰ Members'
99 characteristics (age, gender, etc.) were derived from administrative files. Humana used primary
100 address data to assign a census tract and block group using 2010 Census geography.

101

102 The analytic sample was limited to members who had complete individual and area-level social
103 risk data (N=77,503, 18% of the original sample and 20% of those who were successfully sent a
104 survey). See **Appendix Figure 1** for more details.

105

106 This study was deemed exempt by the Humana Healthcare Research Human Subject Protection
107 Office.

108

109 **Measures**

110 The Humana HRSN survey included questions about multiple individual-level social risks used
111 in these analyses: food insecurity, housing insecurity, transportation insecurity, and utilities
112 insecurity; financial strain; and poor housing quality. Although the HRSN survey also asks about
113 social isolation, this risk was excluded because it does not directly align with the
114 sociodemographic data captured by area-level social risk measures. Per CMS' scoring guide,²¹
115 the prevalence of each risk was determined by respondents' answers to corresponding survey

116 question(s) (see: **Appendix Table 1**) and treated as a dichotomous variable (positive screen:
117 yes/no).

118

119 Three additional variables were created to correspond to different combinations of individual-
120 level social risks: 1) participants who endorsed one or more social risks related to food
121 insecurity, housing insecurity, or financial strain (yes/no); 2) participants who endorsed one or
122 more social risks related to food insecurity, housing insecurity, or transportation insecurity
123 (yes/no); and 3) participants who endorsed one or more social risks related to food, housing,
124 transportation, utilities insecurity, financial strain or poor housing quality (yes/no). The first
125 combination paralleled the analysis conducted by Cottrell et al;¹⁸ the second captured domains
126 that are commonly addressed by SDH interventions and will be incorporated in the 2023 HEDIS
127 quality measures;^{22,23} and the third provided the most comprehensive evaluation of individual
128 social risks.

129

130 Census tracts were linked to corresponding SDI²⁴ scores; census block groups were linked to
131 ADI²⁵ and NSS¹⁵ scores. The 2019 SDI and ADI values were downloaded directly from the
132 Robert Graham Center and Neighborhood Atlas websites, respectively. NSS scores were
133 calculated using 2019 American Community Survey data by Humana, based on the methods
134 described by Ash et al.¹⁵ The components of each measure can be found in **Appendix Table 2**.
135 SDI and ADI scores correspond to percentiles, such that the level of deprivation in each census
136 tract and block group can be ranked against others nationwide. Higher scores indicate greater
137 levels of deprivation, and have been strongly and consistently associated with poor health and
138 health care outcomes.^{26–29} The NSS is a more recent area-level deprivation measure that was

139 developed to augment risk adjustment in the payment model for Massachusetts' Medicaid
140 (MassHealth) program.¹⁵ Some research suggests it may be a stronger predictor of health care
141 utilization than the ADI.³⁰ Unlike the other two measures, the NSS is presented as a
142 standardized range of scores, where 0 represents the mean.

143

144 Similar to the "cold spotting" approach³¹ used by Cottrell et al,¹⁸ all area-level scores were
145 dichotomized into the highest versus three lowest quartiles.

146

147 **Statistical Analysis**

148 Sociodemographic characteristics, individual-level social risks, and individual-level social risks
149 of the study population were described using frequencies and percentages. The characteristics of
150 this sample were compared with Humana's MA member population using standardized
151 proportional differences to gauge internal generalizability. Values greater than 0.2 were
152 considered meaningful.³²

153

154 SDI, ADI, and NSS scores were subsequently tabulated with responses to food insecurity,
155 housing insecurity, or financial strain; food insecurity, housing insecurity, or transportation
156 insecurity; at least one social risk; and each of the six standalone risks (33 crosstabulations in
157 total) to assess agreement between area and individual-level social risks. Agreement was
158 calculated by totaling the number of individuals living in a cold spot with a social risk and the
159 number of individuals that did not live in a cold spot without a social risk, then dividing the sum
160 by the total population. Hypothesis testing was not conducted because the statistical significance
161 of an area-level measure's association with individual-level measures has no bearing on its

162 utility. Instead, row and column percentages from the crosstabulations were used to estimate the
163 sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of
164 all area-level measures, which better gauged the validity and utility of using area-level measures
165 to capture individual-level social risk(s).

166

167 Sensitivity and specificity correspond to the true positive and negative rates, respectively. Within
168 this context, a highly sensitive measure would indicate that most participants who endorsed
169 individual-level risk(s) live in neighborhoods with the highest area-level deprivation (most
170 disadvantaged), and a highly specific measure would indicate that most participants who did not
171 endorse individual-level risk(s) lived in neighborhoods falling in one of the three lowest area-
172 level deprivation quartiles (least disadvantaged). Clinically, PPV and NPVs are used to help to
173 determine the probability of whether individuals with a positive or negative test have the
174 condition of interest. Within this context, a high PPV would indicate that most participants living
175 in the area with the highest deprivation quartile endorsed an individual-level risk(s), and a high
176 NPV would indicate that most participants living in one of the three lowest deprivation quartiles
177 did not endorse an individual-level risk. Unlike sensitivity, PPV and NPV are influenced by the
178 prevalence of individual social risk(s), such that higher proportions of individual social risks will
179 correspond to higher PPVs and lower NPVs.

180

181 Post-hoc crosstabulations of area- and individual-level social risks were constructed and
182 stratified by region and rurality to determine whether they introduced variation. All analyses
183 were conducted in Summer/Fall 2022 using Stata 14 (StataCorp LLC, College Station, TX).

184

185 **Results**

186 Sample characteristics can be found in **Table 1**. Most participants identified as female (58%) or
187 White (73%) and reported speaking English at home (89%). Twenty percent were dually eligible
188 for Medicaid. Just under half were between 65-74 years of age (49%) and over 60% lived in an
189 urban location. There were no meaningful sociodemographic differences between the analytic
190 sample and the total survey-eligible population as determined by standardized proportional
191 differences (see: **Appendix Table 3**). About 55% of participants reported at least one social risk,
192 46% reported a need in food, housing, or financial domains, and 32% reported a need in food,
193 housing, or transportation domains. Financial strain (41%) and food insecurity (26%) were the
194 most prevalent reported needs; housing insecurity (8%) and transportation insecurity (10%) were
195 the least reported needs. One quarter of the sample lived in the highest SDI quartile, 31% lived in
196 the highest ADI quartile, and 20% lived in the highest NSS quartile. Crosstabulations between all
197 area and individual-level measures can be found in **Appendix Table 4**.

198
199 Agreement between area and individual-level social risk indicators ranged from 53-77%; values
200 were generally highest for the NSS and lowest for the ADI (**Table 2**). Sensitivity values for each
201 risk and risk category never exceeded 42% (**Figure 1**). They were highest for food insecurity,
202 transportation insecurity, and poor housing quality. Specificity values were much higher, ranging
203 from 62-87%. They were highest for the “at least one social risk”, as well as “food insecurity,
204 housing insecurity, and/or financial strain” categories. There were some performance
205 discrepancies between the three area-level measures. The ADI consistently had the highest
206 values for sensitivity (35-42%) and the NSS had the lowest (25-32%); the reverse was true for
207 specificity values. There was less inter-measure variation among PPVs and NPVs relative to

208 sensitivity and specificity, but a much wider range of values with PPV ranging from 8-70% and
209 NPV ranging from 48-93% (**Figure 2**).

210

211 The percent agreement between endorsements of food insecurity, housing insecurity, and/or
212 financial strain and SDI was 58% (**Table 2**). The sensitivity for this combination was 32% and
213 the specificity was 81% (**Figure 1**). The PPV and NPV were both 58% (**Figure 2**).

214

215 Stratified crosstabulations between area- and individual-level social risks can be found in
216 **Appendix Table 5** and **Appendix Table 6**.

217

218 **Discussion**

219 This analysis expanded upon prior studies^{18,19} by exploring associations between three area-level
220 deprivation measures and several combinations of individual-level social risks in a national
221 sample of MA members. Consistent with the earlier findings, all three area-level measures in this
222 study were poor indicators of individual-level social risks, with only modest differences in the
223 utility of different area-level measures. While area-level measures appeared to be better equipped
224 at discerning which individuals did not endorse social risks (versus those that did), this is less
225 valuable for most use cases—and likely reflects the low prevalence of some social risks rather
226 than measurement accuracy.

227

228 Notably, this study produced substantially higher specificity values (81% vs. 43%) and lower
229 sensitivity values (32% vs. 60%) than Cottrell et al.,¹⁸ despite the fact that both samples had
230 similarly high rates of self-reported individual-level social risks. This disparity may be attributed

231 to several factors. First, Cottrell et al.¹⁸ leveraged data from a national network of Federally
232 Qualified Health Centers (FQHCs), which serve regions with higher levels of area-level
233 deprivation and patients with fewer resources than other health care settings in the US.³³ It is
234 therefore more likely the FQHC sample includes a greater percentage of individuals with both
235 area and individual-level deprivation, and subsequently, a higher likelihood of overlap between
236 the two. Second, the severity and manifestations of material hardship vary by factors such as race
237 and age.³⁴⁻³⁶ The predominantly White sample was less likely to be subjected to the effects of
238 institutionalized racism (e.g., the social and economic impacts of redlining) than communities of
239 color, and therefore, less likely to reside in areas with high levels of place-based deprivation
240 (e.g., “cold spots”).^{34,35} Yet compared to younger populations, the sample was at greater risk of
241 experiencing financial strain resulting from health issues or living on a fixed income.³⁶ These
242 distinctions reflect the many different types of adversity that are not captured adequately by the
243 more blunt and race-blind area-level measures.³⁷

244

245 The modest performance differences between area-level measures may reflect their composition
246 and methodology. It is unsurprising that the most sensitive and least specific measure (ADI)
247 contained the greatest number of components (17). Although the NSS, which was the least
248 sensitive measure, contained the same number of components as the SDI (7), it excluded housing
249 domains. This likely impacted its ability to detect individuals with housing or associated social
250 needs. Finally, since SDI and ADI scores are constructed relative to census tracts and block
251 groups around the country and the NSS was constructed relative to other Humana members, the
252 percentage of the population living in an NSS “cold spot” was much smaller. This reduced the
253 probability of observing overlap between individual and individual-level social risks since

254 they're not strongly correlated within this sample – and increased the probability that we'd
255 observe a higher specificity.

256

257 These findings support policy efforts to promote individual-level social screening programs in
258 health care settings, including in evolving quality measure initiatives from the National
259 Committee for Quality Assurance (NCQA), CMS, and Joint Commission plans,^{38–40} with the
260 goal of informing patient-level interventions. Deprivation indices, however, have other valuable
261 uses within this arena. Area-level information is typically more likely to capture the true
262 prevalence of population-level risks than information collected from select individuals in a health
263 care organization. Patients that consistently obtain care and consent to screening may not be a
264 representative sample of their communities, especially within health care organizations
265 implementing screening programs in settings (e.g. primary care) that are often less accessible to
266 marginalized populations.⁴¹ Deprivation indices like those examined may therefore be better
267 positioned to inform or supplement population-level assessments and intervention planning.

268

269 A combination of individual and area-level measures may be especially useful for identifying
270 populations with needs and simultaneously surfacing gaps in community-level services. The
271 NCQA's new Health Equity Accreditation Plus designation, for example, emphasizes the
272 importance of using area-level and individually-reported data to inform social care interventions
273 and promote health equity.⁴² Some payors have also begun to use or have proposed using area-
274 level data in conjunction with individual-level social risks to create more equitable payment
275 models.^{43,44} For example, MassHealth has created an integrated model that combines area- and
276 individual-level risk data to increase reimbursement for managed care organizations that serve

277 patients with disproportionately higher social risks.¹⁵ CMS also has proposed incorporating ADI
278 data into their new Accountable Care Organization model, such that plans with dually eligible
279 members or members living with greater deprivation would receive increased funding to address
280 social and other health needs.⁴⁵

281

282 **Limitations**

283 These findings should be interpreted in light of their limitations. First, the study population was
284 comprised of a non-random sample. While the distribution of sociodemographic characteristics
285 was not meaningfully different from the survey-eligible sample, it is conceivable that the results
286 may have been impacted by selection and reporting bias given the low response rate and
287 moderate differences — particularly since there was no information regarding the target sample’s
288 social risks. Since the survey was only offered in English and Spanish, populations that spoke
289 other languages may also be under-reported. In addition, the demographic distribution of the
290 sample skewed older, Whiter, and more female than the US population.⁴⁶ While this provided an
291 opportunity to explore relationships between individual- and individual-level social risks in a
292 unique subset of the population, it limited the external generalizability of these findings. It is also
293 possible that potentially inaccurate, inadequate, or omitted address data— as well as margins of
294 error at the ACS census block group- and tract-level— may have led to measurement bias. Not
295 all area-deprivation indices were examined (notably absent are the NDI employed by Miller-
296 Rosales et al.¹⁹ and the Social Vulnerability Index), nor were all indicators of social conditions
297 (e.g., regional unemployment rates). Additionally, the performance of the area-level measures
298 may differ by neighborhood characteristics that are not captured in the study or data of current

299 area-level measures.

300

301 **Conclusions**

302 This study found that area-level deprivation data from a large MA population did not
303 consistently align with member-reported social risks. The consequences of relying on area-level
304 data as proxies for individual-level screening may span from drawing incorrect inferences in
305 social needs-related health services research to misdiagnosing and under-“treating” patients’
306 social needs. However, it is important to underscore that in many cases, survey results from an
307 engaged health care population are unlikely to reflect the prevalence of needs across a
308 geographic community, nor do they indicate whether there are sufficient health and social service
309 resources to effectively address social needs. In these cases, community deprivation indicators
310 are likely to provide greater value.

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459 **Figure Titles and Footnotes**

460 **Figure 1.** Sensitivity and specificity of area-level deprivation measures

461 SDI = Social Deprivation Index

462 Spec = Specificity

463 ADI = Area Deprivation Index

464 NSS = Neighborhood Stress Score

465 Sens = Sensitivity

466

467 **Figure 2.** Positive and negative predictive values of area-level deprivation measures

468 SDI = Social Deprivation Index

469 PPV = Positive Predictive Value

470 ADI = Area Deprivation Index

471 NSS = Neighborhood Stress Score

472 NPV = Positive Predictive Value

473 **Table 1.** Sociodemographic characteristics of the study population

Characteristic	Study Sample (n, %)
Female	45,127 (58)
Race	
White	56,584 (73)
Black	13,533 (17)
Other	2,814 (6)
Unknown	4,572 (4)
Age	
20-64	14,471 (19)
65-74	38,101 (49)
75-84	21,353 (28)
85+	3,578 (5)
Medicaid dual-eligible	15,606 (20)
English spoken at home ^a	66,898 (89)
Region	
Northeast	2,648 (3)
Midwest	17,446 (23)
South	47,151 (61)
West	10,258 (13)
Rurality	
Urban	48,640 (63)
Suburban	19,507 (25)
Rural	8,699 (11)
Unknown	657 (1)
Social Risks	
At least one social risk	42,937 (55)
Food insecurity, housing insecurity, or financial strain	35,579 (46)
Food, housing, or transportation insecurity	24,517 (32)
Food insecurity	20,124 (26)
Housing insecurity	5,894 (8)
Financial strain	31,570 (41)
Transportation insecurity	7,803 (10)
Utilities insecurity	8,422 (11)
Poor housing quality	16,026 (21)
Highest SDI quartile	19,364 (25)
Highest ADI quartile	24,292 (31)
Highest NSS quartile	15,427 (20)

474 *Note:* ADI = Area Deprivation Index; NSS = Neighborhood Stress Score; SDI = Social
475 Deprivation Index. Sample was drawn from Humana's Health-Related Social Needs Medicare
476 Advantage member survey (N=77,503). At least one social risk category corresponds to
477 affirmative responses to questions regarding food insecurity, housing insecurity, financial strain,

478 transportation insecurity, utilities insecurity, or poor housing quality.
479 ^a Missing 3% of values

480 **Table 2.** Agreement between area-level deprivation indicators and individual-level social risks

Social Risk	Social Deprivation Index (%)	Area Deprivation Index (%)	Neighborhood Stress Scale (%)
At least one social risk			
Agreement	53	54	53
Disagreement	47	46	47
Food insecurity, housing insecurity, or financial strain ^a			
Agreement	58	58	58
Disagreement	42	42	42
Food, housing, or transportation insecurity			
Agreement	65	62	67
Disagreement	35	38	33
Food insecurity			
Agreement	68	64	70
Disagreement	32	36	30
Housing insecurity			
Agreement	73	66	77
Disagreement	27	34	23
Financial strain			
Agreement	60	59	60
Disagreement	40	41	40
Transportation insecurity			
Agreement	73	67	77
Disagreement	27	33	23
Utilities insecurity			
Agreement	71	66	75
Disagreement	29	34	25
Poor housing quality			
Agreement	69	65	72
Disagreement	31	35	28

481 ^a Replication of analysis conducted by Cottrell et al (2020)

Figure 1

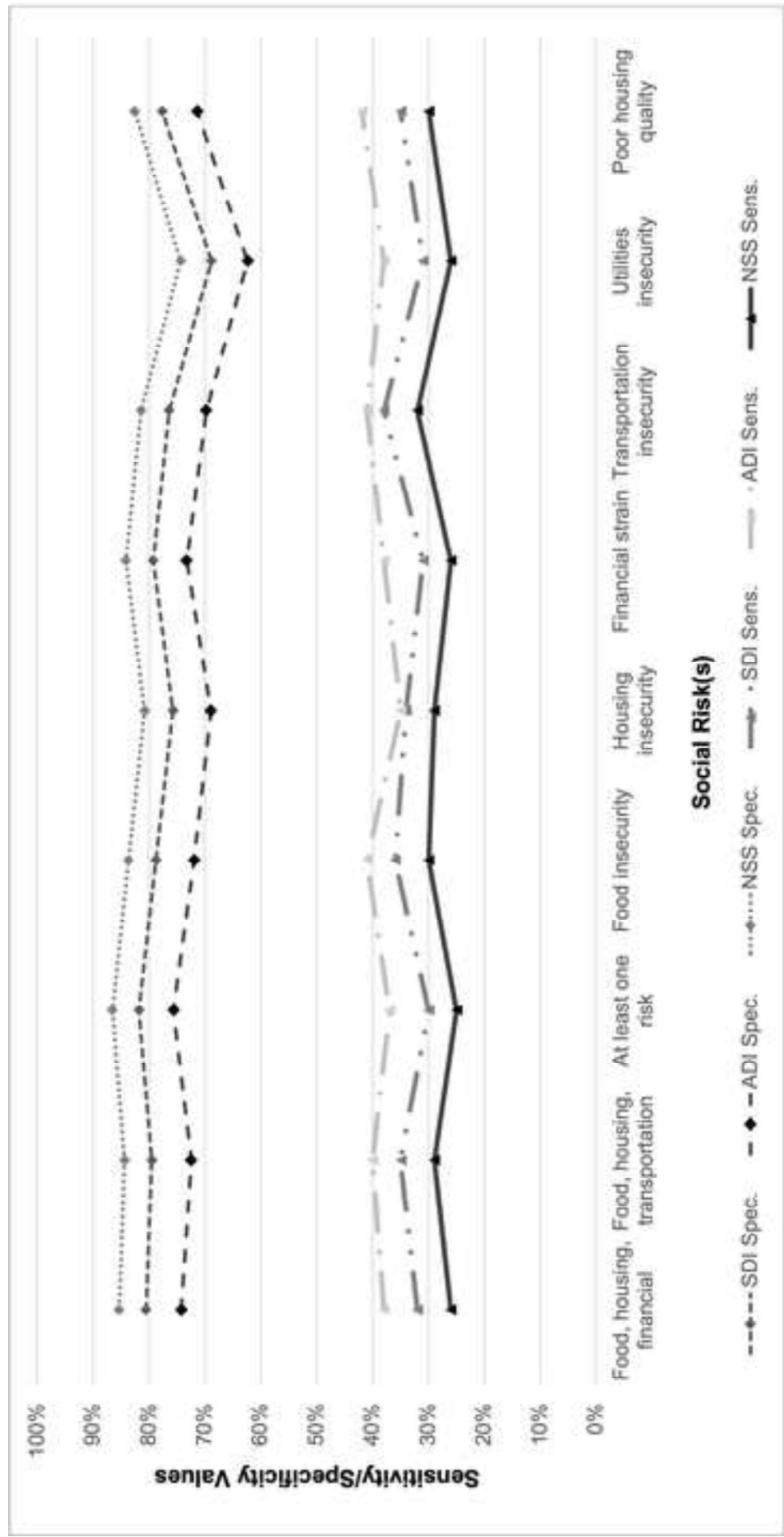
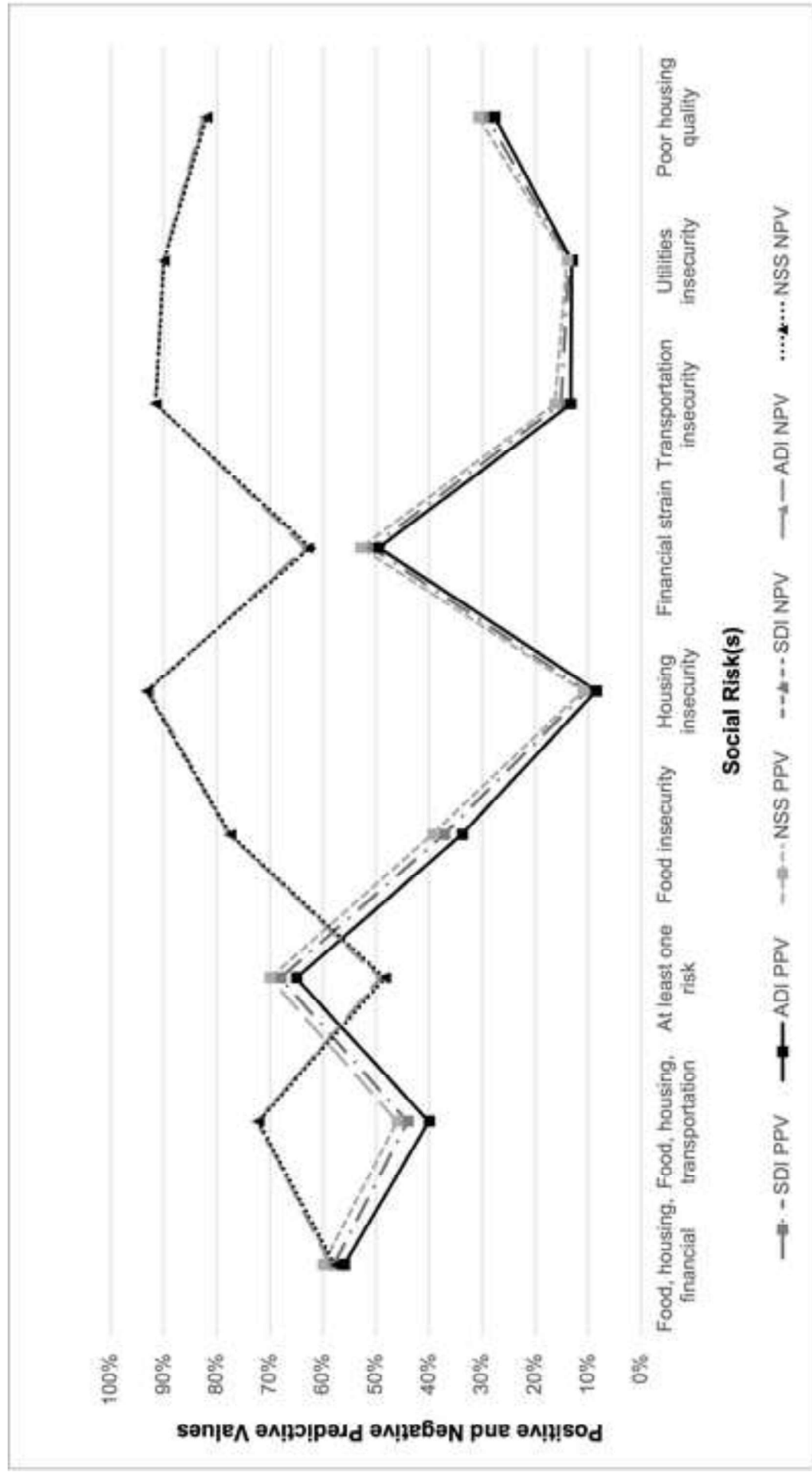


Figure 2

[Click here to access/download;Figure;Figure3.jpg](#)



Erika Brown: Conceptualization, Methodology, Formal analysis, Writing - Original Draft, review and editing. **Stephanie Franklin:** Methodology, Writing- Reviewing and Editing. **Jessica Ryan:** Methodology, Writing- Reviewing and Editing. **Melanie Canterbury:** Methodology, Writing- Reviewing and Editing. **Andy Bowe:** Project administration, formal analysis, Writing- Reviewing and Editing. **Matt Pantell:** Methodology, Writing- Reviewing and Editing. **Erika Cottrell,** Conceptualization, Writing- Reviewing and Editing. **Laura Gottlieb:** Conceptualization, Methodology, Writing- Reviewing and Editing, Supervision.

Assessing area-level deprivation as a proxy for individual-level social risks

American Journal of Preventive Medicine
Appendix Material

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Guide to Figures and Tables

Appendix Figure 1. Study population selection

Appendix Table 1. Adapted Accountable Health Communities tool included in the Humana Health Related Social Needs Survey

Appendix Table 2. Components of the Social Deprivation Index, Area Deprivation Index, and Neighborhood Stress Scale

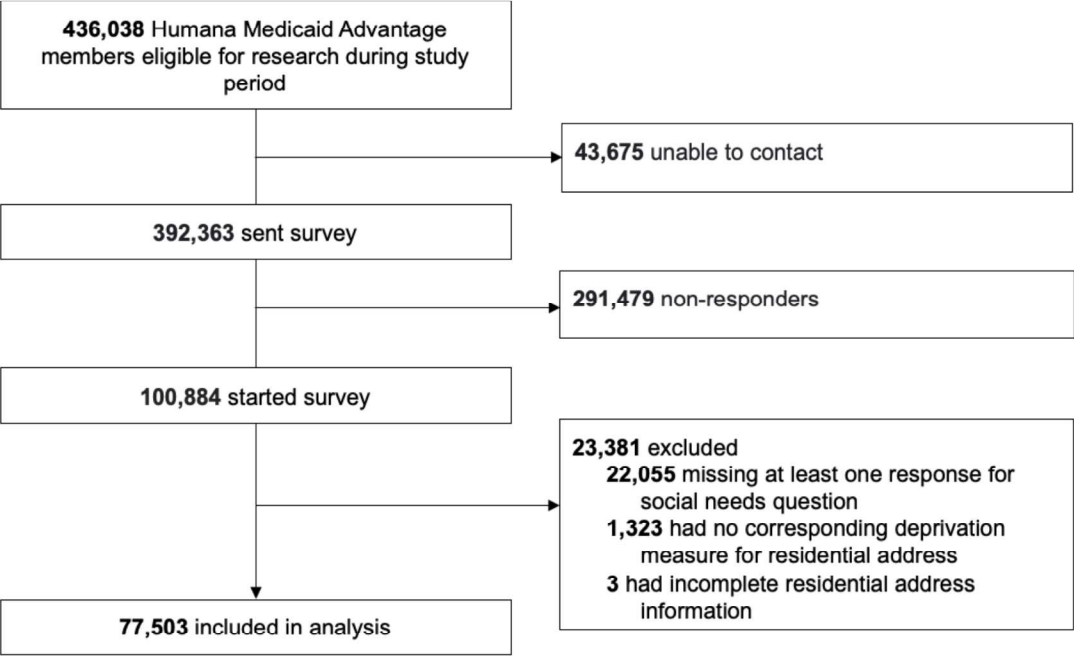
Appendix Table 3. Standardized proportional differences (SPD) between the analytic and survey-eligible populations

Appendix Table 4. Prevalence of social risks stratified by national quartiles of area-level deprivation indices

Appendix Table 5. Prevalence of social risks stratified by national quartiles of area-level deprivation indices and U.S. region

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Appendix Figure 1. Study population selection



Appendix Table 1. Adapted Accountable Health Communities tool included in the Humana Health Related Social Needs Survey

Domain	Question	Responses
Financial Strain	How hard is it for you to pay for the very basics like food, housing, medical care, and heating? Would you say it is:	<ul style="list-style-type: none"> • Not hard at all • Somewhat hard • Very hard
Food Insecurity	<p>Some people have made the following statements about their food situation. Please answer whether the statements were OFTEN, SOMETIMES, or NEVER true for you and your household in the last 12 months.</p> <p>Within the past 12 months, you worried that your food would run out before you got money to buy more.</p> <p>Within the past 12 months, the food you bought just didn't last and you didn't have money to get more.</p>	<ul style="list-style-type: none"> • Never true • Sometimes true (1 of 2 questions) • Sometimes true (both questions) • Sometimes or often true (both questions) • Often true (both questions)
Housing Insecurity	What is your living situation today?	<ul style="list-style-type: none"> • I have a steady place to live • I have a place to live but I am worried about losing it in the future • I do not have a steady place to live
Poor Housing Quality	Think about the place you live. Do you have problems with any of the following? CHOOSE ALL THAT APPLY.	<ul style="list-style-type: none"> • Pests such as bugs, ants, or mice • Mold • Lead paint or pipes • Lack of heat • Oven or stove not working • Smoke detectors missing or not working • Water leaks • None of the above • All of the above
Utility Insecurity	In the past 12 months has the electric, gas, oil, or water	<ul style="list-style-type: none"> • No • Yes

	company threatened to shut off services in your home?	<ul style="list-style-type: none"> • Already shut-off
Unreliable Transportation	In the past 12 months, has a lack of reliable transportation kept you from medical appointments, meetings, work or from getting things needed for daily living?	<ul style="list-style-type: none"> • No • Yes

Bolded answers indicate a positive response/need

Appendix Table 2. Components of the Social Deprivation Index, Area Deprivation Index, and Neighborhood Stress Scale

	Social Deprivation Index	Area Deprivation Index	Neighborhood Stress Scale
Income	<ul style="list-style-type: none"> • % living in poverty 	<ul style="list-style-type: none"> • Median family income • Income disparity • % below poverty level • % below 150 of poverty level 	<ul style="list-style-type: none"> • % below poverty level • % below 200 poverty level
Education	<ul style="list-style-type: none"> • % with less than 12 years of education 	<ul style="list-style-type: none"> • % with <9 years of education • % with at least a high school diploma 	<ul style="list-style-type: none"> • % of people age 25 or older who have no high school degree
Employment	<ul style="list-style-type: none"> • % of non-employed adults younger than 65 years 	<ul style="list-style-type: none"> • % employed in a white-collar occupation • Unemployment rate 	<ul style="list-style-type: none"> • % of non-employed adults
Housing	<ul style="list-style-type: none"> • % living in a rented housing unit • % living in an overcrowded housing unit 	<ul style="list-style-type: none"> • Median home value • Median gross rent • Median monthly mortgage • Home ownership rate • % of housing units with more than one person per room 	N/A
Household composition	<ul style="list-style-type: none"> • % single-parent households with children <18 years of age 	<ul style="list-style-type: none"> • % single-parent households with children <18 years of age 	<ul style="list-style-type: none"> • % of households with a single-parent and children <18 years of age
Household resources	<ul style="list-style-type: none"> • % of households without a motor vehicle 	<ul style="list-style-type: none"> • % without a motor vehicle • % without a telephone • % without complete plumbing 	<ul style="list-style-type: none"> • % of households without a car
Public Assistance	N/A	N/A	<ul style="list-style-type: none"> • % of households receiving public assistance

Data derived from the American Community Survey

Appendix Table 3. Standardized proportional differences (SPD) between the analytic and survey-eligible populations

Characteristic	Study Sample (N, %)	Total Sample (N, %)	SPD
Female	45,127 (58)	240,784 (55)	0.06
Race			
White	56,584 (73)	315,459 (72)	0.01
Black	13,533 (18)	73,598 (17)	0.02
Other	2,814 (4)	22,457 (5)	0.07
Unknown	4,572 (6)	24,524 (6)	0.01
Age			
20-64	14,471 (19)	88,781 (20)	0.04
65-74	38,101 (50)	206,049 (47)	0.04
75-84	21,353 (28)	117,566 (27)	0.01
85+	3,578 (5)	23,642 (5)	0.04
Dual-Medicaid eligible	15,606 (20)	91,921 (21)	0.02
Region			
Northeast	2,648 (34)	16,424 (38)	0.07
Midwest	17,446 (23)	94,858 (22)	0.02
South	47,151 (61)	267,529 (61)	0.01
West	10,258 (13)	57,227 (13)	<0.01
Rurality			
Urban	48,640 (63)	271,923 (62)	0.02
Suburban	19,507 (25)	109,787 (25)	<0.01
Rural	8,699 (11)	50,592 (12)	0.04
Unknown	657 (1)	3,736 (1)	0.01
Highest SDI quartile	19,364 (25)	118,244 ^a (27)	0.12
Highest ADI quartile	24,292 (31)	134,213 ^b (31)	<0.01
Highest NSS quartile	15,427 (20)	90,019 ^c (21)	0.05

Note: SPD = Standardized Proportional Difference. At least one social risk category corresponds to affirmative responses to questions regarding food insecurity, housing insecurity, financial strain, transportation insecurity, utilities insecurity, or poor housing quality. This table does not include “English spoken at home” because that information was not available for non-survey respondents.

^b Missing 4,024 observations

^c Missing 7,561 observations

^d Missing 160 observations

Appendix Table 4. Prevalence of social risks stratified by national quartiles of area-level deprivation indices

	Social Deprivation Index (N, row %, col %)		Area Deprivation Index (N, row %, col %)		Neighborhood Stress Scale (N, row %, col %)	
	Low	High	Low	High	Low	High
At least one social risk						
No	28,288 (82)(49)	6,278 (18)(32)	26,140 (76)(49)	8,426 (24)(35)	29,918 (87)(48)	4,648 (13)(30)
Yes	29,851 (70)(51)	13,086 (30)(68)	27,071 (63)(51)	15,866 (37)(65)	32,158 (75)(52)	10,779 (25)(70)
Food insecurity, housing insecurity, financial strain						
No	33,779 (81)(58)	8,145 (19)(42)	31,132 (74)(59)	10,792 (26)(44)	35,796 (85)(58)	6,128 (15)(40)
Yes	24,360 (68)(42)	11,219 (32)(58)	22,079 (62)(41)	13,500 (38)(56)	26,280 (74)(42)	9,299 (26)(60)
Food, housing, or transportation insecurity						
No	4,2137 (80)(72)	10,849 (20)(56)	38,388 (72)(72)	14,598 (28)(60)	44,724 (84)(72)	8,262 (16)(54)
Yes	16,002 (65)(28)	8,515 (35)(44)	14,823 (60)(28)	9,694 (40)(40)	17,352 (71)(28)	7,165 (29)(46)
Food insecurity						
No	45,210 (79)(78)	12,169 (21)(63)	41,292 (72)(78)	16,087 (28)(66)	48,025 (84)(77)	9,354 (16)(61)
Yes	12,929 (64)(22)	7,195 (36)(37)	11,919 (59)(22)	8,205 (41)(34)	14,051 (70)(23)	6,073 (30)(39)
Housing insecurity						
No	54,232 (76)(93)	17,377 (24)(90)	49,375 (69)(93)	22,234 (31)(92)	57,875 (81)(93)	13,734 (19)(89)
Yes	3,907 (66)(7)	1,987 (34)(10)	3,836 (65)(7)	2,058 (35)(8)	4,201 (71)(7)	1,693 (29)(11)
Financial						
No	36,424 (79)(63)	9,509 (21)(49)	3,663 (73)(63)	12,270 (27)(51)	38,663 (84)(62)	7,270 (16)(47)
Yes	2,1715 (69)(37)	9,855 (31)(51)	19,548 (62)(37)	12,022 (38)(49)	23,413 (74)(38)	8,157 (26)(53)
Transportation						

No	53,273 (76)(92)	16,427 (24)(85)	48,641 (70)(91)	21,059 (30)(87)	56,783 (81)(91)	12,917 (19)(84)
Yes	4,866 (62)(8)	2,937 (38)(15)	4,570 (59)(9)	3,233 (41)(13)	5,293 (68)(9)	2,510 (32)(16)
Utilities						
No	52,340 (76)(90)	16,741(24) (86)	47,959 (69)(90)	21,122 (31)(87)	55,813 (81)(90)	13,268 (19)(86)
Yes	5,799 (69)(10)	2,623 (31)(14)	5,252 (62)(10)	3,170 (38)(13)	6,263 (74)(10)	21,59 (26)(14)
Housing quality						
No	47,740 (78)(82)	13,737 (22)(71)	43,892 (71)(82)	17,585 (29)(72)	50,783 (83)(82)	10,694 (17)(69)
Yes	10,399 (65)(18)	5,627 (35)(29)	9,319 (58)(18)	6,707 (42)(28)	11,293 (70)(18)	4,733 (30)(31)

Note: Sample was drawn from Humana’s Accountable Health Communities Health-related Social Needs Medicare Advantage member survey participants (N=77,503). Low corresponds to 1st-74th percentile of each index; high corresponds to 75th percentile or higher. At least one social risk category corresponds to affirmative responses to questions regarding food insecurity, housing insecurity, financial strain, transportation insecurity, utilities insecurity, or poor housing quality.

Appendix Table 5. Prevalence of social risks stratified by national quartiles of area-level deprivation indices and U.S. region

	Social Deprivation Index (N, row %, col %)		Area Deprivation Index (N, row %, col %)		Neighborhood Stress Scale (N, row %, col %)	
	Low	High	Low	High	Low	High
Northeast	N=2,047	N=601	N=2,028	N=620	N=2,080	N=568
At least one social risk						
No	886 (84)(43)	165 (16)(27)	854 (81)(42)	197 (19)(32)	899 (86)(43)	152 (14)(27)
Yes	1,161 (73)(57)	436 (27)(73)	1,174 (74)(58)	423 (26)(68)	1,181 (74)(57)	416 (26)(73)
Food insecurity, housing insecurity, financial strain						
No	1,052 (83)(51)	217 (17)(36)	1,011 (80)(50)	258 (20)(42)	1,071 (84)(51)	198 (16)(35)
Yes	995 (72)(49)	384 (28)(64)	1,017 (74)(50)	362 (26)(58)	1,009 (73)(49)	370 (27)(65)
Food, housing, or transportation insecurity						
No	1,409 (83)(69)	291 (17)(48)	1,343 (79)(66)	357 (21)(58)	1,433 (84)(69)	267 (16)(47)
Yes	638 (67)(31)	310 (33)(52)	685 (72)(34)	263 (28)(42)	647 (68)(31)	301 (32)(53)
Food insecurity						
No	1,533 (82)(75)	347 (18)(58)	1,471 (78)(73)	409 (22)(66)	1,560 (83)(75)	320 (17)(56)
Yes	514 (67)(25)	254 (33)(42)	557 (73)(27)	211 (27)(34)	520 (68)(25)	248 (32)(44)
Housing insecurity						
No	1,876 (79)(92)	506 (21)(84)	1,829 (77)(90)	553 (23)(89)	1,897 (80)(91)	485 (20)(85)
Yes	171 (64)(8)	95 (36)(16)	199 (75)(10)	67 (25)(11)	183 (69)(9)	83 (31)(15)
Financial						
No	1,150 (81)(56)	263 (19)(44)	1,108 (78)(55)	305 (22)(49)	1,167 (83)(56)	246 (17)(43)
Yes	897 (73)(44)	338 (27)(56)	920 (74)(45)	315 (26)(51)	913 (74)(44)	322 (26)(57)
Transportation						

No	1,843 (79)(90)	482 (21)(80)	1,804 (78)(89)	521 (22)(84)	1,871 (80)(90)	454 (20)(80)
Yes	204 (63)(10)	119 (37)(20)	224 (69)(11)	99 (31)(16)	209 (65)(10)	114 (35)(20)
Utilities						
No	1,819 (78)(89)	502 (22)(84)	1,796 (77)(89)	525 (23)(85)	1,838 (79)(88)	483 (21)(85)
Yes	228 (70)(11)	99 (30)(16)	232 (71)(11)	95 (29)(15)	242 (74)(12)	85 (26)(15)
Housing quality						
No	1,685 (81)(82)	404 (19)(67)	1,648 (79)(81)	441 (21)(71)	1,716 (82)(82)	373 (18)(66)
Yes	362 (65)(18)	197 (35)(33)	380 (68)(19)	179 (32)(29)	364 (65)(18)	195 (35)(34)
Midwest	N=1,3706	N=3,740	N=11,592	N=5,854	N=14,349	N=3,097
At least one social risk						
No	7,185 (85)(52)	1,262 (15)(34)	6,252 (74)(54)	2,195 (26)(37)	7,470 (88)(52)	977 (12)(32)
Yes	6,521 (72)(48)	2,478 (28)(66)	5,340 (59)(46)	3,659 (41)(63)	6,879 (76)(48)	2,120 (24)(68)
Food insecurity, housing insecurity, financial strain						
No	8,530 (84)(62)	1,630 (16)(44)	7,404 (73)(64)	2,756 (27)(47)	8,869 (87)(62)	1,291 (13)(42)
Yes	5,176 (71)(38)	2,110 (29)(56)	4,188 (57)(36)	3,098 (43)(53)	5,480 (75)(38)	1,806 (25)(58)
Food, housing, or transportation insecurity						
No	10,422 (83)(76)	2,181 (17)(58)	8,901 (71)(77)	3,702 (29)(63)	10,898 (86)(76)	1,705 (14)(55)
Yes	3,284 (68)(24)	1,559 (32)(42)	2,691 (56)(23)	2,152 (44)(37)	3,451 (71)(24)	1,392 (29)(45)
Food insecurity						
No	11,082 (82)(81)	2,451 (18)(66)	9,496 (70)(82)	4,037 (30)(69)	11,603 (86)(81)	1,930 (14)(62)
Yes	2,624 (67)(19)	1,289 (33)(34)	2,096 (54)(18)	1,817 (46)(31)	2,746 (70)(19)	1,167 (30)(38)
Housing insecurity						
No	12,966 (79)(95)	3,409 (21)(91)	10,945 (67)(94)	5,430 (33)(93)	13,567 (83)(95)	2,808 (17)(91)

Yes	740 (69)(5)	331 (31)(9)	647 (60)(6)	424 (40)(7)	782 (73)(5)	289 (27)(9)
Financial						
No	9,112 (83)(66)	1,862 (17)(50)	7,898 (72)(68)	3,076 (28)(53)	9,487 (86)(66)	1,487 (14)(48)
Yes	4,594 (71)(34)	1,878 (29)(50)	3,694 (57)(32)	2,778 (43)(47)	4,862 (75)(34)	1,610 (25)(52)
Transportation						
No	12,665 (80)(92)	3,175 (20)(85)	10,729 (68)(93)	5,111 (32)(87)	13,243 (84)(92)	2,597 (16)(84)
Yes	1,041 (65)(8)	565 (35)(15)	863 (54)(7)	743 (46)(13)	1,106 (69)(8)	500 (31)(16)
Utilities						
No	1,2411 (79)(91)	3,227 (21)(86)	10,534 (67)(91)	5,104 (33)(87)	12,989 (83)(91)	2,649 (17)(86)
Yes	1,295 (72)(9)	513 (28)(14)	1,058 (59)(9)	750 (41)(13)	1,360 (75)(9)	448 (25)(14)
Housing quality						
No	11,572 (81)(84)	2,760 (19)(74)	9,906 (69)(85)	4,426 (31)(76)	12,103 (84)(84)	2,229 (16)(72)
Yes	2,134 (69)(16)	980 (31)(26)	1,686 (54)(15)	1,428 (46)(24)	2,246 (72)(16)	868 (28)(28)
South	N=34,631	N=12,520	N=30,493	N=16,658	N=37,058	N=10,093
At least one social risk						
No	16,181 (80)(47)	3,928 (20)(31)	14,504 (72)(48)	5,605 (28)(34)	17,163 (85)(46)	2,946 (15)(29)
Yes	18,450 (68)(53)	8,592 (32)(69)	15,989 (59)(52)	11,053 (41)(66)	19,895 (74)(54)	7,147 (26)(71)
Food insecurity, housing insecurity, financial strain						
No	19,448 (79)(56)	5,147 (21)(41)	17,366 (71)(57)	7,229 (29)(43)	20,679 (84)(56)	3,916 (16)(39)
Yes	15,183 (67)(44)	7,373 (33)(59)	13,127 (58)(43)	9,429 (42)(57)	16,379 (73)(44)	6,177 (27)(61)
Food, housing, or transportation insecurity						
No	24,506 (78)(71)	6,905 (22)(55)	21,614 (69)(71)	9,797 (31)(59)	26,059 (83)(70)	5,352 (17)(53)
Yes	10,125 (64)(29)	5,615 (36)(45)	8,879 (56)(29)	6,861 (44)(41)	10,999 (70)(30)	4,741 (30)(47)
Food insecurity						

No	26,334 (77)(76)	7,728 (23)(62)	23,243 (68)(76)	10,819 (32)(65)	28,016 (82)(76)	6,046 (18)(60)
Yes	8,297 (63)(24)	4,792 (37)(38)	7,250 (55)(24)	5,839 (45)(35)	9,042 (69)(24)	4,047 (31)(40)
Housing insecurity						
No	32,194 (74)(93)	11,251 (26)(90)	28,237 (65)(93)	15,208 (35)(91)	34,471 (79)(93)	8,974 (21)(89)
Yes	2,437 (66)(7)	1,269 (34)(10)	2,256 (61)(7)	1,450 (39)(9)	2,587 (70)(7)	1,119 (30)(11)
Financial						
No	21,070 (78)(61)	6,059 (22)(48)	18,840 (69)(62)	8,289 (31)(50)	22,438 (83)(61)	4,691 (17)(46)
Yes	13,561 (68)(39)	6,461 (32)(52)	11,653 (58)(38)	8,369 (42)(50)	14,620 (73)(39)	5,402 (27)(54)
Transportation						
No	31,610 (75)(91)	10,613 (25)(85)	27,816 (66)(91)	14,407 (34)(86)	33,770 (80)(91)	8,453 (20)(84)
Yes	3,021 (61)(9)	1,907 (39)(15)	2,677 (54)(9)	2,251 (46)(14)	3,288 (67)(9)	1,640 (33)(16)
Utilities						
No	31,042 (74)(90)	10,805 (26)(86)	27,386 (65)(90)	14,461 (35)(87)	33,191 (79)(90)	8,656 (21)(86)
Yes	3,589 (68)(10)	1,715 (32)(14)	3,107 (59)(10)	2,197 (41)(13)	3,867 (73)(10)	1,437 (27)(14)
Housing quality						
No	27,884 (76)(81)	8,691 (24)(69)	24,734 (68)(81)	11,841 (32)(71)	29,711 (81)(80)	6,864 (19)(68)
Yes	6,747 (64)(19)	3,829 (36)(31)	5,759 (54)(19)	4,817 (46)(29)	7,347 (69)(20)	3,229 (31)(32)
West	N=7,755	N=2,503	N=9,098	N=1,160	N=8,589	N=1,669
At least one social risk						
No	4,036 (81)(52)	923 (19)(37)	4,530 (91)(50)	429 (9)(37)	4,386 (88)(51)	573 (12)(34)
Yes	3,719 (70)(48)	1,580 (30)(63)	4,568 (86)(50)	731 (14)(63)	4,203 (79)(49)	1,096 (21)(66)
Food insecurity, housing insecurity, financial strain						
No	4,749 (80)(61)	1,151 (20)(46)	5,351 (91)(59)	549 (9)(47)	5,177 (88)(60)	723 (12)(43)
Yes	3,006 (69)(39)	1,352 (31)(54)	3,747 (86)(41)	611 (14)(53)	3,412 (78)(40)	946 (22)(57)

Food, housing, or transportation insecurity						
No	5,800 (80)(75)	1,472 (20)(59)	6,530 (90)(72)	742 (10)(64)	6,334 (87)(74)	938 (13)(56)
Yes	1,955 (65)(25)	1,031 (35)(41)	2,568 (86)(28)	418 (14)(36)	2,255 (76)(26)	731 (24)(44)
Food insecurity						
No	6,261 (79)(81)	1,643 (21)(66)	7,082 (90)(78)	822 (10)(71)	6,846 (87)(80)	1,058 (13)(63)
Yes	1,494 (63)(19)	860 (37)(34)	2,016 (86)(22)	338 (14)(29)	1,743 (74)(20)	611 (26)(37)
Housing insecurity						
No	7,196 (76)(93)	2,211 (24)(88)	8,364 (89)(92)	1,043 (11)(90)	7,940 (84)(92)	1,467 (16)(88)
Yes	559 (66)(7)	292 (34)(12)	734 (86)(8)	117 (14)(10)	649 (76)(8)	202 (24)(12)
Financial						
No	5,092 (79)(66)	1,325 (21)(53)	5,817 (91)(64)	600 (9)(52)	5,571 (87)(65)	846 (13)(51)
Yes	2,663 (69)(34)	1,178 (31)(47)	3,281 (85)(36)	560 (15)(48)	3018 (79)(35)	823 (21)(49)
Transportation						
No	7,155 (77)(92)	2,157 (23)(86)	8,292 (89)(91)	1,020 (11)(88)	7,899 (85)(92)	1,413 (15)(85)
Yes	600 (63)(8)	346 (37)(14)	806 (85)(9)	140 (15)(12)	690 (73)(8)	256 (27)(15)
Utilities						
No	7,068 (76)(91)	2,207 (24)(88)	8,243 (89)(91)	1,032 (11)(89)	7,795 (84)(91)	1,480 (16)(89)
Yes	687 (70)(9)	296 (30)(12)	855 (87)(9)	128 (13)(11)	794 (81)(9)	189 (19)(11)
Housing quality						
No	6,599 (78)(85)	1,882 (22)(75)	7,604 (90)(84)	877 (10)(76)	7,253 (86)(84)	1,228 (14)(74)
Yes	1,156 (65)(15)	621 (35)(25)	1,494 (84)(16)	283 (16)(24)	1,336 (75)(16)	441 (25)(26)

Note: Sample was drawn from Humana’s Accountable Health Communities Health-related Social Needs Medicare Advantage member survey participants (N=77,503). Low corresponds to 1st-74th percentile of each index; high corresponds to 75th percentile or higher. U.S. region was determined in accordance with the U.S. Census definition. At least one social risk category corresponds to affirmative responses to questions regarding food insecurity, housing insecurity, financial strain, transportation insecurity, utilities insecurity, or poor housing quality.

Appendix Table 6. Prevalence of social risks stratified by national quartiles of area-level deprivation indices and rurality

	Social Deprivation Index (N, row %, col %)		Area Deprivation Index (N, row %, col %)		Neighborhood Stress Scale (N, row %, col %)	
	Low	High	Low	High	Low	High
Urban	N=34,486	N=14,154	N=35,493	N=13,147	N=37,550	N=11,090
At least one social risk						
No	17,466 (79)(51)	4,540 (21)(32)	17,561 (80)(49)	4,445 (20)(34)	18,698 (85)(50)	3,308 (15)(30)
Yes	17,020 (64)(49)	9,614 (36)(68)	17,932 (67)(51)	8,702 (33)(66)	18,852 (71)(50)	7,782 (29)(70)
Food insecurity, housing insecurity, financial strain						
No	20,700 (78)(60)	5,902 (22)(42)	20,880 (78)(59)	5,722 (22)(44)	22,226 (84)(59)	4,376 (16)(39)
Yes	13,786 (63)(40)	8,252 (37)(58)	14,613 (66)(41)	7,425 (34)(56)	15,324 (70)(41)	6,714 (30)(61)
Food, housing, or transportation insecurity						
No	2,5218 (76)(73)	7,812 (24)(55)	25,440 (77)(72)	7,590 (23)(58)	27,207 (82)(72)	5,823 (18)(53)
Yes	9,268 (59)(27)	6,342 (41)(45)	10,053 (64)(28)	5,557 (36)(42)	10,343 (66)(28)	5,267 (34)(47)
Food insecurity						
No	27,093 (75)(79)	8,798 (25)(62)	27,458 (77)(77)	8,433 (23)(64)	29,258 (82)(78)	6,633 (18)(60)
Yes	7,393 (58)(21)	5,356 (42)(38)	8,035 (63)(23)	4,714 (37)(36)	8,292 (65)(22)	4,457 (35)(40)
Housing insecurity						
No	32,062 (72)(93)	12598 (28)(89)	32,748 (73)(92)	11,912 (27)(91)	34,875 (78)(93)	9,785 (22)(88)
Yes	2,424 (61)(7)	1,556 (39)(11)	2,745 (69)(8)	1,235 (31)(9)	2,675 (67)(7)	1,305 (33)(12)
Financial						
No	22,258 (76)(65)	6,954 (24)(49)	22,616 (77)(64)	6,596 (23)(50)	23,972 (82)(64)	5,240 (18)(47)
Yes	12,228 (63)(35)	7,200 (37)(51)	12,877 (66)(36)	6,551 (34)(50)	13,578 (70)(36)	5,850 (30)(53)
Transportation						

No	31,609 (73)(92)	11,943 (27)(84)	32,321 (74)(91)	11,231 (26)(85)	34,332 (79)(91)	9,220 (21)(83)
Yes	2,877 (57)(8)	2,211 (43)(16)	3,172 (62)(9)	1,916 (38)(15)	3,218 (63)(9)	1,870 (37)(17)
Utilities						
No	31,165 (72)(90)	12,199 (28)(86)	31,989 (74)(90)	11,375 (26)(87)	33,850 (78)(90)	9,514 (22)(86)
Yes	3,321 (63)(10)	1,955 (37)(14)	3,504 (66)(10)	1772 (34)(13)	3,700 (70)(10)	1,576 (30)(14)
Housing quality						
No	28,926 (74)(84)	10,008 (26)(71)	29,465 (76)(83)	9,469 (24)(72)	31,264 (80)(83)	7,670 (20)(69)
Yes	5,560 (57)(16)	4,146 (43)(29)	6,028 (62)(17)	3,678 (38)(28)	6,286 (65)(17)	3,420 (35)(31)
Suburban	N=16,062	N=3,445	N=13,018	N=6,489	N=16,858	N=2,649
At least one social risk						
No	7,566 (87)(47)	1,164 (13)(34)	6,373 (73)(49)	2,357 (27)(36)	7,888 (90)(47)	842 (10)(32)
Yes	8,496 (79)(53)	2,281 (21)(66)	6,645 (62)(51)	4,132 (38)(64)	8,970 (83)(53)	1,807 (17)(68)
Food insecurity, housing insecurity, financial strain						
No	9,117 (86)(57)	1,506 (14)(44)	7,621 (72)(59)	3,002 (28)(46)	9,524 (90)(56)	1,099 (10)(41)
Yes	6,945 (78)(43)	1,939 (22)(56)	5,397 (61)(41)	3,487 (39)(54)	7,334 (83)(44)	1,550 (17)(59)
Food, housing, or transportation insecurity						
No	11,635 (85)(72)	2,004 (15)(58)	9,557 (70)(73)	4,082 (30)(63)	12,150 (89)(72)	1,489 (11)(56)
Yes	4,427 (75)(28)	1,441 (25)(42)	3,461 (59)(27)	2,407 (41)(37)	4,708 (80)(28)	1,160 (20)(44)
Food insecurity						
No	12,453 (85)(78)	2,227 (15)(65)	10,212 (70)(78)	4,468 (30)(69)	13,015 (89)(77)	1,665 (11)(63)
Yes	3,609 (75)(22)	1,218 (25)(35)	2,806 (58)(22)	2,021 (42)(31)	3,843 (80)(23)	984 (20)(37)
Housing insecurity						
No	15,076 (83)(94)	3,170 (17)(92)	12,227 (67)(94)	6,019 (33)(93)	15,825 (87)(94)	2,421 (13)(91)

Yes	986 (78)(6)	275 (22)(8)	791 (63)(6)	470 (37)(7)	1,033 (82)(6)	228 (18)(9)
Financial						
No	9,833 (85)(61)	1,730 (15)(50)	8,190 (71)(63)	3,373 (29)(52)	10,279 (89)(61)	1,284 (11)(48)
Yes	6,229 (78)(39)	1,715 (22)(50)	4,828 (61)(37)	3,116 (39)(48)	6,579 (83)(39)	1,365 (17)(52)
Transportation						
No	1,4749 (83)(92)	2,975 (17)(86)	11,996 (68)(92)	5,728 (32)(88)	15,460 (87)(92)	2,264 (13)(85)
Yes	1,313 (74)(8)	470 (26)(14)	1,022 (57)(8)	761 (43)(12)	1,398 (78)(8)	385 (22)(15)
Utilities						
No	14,383 (83)(90)	2,979 (17)(86)	11,721 (68)(90)	5,641 (32)(87)	15,087 (87)(89)	2,275 (13)(86)
Yes	1,679 (78)(10)	466 (22)(14)	1,297 (60)(10)	848 (40)(13)	1,771 (83)(11)	374 (17)(14)
Housing quality						
No	12,884 (84)(80)	2,483 (16)(72)	10,609 (69)(81)	4,758 (31)(73)	13,511 (88)(80)	1,856 (12)(70)
Yes	3,178 (77)(20)	962 (23)(28)	2,409 (58)(19)	1,731 (42)(27)	3,347 (81)(20)	793 (19)(30)
Rural	N=7,018	N=1,681	N=4,110	N=4,589	N=7,061	N=1,638
At least one social risk						
No	2,947 (84)(42)	548 (16)(33)	1,902 (54)(46)	1,593 (46)(35)	3,014 (86)(43)	481 (14)(29)
Yes	4,071 (78)(58)	1,133 (22)(67)	2,208 (42)(54)	2,996 (58)(65)	4,047 (78)(57)	1,157 (22)(71)
Food insecurity, housing insecurity, financial strain						
No	3,607 (84)(51)	703 (16)(42)	2,281 (53)(55)	2,029 (47)(44)	3,676 (85)(52)	634 (15)(39)
Yes	3,411 (78)(49)	978 (22)(58)	1,829 (42)(45)	2,560 (58)(56)	3,385 (77)(48)	1,004 (23)(61)
Food, housing, or transportation insecurity						
No	4,854 (83)(69)	986 (17)(59)	2,962 (51)(72)	2,878 (49)(63)	4,917 (84)(70)	923 (16)(56)
Yes	2,164 (76)(31)	695 (24)(41)	1,148 (40)(28)	1,711 (60)(37)	2,144 (75)(30)	715 (25)(44)
Food insecurity						

No	5,196 (83)(74)	1,086 (17)(65)	3,150 (50)(77)	3,132 (50)(68)	5,258 (84)(74)	1,024 (16)(63)
Yes	1,822 (75)(26)	595 (25)(35)	960 (40)(23)	1,457 (60)(32)	1,803 (75)(26)	614 (25)(37)
Housing insecurity						
No	6,563 (81)(94)	1,536 (19)(91)	3,860 (48)(94)	4,239 (52)(92)	6,617 (82)(94)	1,482 (18)(90)
Yes	455 (76)(6)	145 (24)(9)	250 (42)(6)	350 (58)(8)	444 (74)(6)	156 (26)(10)
Financial						
No	3,952 (83)(56)	786 (17)(47)	2,477 (52)(60)	2,261 (48)(49)	4,015 (85)(57)	723 (15)(44)
Yes	3,066 (77)(44)	895 (23)(53)	1,633 (41)(40)	2,328 (59)(51)	3,046 (77)(43)	915 (23)(56)
Transportation						
No	6,385 (82)(91)	1,436 (18)(85)	3,783 (48)(92)	4,038 (52)(88)	6,431 (82)(91)	1,390 (18)(85)
Yes	633 (72)(9)	245 (28)(15)	327 (37)(8)	551 (63)(12)	630 (72)(9)	248 (28)(15)
Utilities						
No	6,258 (81)(89)	1,486 (19)(88)	3,701 (48)(90)	4,043 (52)(88)	6,312 (82)(89)	1,432 (18)(87)
Yes	760 (80)(11)	195 (20)(12)	409 (43)(10)	546 (57)(12)	749 (78)(11)	206 (22)(13)
Housing quality						
No	5,431 (82)(77)	1,180 (18)(70)	3,304 (50)(80)	3,307 (50)(72)	5,485 (83)(78)	1,126 (17)(69)
Yes	1,587 (76)(23)	501 (24)(30)	806 (39)(20)	1,282 (61)(28)	1,576 (75)(22)	512 (25)(31)

Note: Sample was drawn from Humana’s Accountable Health Communities Health-Related Social Needs Medicare Advantage survey participants and restricted to those with complete information regarding residence rurality (N= 76,846). Low corresponds to 1st-74th percentile of each index; high corresponds to 75th percentile or higher. Rurality was determined by U.S. Census tract rural-urban commuting area codes. At least one social risk category corresponds to affirmative responses to questions regarding food insecurity, housing insecurity, financial strain, transportation insecurity, utilities insecurity, or poor housing quality.