

Appendix B. Data and Methodology

This report uses data for active, doctoral-level psychologists (as defined by license type and license status for each state) obtained from state licensing boards from the 50 states and the District of Columbia. Records of psychologists were from 2012 to 2015, depending on the most recent state licensing board lists available. Forty-two out of the 51 lists were from 2014 or 2015.

Psychologists were first de-duplicated based on their records from the state licensing boards. Two records of licensed psychologists were regarded as duplicates when records had

- a) Exact match of names (first names and last names),
and
- b) Exact match of email addresses, zip codes, addresses (street numbers, street names, *and* city names), *or* phone numbers.

In case of misspelled names, records were also de-duplicated based on the exact match of email addresses and *approximate* match of names.⁹

Records of licensed psychologists were then linked to counties through zip codes, and aggregated and counted at the county level.

The addresses provided by the state licensing boards were not necessarily the practicing addresses of the psychologists, but could be their *home addresses*. It is unclear what proportion of licensed psychologists reported home addresses instead of practicing addresses. However, the inclusion of home addresses can only minimally affect the analysis given the usual geographic proximity between one's work location and home location.

The numbers of records from all states are listed in Table 3.

9. Exact match refers to cases where specific fields of records were exactly the same. Approximate match refers to cases where fields of records were 80 percent similar.

Table 3. Number of Records of Licensed Psychologists by State, 2012-2015

State	Number of Records with Zip Codes	Number of Records with Missing Zip Codes	Total Number of Records
AK	195	-	195
AL	733	-	733
AR	481	2	483
AZ	1,532	2	1,534
CA	12,851	5	12,856
CO	2,290	253	2,543
CT	1,906	3	1,909
DC	971	27	998
DE	315	-	315
FL	4,756	19	4,775
GA	2,290	-	2,290
HI	N/A*	N/A	665
IA	539	1	540
ID	257	-	257
IL	4,596	-	4,596
IN	1,418	-	1,418
KS	736	1	737
KY	946	-	946
LA	638	-	638
MA	5,120	7	5,127
MD	2,872	20	2,892
ME	600	2	602
MI	2,705	-	2,705
MN	3,639	16	3,655
MO	1,641	2	1,643
MS	363	-	363
MT	249	-	249
NC	3,642	1	3,643
ND	225	-	225
NE	603	1	604
NH	610	3	613
NJ	3,941	76	4,017
NM	649	-	649
NV	441	1	442
NY	10,661	530	11,191
OH	3,494	5	3,499
OK	N/A	N/A	576
OR	1,591	1	1,592
PA	5,543	13	5,556
RI	653	-	653
SC	669	5	674
SD	191	1	192
TN	1,188	19	1,207
TX	5,701	13	5,714
UT	N/A	N/A	820
VA	3,162	12	3,174
VT	607	1	608
WA	2,459	5	2,464
WI	1,685	1	1,686
WV	512	-	512
WY	182	-	182
Grand Total	103,048	1,048	106,157

Source: American Psychological Association, 2012-2015 State Licensing Board Lists

* Numbers of records in Hawaii (HI), Oklahoma (OK), and Utah (UT) were only reported in totals due to the unavailability of records with zip codes in these states.

Hot Spot Analysis

Hot spot analysis identifies statistically significant spatial clusters of high values (hot spots) and low values (cold spots), and is widely used in spatial analysis by federal agencies such as the Centers for Disease Control and Prevention.

Hot spot analysis uses a z-score statistic called Getis-Ord local statistic (G_i^*) to identify locations (i.e., counties in this analysis) with statistically higher or lower values. The Getis-Ord statistic is calculated as follows:

$$G_i^* = \frac{\sum_{j=1}^n w_{ij} x_j - \bar{x} \sum_{j=1}^n w_{ij}}{\sqrt{\frac{[n \sum_{j=1}^n w_{ij}^2 - (\sum_{j=1}^n w_{ij})^2]}{n-1}}}$$

where x_i is the value for county i , w_{ij} is the spatial weight between county i and j (assigned based on inverse geographic distance such that closer counties were assigned larger weights), n is the total number of counties, and

$$\bar{x} = \frac{\sum_{j=1}^n x_j}{n}, \quad S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{x})^2}$$

Counties in Hawaii, Oklahoma, and Utah were included in the analysis using state means of licensed psychologists per county. Note that the spatial weight assigned was determined only by geographic distance between counties, therefore the effect of state borders was not included in this spatial analysis.

Regression Model

In analyzing the relationship between the county-level concentration of licensed psychologists and health indicators, the following regression model was used:

$$H_i = \alpha + \beta_1 LP_i + \beta_2 D_i + \beta_3 SE_i + \beta_4 HC_i + \beta_5 EV_i + c_i + \varepsilon_i,$$

H_i is the value of health indicator in county i . LP_i is the concentration of licensed psychologists (number of licensed psychologists per 100,000 population). D_i is a vector of county-level demographic variables including population, percent population below 18 years old, percent population above 65 years old, percent population White (non-Hispanic), percent population female, and percent population in rural areas. SE_i is a vector of county-level socio-economic variables including median household income, unemployment rate, education attainment, and violent crime cases. HC_i is a vector of control variables related to health care including insurance coverage and relative healthcare cost. EV_i is a vector of county-level environmental variables including air pollution, percent population exposed to drinking water violations, and percent population with severe housing problems. Regressions were conducted with Regional fixed effects c_i . Regression results (with original coefficients and standardized coefficients) are listed in Tables 4 and Table 5.

Table 4(a). Regression Results: County-Level Licensed Psychologists with Health Indicators

Dependent Variables Independent Variables	(1) Percent Population with Poor or Fair Health	(2) Poor Mental Health Days per Month	(3) Poor Physical Health Days per Month
Licensed Psychologists per 100,000 Population	-0.0001* (-2.30)	-0.0018* (-2.26)	-0.0032*** (-4.20)
Demographic Variables			
Population	0.0000 (1.80)	-0.0000 (-0.56)	0.0000 (0.40)
Percent Population below 18 Years Old	0.1502** (3.28)	-2.8792** (-2.81)	-1.2593 (-1.33)
Percent Population above 65 Years Old	0.0116 (0.36)	-0.2819 (-0.38)	-0.9228 (-1.36)
Percent Population White	-0.0322*** (-3.86)	-1.2944*** (-7.28)	-1.6757*** (-9.29)
Percent Population Female	-0.1143 (-1.86)	0.9325 (0.68)	-2.9109* (-2.25)
Percent Population Living in Rural Areas	0.0097* (2.39)	-0.1853* (-2.03)	0.0434 (0.50)
Socio-Economic Variables			
Median Household Income	-0.0000*** (-3.52)	-0.0000 (-1.96)	-0.0000*** (-3.56)
Unemployment Rate	0.2569*** (5.61)	2.5623* (2.44)	3.3706*** (3.63)
Percent Population with High School Degrees	0.0035 (0.31)	-0.4506 (-1.70)	-0.1264 (-0.48)
Violent Crime Cases per 100,00 Population	0.0000 (1.36)	0.0002 (1.70)	0.0001 (1.28)
Health Insurance			
Percent Uninsured Adults	0.0696* (1.99)	-2.1732** (-2.74)	--2.1920** (-2.89)
Percent Uninsured Children	-0.2883*** (-6.48)	-0.9569 (-0.98)	-3.1760*** (-3.38)
Price-Adjusted Healthcare Cost	0.2649*** (9.44)	3.2575*** (5.40)	5.0465*** (8.45)
Could not See Doctor due to Cost	0.3780*** (13.49)	7.2482*** (10.82)	7.0744*** (12.29)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.0007 (1.07)	0.0575*** (4.22)	0.0444*** (3.32)
Percent Population Exposed to Drinking Water Violation	0.0012 (0.21)	-0.0749 (-0.55)	0.0360 (0.26)
Percent Households with Severe Housing Problems	-0.0875** (-2.66)	-0.6560 (-0.88)	-1.8912* (-2.53)
R-Squared	0.678	0.378	0.544
N	2008	1962	2008

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.

Table 4(b). Regression Results: County-Level Licensed Psychologists with Health Indicators (Continued)

Dependent Variables Independent Variables	(4) Percent Adult Smoking	(5) Percent Adult Obese	(6) Percent Population Physically Inactive
Licensed Psychologists per 100,000 Population	-0.0003*** (-6.60)	-0.0003*** (-8.08)	-0.0004*** (-8.37)
Demographic Variables			
Population	-0.0000*** (-4.11)	-0.0000** (-3.16)	-0.0000* (-2.24)
Percent Population below 18 Years Old	-0.0765 (-1.30)	0.3660*** (9.02)	0.2427*** (6.03)
Percent Population above 65 Years Old	-0.0971* (-2.44)	-0.0612 (-1.94)	0.0591 (1.90)
Percent Population White	-0.1063*** (-9.86)	0.0475*** (6.61)	0.0020 (0.31)
Percent Population Female	-0.0922 (-1.34)	-0.1273** (-2.71)	0.0080 (0.18)
Percent Population Living in Rural Areas	0.0105* (2.11)	0.0225*** (6.53)	0.0170*** (4.57)
Socio-Economic Variables			
Median Household Income	-0.0000*** (-6.25)	-0.0000*** (-8.94)	-0.0000*** (-4.98)
Unemployment Rate	0.1679** (2.78)	0.0809 (1.93)	-0.0888* (-2.21)
Percent Population with High School Degrees	-0.0392** (-2.71)	-0.0171 (-1.91)	0.0170 (1.90)
Violent Crime Cases per 100,00 Population	0.0000* (2.40)	0.0000** (3.28)	0.0000*** (4.74)
Health Insurance			
Percent Uninsured Adults	-0.1434** (-3.28)	0.0181 (0.60)	0.0965** (2.94)
Percent Uninsured Children	-0.0649 (-1.19)	-0.3070*** (-7.81)	-0.3203*** (-8.10)
Price-Adjusted Healthcare Cost	0.1379*** (4.96)	0.1005*** (4.79)	0.2659*** (10.99)
Could not See Doctor due to Cost	0.4011*** (11.96)	-0.0362 (-1.90)	0.0624** (3.05)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.0041*** (5.70)	-0.0016*** (-3.42)	0.0030*** (5.42)
Percent Population Exposed to Drinking Water Violation	0.0158* (2.12)	-0.0080 (-1.78)	-0.0016 (-0.32)
Percent Households with Severe Housing Problems	-0.2216*** (-5.50)	-0.1356*** (-5.31)	-0.2738*** (-10.63)
R-Squared	0.524	0.665	0.731
N	2006	2027	2027

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.

Table 4(c). Regression Results: County-Level Licensed Psychologists with Health Indicators (Continued)

Dependent Variables Independent Variables	(7) Teen Births	(8) Percent Excessive Drinking	(9) Percent Population Diagnosed with Diabetes
Licensed Psychologists per 100,000 Population	-0.0009* (-1.96)	-0.0010** (-3.02)	-0.0011*** (-6.58)
Demographic Variables			
Population	0.0000** (2.65)	-0.0000 (-0.42)	-0.0000 (-0.12)
Percent Population below 18 Years Old	7.9982*** (17.57)	-1.1991** (-3.22)	1.5269*** (7.51)
Percent Population above 65 Years Old	3.4131*** (10.69)	-0.2684 (-0.95)	1.7312*** (12.82)
Percent Population White	-0.1450*** (-3.35)	-0.0149 (-0.23)	0.1184*** (3.30)
Percent Population Female	-4.3940*** (-10.39)	-1.4301** (-3.09)	0.2678 (1.38)
Percent Population Living in Rural Areas	-0.1975*** (-6.40)	0.0342 (1.05)	0.0617*** (3.98)
Socio-Economic Variables			
Median Household Income	-0.0000*** (-11.56)	0.0000*** (3.45)	-0.0000*** (-4.82)
Unemployment Rate	0.4842 (1.64)	-0.1925 (-0.52)	1.2860*** (6.62)
Percent Population with High School Degrees	-0.5908*** (-7.74)	-0.2094* (-2.03)	-0.2312*** (-5.54)
Violent Crime Cases per 100,00 Population	0.0004*** (10.53)	0.0001* (2.09)	0.0000* (2.37)
Health Insurance			
Percent Uninsured Adults	0.8841*** (3.41)	-0.9571** (-3.07)	0.2936* (2.05)
Percent Uninsured Children	-0.3171 (-1.00)	1.6136*** (4.44)	-1.2243*** (-7.29)
Price-Adjusted Healthcare Cost	0.2282 (1.45)	-0.7482*** (-3.50)	0.5035*** (5.47)
Could not See Doctor due to Cost	1.0825*** (7.21)	-0.4642* (-2.06)	-0.0967 (-1.12)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.0135** (3.20)	-0.0244*** (-4.87)	0.0040 (1.69)
Percent Population Exposed to Drinking Water Violation	-0.1089* (-2.30)	0.0571 (1.11)	-0.0351 (-1.76)
Percent Households with Severe Housing Problems	-1.4478*** (-6.84)	1.5198*** (5.88)	-0.5210*** (-4.23)
R-Squared	0.775	0.405	0.733
N	2027	1623	2027

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. Dependent variables were normalized based on log transformation due to skewness in original distributions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.

Table 5(a). Regression Results: County-Level Licensed Psychologists with Health Indicators, Standardized Coefficients

Dependent Variables Independent Variables	(1) Percent Population with Poor or Fair Health	(2) Poor Mental Health Days per Month	(3) Poor Physical Health Days per Month
Licensed Psychologists per 100,000 Population	-0.032* (-2.30)	-0.043* (-2.26)	-0.067*** (-4.20)
Demographic Variables			
Population	0.012 (1.80)	-0.008 (-0.56)	0.002 (0.40)
Percent Population below 18 Years Old	0.077** (3.28)	-0.093** (-2.81)	-0.036 (-1.33)
Percent Population above 65 Years Old	0.007 (0.36)	-0.011 (-0.38)	-0.033 (-1.36)
Percent Population White	-0.089*** (-3.86)	-0.221*** (-7.28)	-0.258*** (-9.29)
Percent Population Female	-0.034 (-1.86)	0.018 (0.68)	-0.049* (-2.25)
Percent Population Living in Rural Areas	0.047* (2.39)	-0.056* (-2.03)	0.012 (0.50)
Socio-Economic Variables			
Median Household Income	-0.090*** (-3.52)	-0.071 (-1.96)	-0.107*** (-3.56)
Unemployment Rate	0.108*** (5.61)	0.068* (2.44)	0.079*** (3.63)
Percent Population with High School Degrees	0.005 (0.31)	-0.043 (-1.70)	-0.011 (-0.48)
Violent Crime Cases per 100,00 Population	0.024 (1.36)	0.041 (1.70)	0.025 (1.28)
Health Insurance			
Percent Uninsured Adults	0.074* (1.99)	-0.144** (-2.74)	-0.130** (-2.89)
Percent Uninsured Children	-0.152*** (-6.48)	-0.031 (-0.98)	-0.094*** (-3.38)
Price-Adjusted Healthcare Cost	0.324*** (9.44)	0.248*** (5.40)	0.345*** (8.45)
Could not See Doctor due to Cost	0.349*** (13.49)	0.414*** (10.82)	0.365*** (12.29)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.017 (1.07)	0.092*** (4.22)	0.064*** (3.32)
Percent Population Exposed to Drinking Water Violation	0.003 (0.21)	-0.011 (-0.55)	0.005 (0.26)
Percent Households with Severe Housing Problems	-0.050** (-2.66)	-0.029 (-0.88)	-0.073* (-2.53)
R-Squared	0.678	0.378	0.544
N	2008	1962	2008

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.

Table 5(b). Regression Results: County-Level Licensed Psychologists with Health Indicators, Standardized Coefficients (Continued)

Dependent Variables Independent Variables	(4) Percent Adult Smoking	(5) Percent Adult Obese	(6) Percent Population Physically Inactive
Licensed Psychologists per 100,000 Population	-0.115*** (-6.60)	-0.164*** (-8.08)	-0.141*** (-8.37)
Demographic Variables			
Population	-0.025*** (-4.11)	-0.042** (-3.16)	-0.019* (-2.24)
Percent Population below 18 Years Old	-0.040 (-1.30)	0.246*** (9.02)	0.131*** (6.03)
Percent Population above 65 Years Old	-0.064* (-2.44)	-0.052 (-1.94)	0.040 (1.90)
Percent Population White	-0.299*** (-9.86)	0.170*** (6.61)	0.006 (0.31)
Percent Population Female	-0.028 (-1.34)	-0.050** (-2.71)	0.003 (0.18)
Percent Population Living in Rural Areas	0.052* (2.11)	0.142*** (6.53)	0.086*** (4.57)
Socio-Economic Variables			
Median Household Income	-0.197*** (-6.25)	-0.269*** (-8.94)	-0.135*** (-4.98)
Unemployment Rate	0.072** (2.78)	0.045 (1.93)	-0.039* (-2.21)
Percent Population with High School Degrees	-0.061** (-2.71)	-0.034 (-1.91)	0.28 (1.90)
Violent Crime Cases per 100,00 Population	0.048* (2.40)	0.057** (3.28)	0.070*** (4.74)
Health Insurance			
Percent Uninsured Adults	-0.154** (-3.28)	0.025 (0.60)	0.108** (2.94)
Percent Uninsured Children	-0.035 (-1.19)	-0.212*** (-7.81)	-0.178*** (-8.10)
Price-Adjusted Healthcare Cost	0.171*** (4.96)	0.160*** (4.79)	0.341*** (10.99)
Could not See Doctor due to Cost	0.376*** (11.96)	-0.044 (-1.90)	0.061** (3.05)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.108*** (5.70)	-0.055*** (-3.42)	0.081*** (5.42)
Percent Population Exposed to Drinking Water Violation	0.037* (2.12)	-0.024 (-1.78)	-0.004 (-0.32)
Percent Households with Severe Housing Problems	-0.157*** (-5.50)	-0.122*** (-5.31)	-0.198*** (-10.63)
R-Squared	0.524	0.665	0.731
N	2006	2027	2027

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.

Table 4(c). Regression Results: County-Level Licensed Psychologists with Health Indicators
Standardized Coefficients (Continued)

Dependent Variables Independent Variables	(7) Teen Births	(8) Percent Excessive Drinking	(9) Percent Population Diagnosed with Diabetes
Licensed Psychologists per 100,000 Population	-0.041* (-1.96)	-0.074** (-3.02)	-0.109*** (-6.58)
Demographic Variables			
Population	0.018** (2.65)	-0.007 (-0.42)	-0.001 (-0.12)
Percent Population below 18 Years Old	0.497*** (17.57)	-0.120** (-3.22)	0.201*** (7.51)
Percent Population above 65 Years Old	0.267*** (10.69)	-0.034 (-0.95)	0.288*** (12.82)
Percent Population White	-0.048*** (-3.35)	-0.007 (-0.23)	0.083*** (3.30)
Percent Population Female	-0.159*** (-10.39)	-0.077** (-3.09)	0.021 (1.38)
Percent Population Living in Rural Areas	-0.115*** (-6.40)	0.029 (1.05)	0.076*** (3.98)
Socio-Economic Variables			
Median Household Income	-0.382*** (-11.56)	0.158*** (3.45)	-0.140*** (-4.82)
Unemployment Rate	0.025 (1.64)	-0.015 (-0.52)	0.139*** (6.62)
Percent Population with High School Degrees	-0.109*** (-7.74)	-0.058* (-2.03)	-0.090*** (-5.54)
Violent Crime Cases per 100,00 Population	0.70*** (10.53)	0.053* (2.09)	0.038* (2.37)
Health Insurance			
Percent Uninsured Adults	0.113*** (3.41)	-0.187** (-3.07)	0.080* (2.05)
Percent Uninsured Children	-0.020 (-1.00)	0.155*** (4.44)	-0.166*** (-7.29)
Price-Adjusted Healthcare Cost	0.034 (1.45)	-0.155*** (-3.50)	0.158*** (5.47)
Could not See Doctor due to Cost	0.121*** (7.21)	-0.072* (-2.06)	-0.023 (-1.12)
Environmental Variables			
Air Pollution- Density of Particulate Matter	0.042** (3.20)	-0.115*** (-4.87)	0.026 (1.69)
Percent Population Exposed to Drinking Water Violation	-0.030* (-2.30)	0.024 (1.11)	-0.021 (-1.76)
Percent Households with Severe Housing Problems	-0.121*** (-6.84)	0.198*** (5.88)	-0.092*** (-4.23)
R-Squared	0.775	0.405	0.733
N	2027	1623	2027

Note: Regressions were conducted with constant, regional fixed effects, and robust standard errors; t values are in parenthesis. Dependent variables were normalized based on log transformation due to skewness in original distributions. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Source: American Psychological Association, 2012-2015 State Licensing Board Lists; Robert Wood Johnson Foundation, 2015 County Health Rankings.