Health Places, Health Lives
WQS Results

11/21/2019

Statistical Methods

There were 207 census tracts with missing LEB measures that were imputed using k-nearest neighbor clustering; k was selected as the square root of the sample size (N = 1875) rounded to the nearest integer. The raw and imputed LEB measures are summarized in the table below, where we see that imputation did not meaningfully change the mean, median or standard deviation. Indicator values were converted into z-scores by subtracting the indicator's mean and dividing by that indicator's standard deviation, while indicators negatively associated with LEB were also multiplied by -1. These choices implied that an increasing numerical value for any indicator would represent an increasingly beneficial value and lead to a positive HOI framing, with larger values indicative of less disadvantaged census tracts. Weighted quantile summation regression (WQS) was used to estimate indicator weights by regressing the 13 indicators against LEB, where each indicator is weighted to maximize the association between the overall HOI scores and LEB. These indicator weights sum to one, so that each weight is interpretable as a percentage of association with LEB explained by the corresponding indicator. The R computational software was used, specifically with the *KNNImpute* function for imputing LEB values and the WQS package for determining indicator weights for calculating the HOI.

Results

The following table provides summaries for LEB and the raw HOI indicators. Note that the summaries for the LEB with missing values imputed are similar to summaries for the actual LEB values. The 13 indicators are each positively associated with LEB with the exception of the Food Access Index; the z-scores for this index are thus multiplied by -1 so that they have a positive association with LEB.
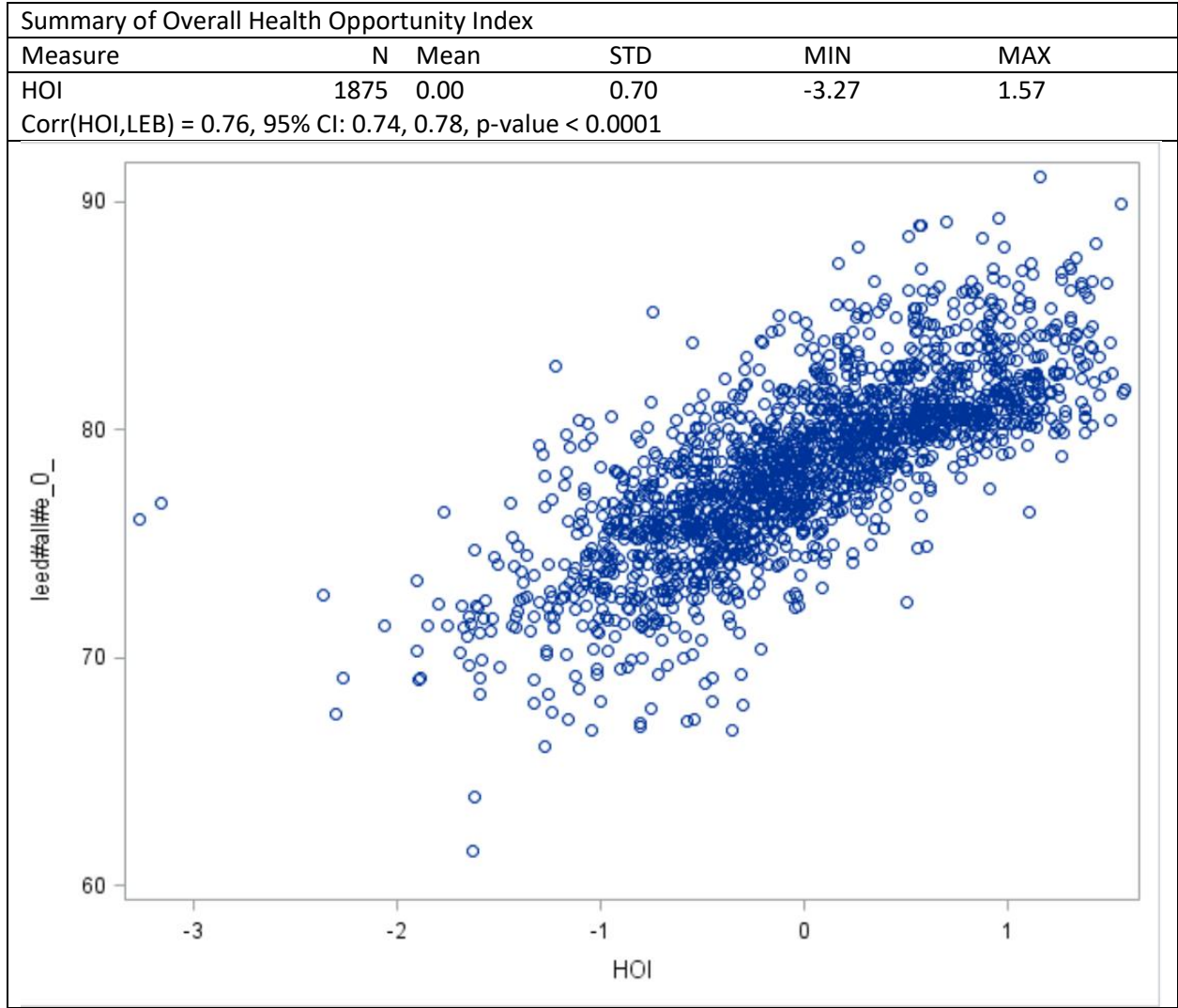
Data Summaries						
Measure	N	Mean	Median	SD	MIN/MAX	Correlation with LEB
LEB	1668	78.3	78.6	3.9	61.5/91.1	--
LEB (Imputed)	1875	78.4	78.7	3.8	61.5/91.1	--
Air Quality Index	1875	0.83	0.85	0.11	0/1	0.03
Population Churning Index	1875	0.82	0.85	0.13	0.02/1.00	0.12
Population Density Index	1875	0.04	0.03	0.07	0.00/1.00	0.13
Walkability Index	1875	0.18	0.17	0.11	0.00/1.00	0.11
Affordability Index	1875	0.54	0.56	0.13	0.00/0.83	0.69
Education Index	1875	0.74	0.73	0.08	0.00/1.00	0.67

Food Access Index	1875	0.07	0.06	0.07	0.00/0.69	-0.29
Material Deprivation	1875	0.46	0.46	0.14	0.00/1.00	0.54
Access to Employment	1875	0.10	0.11	0.04	0.00/0.70	0.22
Income Inequality	1875	0.47	0.48	0.09	0.00/0.91	0.25
Job Participation	1875	0.66	0.67	0.11	0.00/1.00	0.36
Access to Healthcare	1875	0.43	0.46	0.12	0.00/1.00	0.15
Segregation	1875	0.74	0.76	0.17	0.00/1.00	0.06

Overall Health Opportunity Index

The indicator weights from the WQS regression of the HOI and LEB are found in the following table. Here we see that the Affordability Index (weight = 26%) and the Education Index (weight = 37%) were allotted the largest proportion of the association between the HOI and LEB. Other indicators with greater than 5% weight were the Population Churning Index (7%), Material Deprivation (10%), and Job Participation (7%). The HOI values are based on z-scores of the indicators, the mean HOI is zero-valued, with a range between -3.27 to 1.57; note that these values can be calibrated to any desired scale. Most importantly, we see that the HOI values have a strong, positive correlation with LEB (r = 0.76), implying that census tracts with larger HOI values are associated with high LEBs, while census tracts with smaller HOI values are associated with higher LEBs. This association is shown visually in the corresponding scatter plot
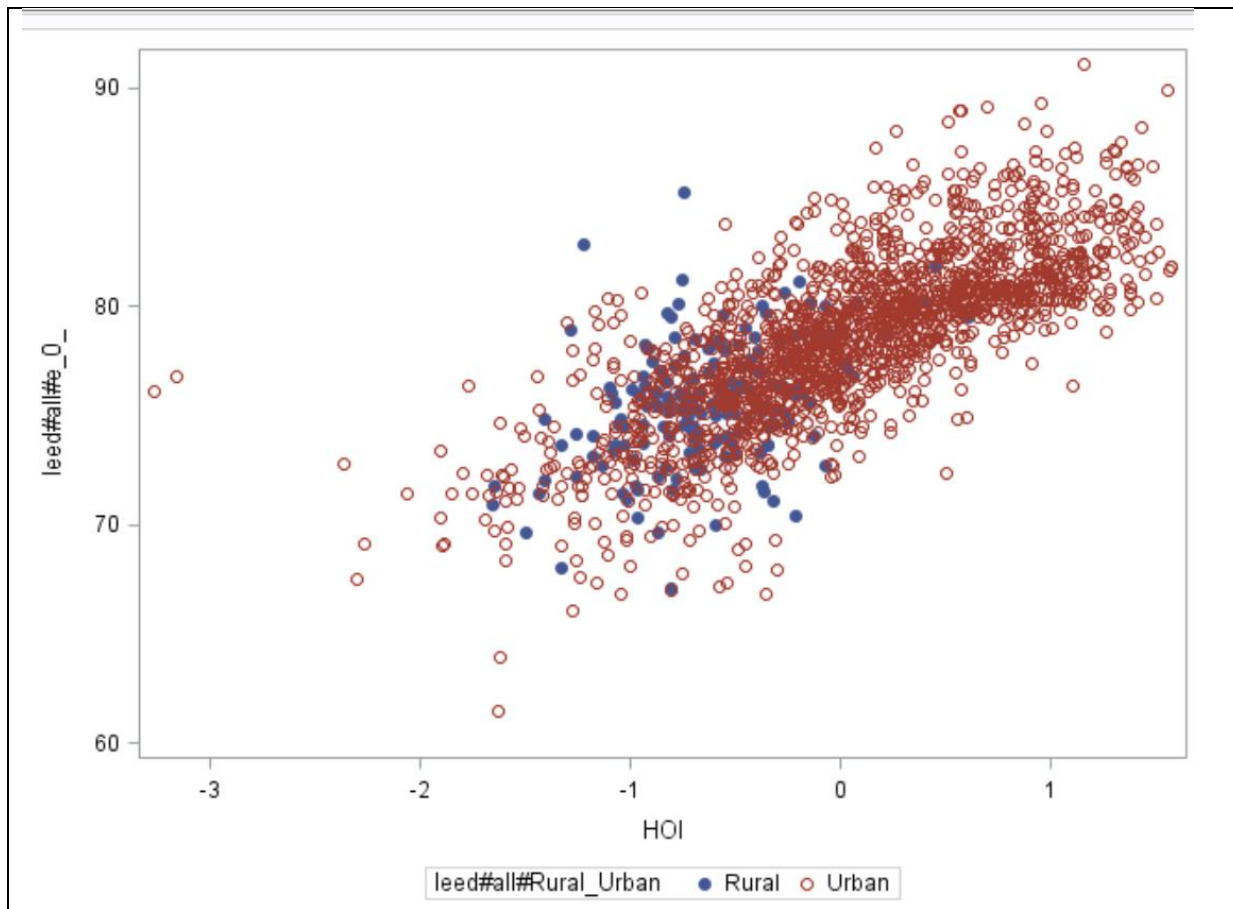
Indicator Weights and Profile Totals		
Community Environmental Profile	Weights	
Air Quality Index	0.020	
Population Churning Index	0.065	
Population Density Index	0.010	Total
Walkability Index	0.010	0.105
Consumer Opportunity Profile	Weights	
Affordability Index	0.262	
Education Index	0.365	
Food Access Index	0.029	Total
Material Deprivation	0.099	0.755
Economic Opportunity Profile	Weights	
Access to Employment	0.010	
Income Inequality	0.010	Total
Job Participation	0.071	0.092
Wellness Disparity	Weights	
Access to Healthcare	0.024	Total
Segregation	0.025	0.048

Summary of Overall Health Opportunity Index					
Measure	N	Mean	STD	MIN	MAX
HOI	1875	0.00	0.70	-3.27	1.57
Corr(HOI,LEB) = 0.76, 95% CI: 0.74, 0.78, p-value < 0.0001					

Health Opportunity Index by Location (Rural vs. Urban)

Inspecting differences in the HOI by rural and urban locations shows that urban locations on average have higher mean HOI than do rural locations; these results mirror what we see for LEB, where urban locations had higher LEB on average than rural locations. Further, the association between HOI and LEB was stronger for urban locations (r = 0.76) than in rural locations (r = 0.44). These results are visually shown in the accompanying scatter plot, which shows most of the HOI-LEB pairs for rural locations taking place in the lower quarter of the plot, indicating greater instances of both lower HOI and LEB. Calculating HOI values separately for rural and urban locations did little to change the HOI values and associations with LEB, though rural locations had higher weights than urban locations for Air Quality, Population Churning, and Segregation, while urban locations had higher weights than rural locations for Affordability Index, Education Index, and Material Deprivation.

Results by Location (Rural vs. Urban)										
			Overall HOI by Location				Separate HOI by Location			
Measure	Location	N	Mean	SD	MIN	MAX	Mean	SD	MIN	MAX
HOI	Rural	180	-0.62	0.39	-1.66	0.60	-0.31	0.32	-1.07	0.73
	Urban	1695	0.07	0.69	-3.27	1.57	0.07	0.69	-3.00	1.58
			Diff = -0.69, 95% CI: -0.75, -0.62, p-value < 0.0001				Diff = -0.37, 95% CI: -0.43, -0.32 p-value < 0.0001			
LEB	Rural	180	75.6	2.8	67.1	85.2	--	--	--	--
	Urban	1695	78.7	3.8	61.5	91.1	--	--	--	--
			Diff = -3.1, 95% CI: -3.5, -2.6, p-value < 0.0001							
	Rural: Corr(HOI,LEB)		r = 0.44, 95% CI: 0.31, 0.55, p-value < 0.0001				r = 0.48, 95% CI: 0.36, 0.59, p-value < 0.0001			
	URban: Corr(HOI,LEB)		r = 0.76, 95% CI: 0.74, 0.78, p-value < 0.0001				r = 0.76, 95% CI: 0.74, 0.78, p-value < 0.0001			

Indicator Weights and Profile Totals per Location				
Community Environmental Profile	Rural Weights		Urban Weights	
Air Quality Index	0.099		0.020	
Population Churning Index	0.189		0.045	
Population Density Index	0.002	Total	0.010	Total
Walkability Index	0.010	0.300	0.009	0.084
Consumer Opportunity Profile				
Affordability Index	0.121		0.264	
Education Index	0.276		0.345	
Food Access Index	0.066	Total	0.030	Total
Material Deprivation	0.035	0.497	0.122	0.762
Economic Opportunity Profile				
Access to Employment	0.024		0.010	
Income Inequality	0.007	Total	0.011	Total
Job Participation	0.049	0.080	0.071	0.092
Wellness Disparity				
Access to Healthcare	0.008	Total	0.042	Total
Segregation	0.114	0.122	0.020	0.062

Health Opportunity Index by Health Service Area (I-V)

HOI values are summarized by HSA in the following table, where we see that the HOI values are highest in HSA II and are somewhat lower in HSAs I, III, IV and V; these results track with LEB between the five HSAs. The associations between HOI and LEB were strongest in HSAs III, IV and V, and were lowest (though still strong) in HSAs I and II. The scatter plot visually shows the HOI-LEB pairings, where we can see that HSA II has most of the larger HOI-LEB values, though generally the five HSAs are evenly dispersed. Computing separate HOIs for each HSA did not meaningfully change these results, though we can see there were some inter-HSA indicator weight disparities, notably for Population Churning Index (highest in HSA II), Affordability Index (highest in HSA II), Education Index and Material Deprivation (lowest in HSA II), Access to Employment (highest in HSA IV), Job Participation (highest in HSA III), and Access to Healthcare (highest in HSAs I and IV).

Results by Region (Heath Service Area)										
			Overall HOI by HSA				Separate HOI by HSA			
Measure	Region	N	Mean	STD	MIN	MAX	Mean	STD	MIN	MAX
HOI	HSA I	264	-0.07	0.45	-1.36	1.36	-0.05	0.42	-1.19	1.44
	HSA II	515	0.62	0.58	-3.27	1.57	0.56	0.45	-1.56	1.45
	HSA III	323	-0.45	0.51	-1.91	0.89	-0.41	0.50	-2.06	0.86
	HSA IV	329	-0.23	0.72	-2.30	1.41	-0.25	0.61	-2.02	1.04
	HSA V	444	-0.18	0.57	-2.36	1.12	-0.16	0.60	-2.18	1.33
			$F_{(4,1870)} = 225.6$, p-value < 0.0001				$F_{(4,1870)} = 226.7$, p-value < 0.0001			
LEB	HSA I	264	78.7	2.6	68.1	87.1	--	--	--	--
	HSA II	515	81.7	2.5	75.4	91.1	--	--	--	--
	HSA III	323	76.0	3.0	67.1	83.6	--	--	--	--
	HSA IV	329	77.2	3.8	66.8	89.3	--	--	--	--
	HSA V	444	77.0	3.6	61.5	89.0	--	--	--	--
			$F_{(4,1870)} = 220.5$, p-value < 0.0001							
HSA I: Corr(HOI,LEB)			r= 0.55, 95% CI: 0.46, 0.63, p-value < 0.0001				r=0.55 , 95% CI: 0.46, 0.63, p-value < 0.0001			
HSA II: Corr(HOI,LEB			r = 0.47, 95% CI: 0.40, 0.53, p-value < 0.0001				r = 0.52 , 95% CI: 0.45, 0.58, p-value < 0.0001			
HSA III: Corr(HOI,LEB)			r= 0.69, 95% CI: 0.63, 0.75, p-value < 0.0001				r=0.71 , 95% CI: 0.65, 0.76, p-value < 0.0001			
HSA IV: Corr(HOI,LEB)			r = 0.76, 95% CI: 0.71, 0.80, p-value < 0.0001				r= 0.77, 95% CI: 0.72, 0.81, p-value < 0.0001			
HSA V: Corr(HOI,LEB)			r = 0.72, 95% CI: 0.67, 0.76, p-value < 0.0001				r=0.75 , 95% CI: 0.70, 0.79, p-value <			
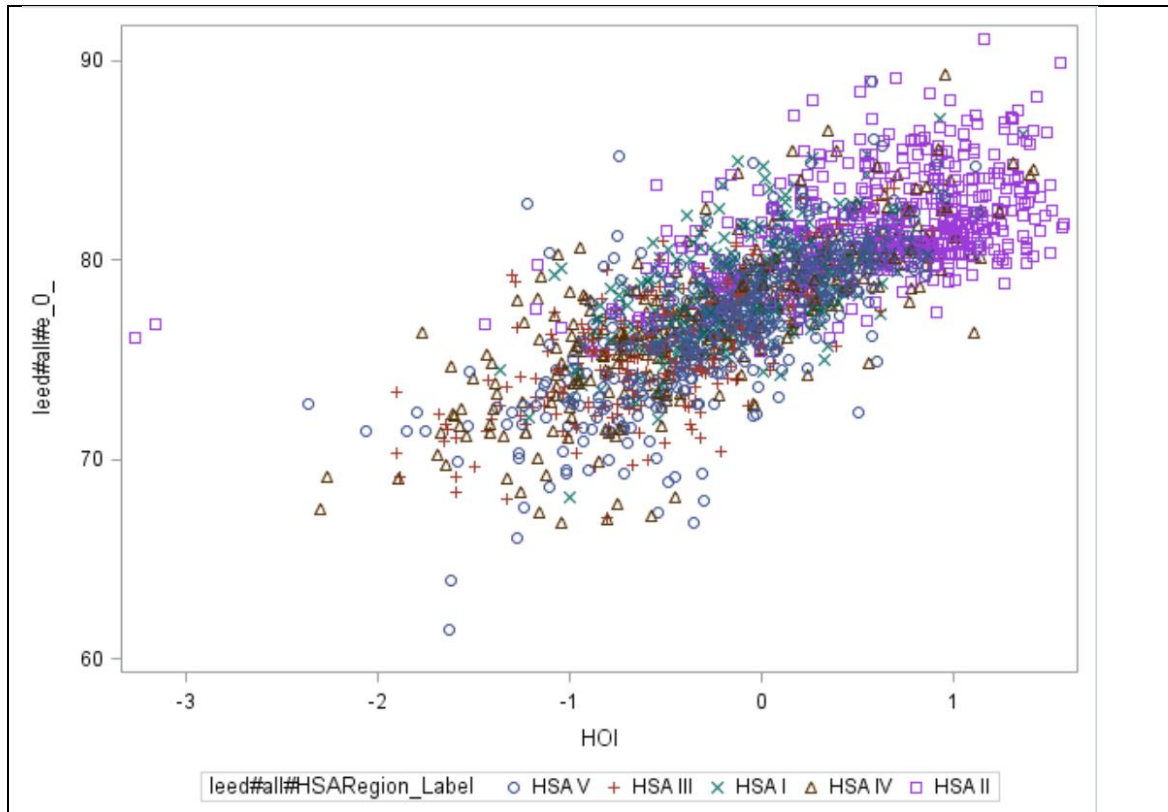
Indicator Weights and Profile Totals per Region					
Community Environmental Profile	HSA I Weights	HSA II Weights	HSA III Weights	HSA IV Weights	HSA V Weights
Air Quality Index	0.050	0.006	0.017	0.173	0.106
Population Churning Index	0.061	0.144	0.075	0.014	0.048
Population Density Index	0.007	0.022	0.008	0.023	0.004
Walkability Index	0.012	0.101	0.004	0.006	0.003
Total	0.130	0.273	0.105	0.217	0.161
Consumer Opportunity Profile					
Affordability Index	0.138	0.332	0.126	0.107	0.171
Education Index	0.347	0.199	0.341	0.288	0.390
Food Access Index	0.037	0.117	0.080	0.019	0.012
Material Deprivation	0.152	0.035	0.200	0.153	0.194
Total	0.673	0.682	0.746	0.566	0.767
Economic Opportunity Profile					
Access to Employment	0.010	0.005	0.010	0.095	0.011
Income Inequality	0.009	0.006	0.023	0.017	0.017
Job Participation	0.038	0.004	0.085	0.024	0.012
Total	0.057	0.015	0.118	0.136	0.040
Wellness Disparity					
Access to Healthcare	0.093	0.019	0.007	0.070	0.004
Segregation	0.046	0.011	0.024	0.011	0.029
Total	0.140	0.030	0.031	0.081	0.032s

Health Opportunity Index by Health District Level

HOI values are summarized by Health District Level (HDL) in the following table, where we see some amount of HDL-level variability. The associations between HOI and LEB were generally strong, with exceptions being Cumberland Plateau, Eastern Shore, Lenowisco, Piedmont, Southside and Three Rivers. Notably, the HOI for the Eastern Shore had a strong association with life expectancy in the negative direction (large HOI was associated with lower LEB). The particular indicator weights were generally similar to the overall model, in that the Affordability Index and Education Index typically had the largest weights within the HDLs, though there was some variability in the weight distributions.

Results by Heath District Level										
			Overall HOI by HDL				Separate HOI by HDL			
Measure	Region	N	Mean	STD	MIN	MAX	Mean	STD	MIN	MAX
HOI	Alexandria	38	0.68	0.52	-0.78	1.39	0.44	0.43	-0.49	1.09
	Alleghany	40	0.03	0.37	-0.92	0.86	0.04	0.33	-0.75	0.64
	Arlington	58	0.74	0.75	-3.16	1.57	0.51	0.44	-0.95	1.25
	Central Shanando	62	-0.35	0.35	-1.22	0.24	-0.32	0.33	-1.13	0.17
	Central Virginia	60	-0.37	0.54	-1.90	0.68	-0.39	0.57	-2.15	0.59
	Chesapeake	41	-0.04	0.51	-1.04	0.79	-0.02	0.54	-1.05	0.87
	Chesterfield	81	0.11	0.61	-1.65	1.14	0.11	0.52	-1.50	0.98
	Chickahominy	34	0.17	0.45	-0.96	1.11	-0.01	0.46	-1.52	0.80
	Crater	40	-0.79	0.55	-2.27	0.20	-0.57	0.48	-1.72	0.26
	Cumberland Plate	29	-0.80	0.32	-1.66	-0.22	-0.67	0.21	-1.42	-0.33
	Eastern Shore	11	-0.63	0.30	-1.22	-0.27	-0.26	0.26	-0.72	0.09
	Fairfax	263	0.70	0.51	-1.44	1.57	0.58	0.40	-0.93	1.34
	Hampton	33	-0.42	0.64	-2.36	0.43	-0.41	0.60	-2.19	0.44
	Henrico	63	0.06	0.64	-1.62	1.41	-0.02	0.54	-1.26	1.03
	Lenowsico	24	-0.70	0.29	-1.29	-0.17	-0.50	0.25	-1.08	-0.01
	Lord Fairfax	44	-0.19	0.40	-1.36	0.40	-0.21	0.38	-1.35	0.40
	Loudoun	65	0.63	0.65	-3.27	1.38	0.48	0.39	-1.12	0.98
	Mount Rogers	48	-0.54	0.42	-1.89	0.57	-0.40	0.35	-1.46	0.37
	New River	34	-0.13	0.43	-0.9	0.89	-0.19	0.42	-0.85	1.36
	Norfolk	77	-0.40	0.59	-1.79	1.11	-0.41	0.58	-1.73	1.15
	Peninsula	75	-0.10	0.64	-2.07	0.96	-0.10	0.65	-2.02	0.96
	Piedmont	23	-0.73	0.42	-1.40	0.60	-0.17	0.34	-0.38	0.63
	Pittsylvania-Dan	32	-0.61	0.43	-1.65	0.22	-0.27	0.33	-0.88	0.47
	Portsmouth	31	-0.54	0.51	-1.85	0.26	-0.53	0.53	-1.75	0.32
	Prince William	84	0.33	0.51	-0.89	1.10	0.23	0.35	-0.76	0.76
	Rappahannock	77	0.07	0.38	-1.05	0.86	-0.20	0.33	-1.10	0.68
	Rap. Rapidan	39	-0.02	0.37	-0.73	0.69	-0.18	0.29	-0.72	0.42
	Richmond	66	-0.45	0.83	-2.30	1.39	-0.57	0.69	-2.00	1.01
	Roanoke	23	-0.62	0.69	-1.91	0.65	-0.55	0.54	-1.72	0.30
	Southside	22	-0.71	0.21	-1.08	-0.39	-0.27	0.19	-0.81	0.08
	Thomas Jefferson	49	0.11	0.54	-0.89	1.34	0.15	0.47	-0.77	1.08
	Three Rivers	35	-0.21	0.26	-0.77	0.39	-0.15	0.29	-1.03	0.28
	Virginia Beach	99	0.10	0.42	-0.98	1.12	0.17	0.40	-0.76	1.24
	West Piedmont	33	-0.61	0.43	-1.49	0.44	-0.53	0.43	-1.53	0.25

	Region	N								
	Western Tidewater	42	-0.16	0.56	-1.33	0.85	0.19	0.58	-1.11	1.36
			F(34,1840) = 43.5, p-value < 0.0001				F(34,1840) = 45.0, p-value < 0.0001			
LEB	Alexandria	38	81.2	2.3	75.4	86.0	--	--	--	--
	Alleghany	40	78.1	3.0	69.7	83.1	--	--	--	--
	Arlington	58	81.8	2.4	76.8	88.0	--	--	--	--
	Central Shanando	62	78.4	2.8	68.1	85.0	--	--	--	--
	Central Virginia	60	76.6	2.9	69.1	83.6	--	--	--	--
	Chesapeake	41	77.5	3.2	70.0	82.5	--	--	--	--
	Chesterfield	81	78.9	2.9	69.7	85.5	--	--	--	--
	Chickahominy	34	78.3	1.9	74.1	82.8	--	--	--	--
	Crater	40	74.0	3.6	68.4	84.0	--	--	--	--
	Cumberland Plate	29	74.4	2.7	37.1	79.3	--	--	--	--
	Eastern Shore	11	78.3	3.6	73.1	85.2	--	--	--	--
	Fairfax	263	82.3	2.7	76.2	91.1	--	--	--	--
	Hampton	33	75.7	3.1	69.9	82.2	--	--	--	--
	Henrico	63	78.7	3.1	71.5	85.6	--	--	--	--
	Lenowsico	24	75.0	2.3	69.6	81.0	--	--	--	--
	Lord Fairfax	44	78.0	2.5	72.0	83.8	--	--	--	--
	Loudoun	65	81.5	2.0	76.1	86.3	--	--	--	--
	Mount Rogers	48	75.9	2.4	69.1	81.2	--	--	--	--
	New River	34	77.5	2.4	72.3	81.5	--	--	--	--
	Norfolk	77	75.4	4.1	61.5	84.9	--	--	--	--
	Peninsula	75	77.9	3.9	68.9	89.0	--	--	--	--
	Piedmont	23	76.6	1.9	73.4	80.3	--	--	--	--
	Pittsylvania-Dan	32	74.7	2.6	68.0	78.7	--	--	--	--
	Portsmouth	31	73.5	3.9	66.1	79.7	--	--	--	--
	Prince William	84	80.0	1.8	75.4	86.0	--	--	--	--
	Rappahannock	77	75.8	2.2	73.5	85.1	--	--	--	--
	Rap. Rapidan	39	79.0	2.0	75.1	84.2				
	Richmond	66	75.5	5.0	66.8	89.3	--	--	--	--
	Roanoke	23	75.0	3.4	68.4	83.6	--	--	--	--
	Southside	22	76.1	1.3	73.7	78.5	--	--	--	--
	Thomas Jefferson	49	79.6	3.3	73.3	87.1	--	--	--	--
	Three Rivers	35	77.9	2.4	73.6	84.9	--	--	--	--
	Virginia Beach	99	78.5	2.6	72.9	86.1	--	--	--	--
	West Piedmont	33	75.1	2.7	69.6	81.8	--	--	--	--
	Western Tidewater	42	76.5	2.9	70.1	81.3	--	--	--	--
			F(34,1840) = 40.4, p-value < 0.0001							

	Corr(HOI,LEB) (Overall)	Corr(HOI,LEB) (Per HDL)
Alexandria	r= 0.51, 95% CI: 0.22, 0.71, p-value = 0.0008	r = 0.45, 95% CI: 0.16, 0.67, p-value = 0.0034
Alleghany	r= 0.63, 95% CI: 0.39, 0.78, p-value < 0.0001	r=0.70, 95% CI: 0.50, 0.83, p-value < 0.0001

Arlington	r= 0.53, 95% CI: 0.31, 0.69, p-value < 0.0001	R=0.60, 95% CI: 0.40, 0.74, p-value < 0.0001
Central Shanando	r= 0.54, 95% CI: 0.34, 0.70, p-value < 0.0001	r=0.52, 95% CI: 0.31, 0.68, p-value < 0.0001
Central Virginia	r= 0.78, 95% CI: 0.66, 0.86, p-value < 0.0001	r=0.77, 95% CI: 0.65, 0.86, p-value < 0.0001
Chesapeake	r= 0.87, 95% CI: 0.77, 0.93, p-value < 0.0001	R=0.88, 95% CI: 0.78, 0.93, p-value < 0.0001
Chesterfield	r= 0.74, 95% CI: 0.62, 0.82, p-value < 0.0001	R=0.70, 95% CI: 0.57, 0.80, p-value < 0.0001
Chickahominy	r= 0.53, 95% CI: 0.24, 0.74, p-value = 0.0008	r=0.49, 95% CI: 0.18, 0.71, p-value = 0.0024
Crater	r= 0.77, 95% CI: 0.61, 0.87, p-value < 0.0001	r=0.78, 95% CI: 0.63, 0.88, p-value < 0.0001
Cumberland Plate	r= 0.05, 95% CI: -0.32, 0.41, p-value = 0.7814	R=0.21, 95% CI: -0.18, 0.53, p-value = 0.2851
Eastern Shore	r= -0.56, 95% CI: -0.87, 0.07, p-value = 0.0635	R=-0.36, 95% CI: -0.79, 0.31, p-value = 0.2670
Fairfax	r= 0.40, 95% CI: 0.29, 0.49, p-value < 0.0001	R=0.45, 95% CI: 0.35, 0.54, p-value< 0.0001
Hampton	r= 0.69, 95% CI: 0.46, 0.84, p-value < 0.0001	R=0.71, 95% CI: 0.48, 0.85, p-value<0.0001
Henrico	r= 0.70, 95% CI: 0.55, 0.81, p-value < 0.0001	R=0.73, 95% CI: 0.59, 0.83, p-value < 0.0001
Lenowsico	r= -0.02, 95% CI: -0.42, 0.38, p-value = 0.9139	R=0.03, 95% CI: -0.38, 0.43, p-value = 0.8787
Lord Fairfax	r= 0.67, 95% CI: 0.47, 0.81, p-value < 0.0001	r=0.68, 95% CI: 0.48, 0.81, p-value < 0.0001
Loudoun	r= 0.50, 95% CI: 0.29, 0.66, p-value < 0.0001	R=0.51, 95% CI: 0.30, 0.67, p-value < 0.0001
Mount Rogers	r= 0.55, 95% CI: 0.31, 0.72, p-value < 0.0001	R=0.57, 95% CI: 0.34, 0.73, p-value < 0.0001
New River	r= 0.69, 95% CI: 0.46, 0.83, p-value < 0.0001	r=0.70, 95% CI: 0.48, 0.84, p-value < 0.0001
Norfolk	r= 0.66, 95% CI: 0.51, 0.77, p-value < 0.0001	R=0.70, 95% CI: 0.57, 0.80, p-value < 0.0001
Peninsula	r= 0.82, 95% CI: 0.73, 0.88, p-value < 0.0001	r=0.84, 95% CI: 0.75, 0.89, p-value < 0.0001
Piedmont	r= 0.13, 95% CI: -0.29, 0.52, p-value = 0.5346	R=0.28, 95% CI: -0.15, 0.62, p-value = 0.1876
Pittsylvania-Dan	r= 0.62, 95% CI: 0.35, 0.80, p-value < 0.0001	r=0.75, 95% CI: 0.54, 0.87, p-value < 0.0001
Portsmouth	r= 0.69, 95% CI: 0.45, 0.84, p-value < 0.0001	R=0.77, 95% CI: 0.56, 0.88, p-value < 0.0001
Prince William	r= 0.41, 95% CI: 0.21, 0.57, p-value < 0.0001	r=0.45, 95% CI: 0.26, 0.61, p-value < 0.0001
Rappahannock	r= 0.35, 95% CI: 0.14, 0.53, p-value = 0.0014	R=0.35, 95% CI: 0.14, 0.53, p-value = 0.0014

Rap. Rapidan	r= 0.33, 95% CI: 0.02, 0.59, p-value = 0.0344	R=0.46, 95% CI: 0.17, 0.68, p-value = 0.0025
Richmond	r= 0.77, 95% CI: 0.64, 0.85, p-value < 0.0001	R=0.79, 95% CI: 0.68, 0.87, p-value < 0.0001
Roanoke	r= 0.86, 95% CI: 0.69, 0.94, p-value < 0.0001	r=0.80, 95% CI: 0.57, 0.91, p-value < 0.0001
Southside	r= -0.06, 95% CI: -0.47, 0.37, p-value = 0.7967	R=0.25, 95% CI: -0.19, 0.61, p-value = 0.2514
Thomas Jefferson	r= 0.73, 95% CI: 0.56, 0.84, p-value < 0.0001	r=0.73, 95% CI: 0.56, 0.84, p-value < 0.0001
Three Rivers	r= 0.22, 95% CI: -0.12, 0.52, p-value = 0.1943	R=0.23, 95% CI: -0.11, 0.52, p-value = 0.1823
Virginia Beach	r= 0.74, 95% CI: 0.64, 0.82, p-value < 0.0001	R=0.75, 95% CI: 0.64, 0.82, p-value < 0.0001
West Piedmont	r= 0.65, 95% CI: 0.40, 0.81, p-value < 0.0001	r=0.60, 95% CI: 0.32, 0.78, p-value = 0.0001
Western Tidewater	r= 0.69, 95% CI: 0.49, 0.82, p-value < 0.0001	r=0.77, 95% CI: 0.60, 0.87, p-value < 0.0001

Indicator Weights per Health District Level													
	AQ	PCI	PDI	WI	AI	EI	FAI	MD	AE	II	JP	AH	S
Alexandria[2]	0.01	0.17	0.01	0.05	0.28	0.17	0.12	0.06	0.01	0.01	0.01	0.09	0.02
Alleghany[8]	0.05	0.16	0.06	0.03	0.08	0.21	0.08	0.17	0.03	0.03	0.06	0.03	0.01
Arlington[2]	0.01	0.17	0.01	0.05	0.28	0.17	0.12	0.06	0.01	0.01	0.01	0.09	0.02
Central Shenandoah	0.05	0.14	0.00	0.00	0.09	0.24	0.12	0.03	0.00	0.06	0.19	0.00	0.07
Central Virginia	0.09	0.04	0.01	0.01	0.17	0.40	0.12	0.02	0.01	0.05	0.06	0.01	0.01
Chesapeake[4]	0.06	0.01	0.01	0.01	0.17	0.41	0.01	0.19	0.04	0.02	0.03	0.03	0.02
Chesterfield[7]	0.12	0.01	0.01	0.02	0.10	0.33	0.03	0.17	0.09	0.04	0.03	0.02	0.03
Chickahominy	0.06	0.01	0.01	0.04	0.05	0.48	0.00	0.01	0.04	0.10	0.02	0.14	0.05
Crater	0.14	0.08	0.11	0.01	0.21	0.12	0.06	0.07	0.04	0.05	0.06	0.04	0.01
Cumberland Plate[1]	0.13	0.04	0.05	0.00	0.21	0.17	0.01	0.15	0.17	0.09	0.03	0.01	0.09
Eastern Shore[3]	0.06	0.05	0.09	0.02	0.22	0.04	0.09	0.01	0.01	0.01	0.01	0.11	0.27
Fairfax[2]	0.01	0.17	0.01	0.05	0.28	0.17	0.12	0.06	0.01	0.01	0.01	0.09	0.02
Hampton[4]	0.06	0.01	0.01	0.01	0.17	0.41	0.01	0.19	0.04	0.02	0.03	0.03	0.02
Henrico[7]	0.12	0.01	0.01	0.02	0.10	0.33	0.03	0.17	0.09	0.04	0.03	0.02	0.03
Lenowsico[1]	0.13	0.04	0.05	0.00	0.21	0.17	0.01	0.15	0.17	0.09	0.03	0.01	0.09
Lord Fairfax	0.04	0.04	0.01	0.03	0.26	0.37	0.05	0.09	0.03	0.01	0.06	0.00	0.00
Loudoun[2]	0.01	0.17	0.01	0.05	0.28	0.17	0.12	0.06	0.01	0.01	0.01	0.09	0.02
Mount Rogers[1]	0.13	0.04	0.05	0.00	0.21	0.17	0.01	0.15	0.17	0.09	0.03	0.01	0.09
New River	0.02	0.01	0.09	0.04	0.13	0.30	0.03	0.13	0.06	0.11	0.07	0.01	0.00
Norfolk[4]	0.06	0.01	0.01	0.01	0.17	0.41	0.01	0.19	0.04	0.02	0.03	0.03	0.02
Peninsula	0.04	0.11	0.01	0.00	0.16	0.37	0.04	0.15	0.00	0.05	0.03	0.00	0.04

Piedmont[5]	0.26	0.03	0.02	0.04	0.01	0.07	0.02	0.12	0.06	0.28	0.01	0.01	0.07
Pittsylvania-Danville	0.06	0.28	0.08	0.14	0.11	0.03	0.07	0.07	0.01	0.05	0.01	0.03	0.04
Portsmouth[4]	0.06	0.01	0.01	0.01	0.17	0.41	0.01	0.19	0.04	0.02	0.03	0.03	0.02
Prince William	0.01	0.20	0.03	0.13	0.03	0.15	0.14	0.05	0.03	0.14	0.01	0.02	0.07
Rappahannock[6]	0.06	0.01	0.04	0.11	0.04	0.37	0.04	0.02	0.03	0.01	0.01	0.14	0.12
Rap. Rapidan[6]	0.06	0.01	0.04	0.11	0.04	0.37	0.04	0.02	0.03	0.01	0.01	0.14	0.12
Richmond[7]	0.12	0.01	0.01	0.02	0.10	0.33	0.03	0.17	0.09	0.04	0.03	0.02	0.03
Roanoke[8]	0.05	0.16	0.06	0.03	0.08	0.21	0.08	0.17	0.03	0.03	0.06	0.03	0.01
Southside[5]	0.26	0.03	0.02	0.04	0.01	0.07	0.02	0.12	0.06	0.28	0.01	0.01	0.07
Thomas Jefferson	0.05	0.04	0.01	0.05	0.19	0.20	0.03	0.14	0.03	0.05	0.01	0.08	0.12
Three Rivers[3]	0.06	0.05	0.09	0.02	0.22	0.04	0.09	0.01	0.01	0.01	0.01	0.11	0.27
Virginia Beach[4]	0.06	0.01	0.01	0.01	0.17	0.41	0.01	0.19	0.04	0.02	0.03	0.03	0.02
West Piedmont	0.08	0.05	0.12	0.03	0.08	0.23	0.08	0.05	0.00	0.05	0.01	0.19	0.03
Western Tidewater	0.13	0.09	0.00	0.01	0.03	0.16	0.00	0.26	0.01	0.06	0.02	0.02	0.21
[1,2,3,4,5,6,7,8]Indicates Health District Levels were merged due to small sample sizes and model non-convergence													

Map of Health Districts: http://www.vdh.virginia.gov/local-health-districts/

Merged Health Districts:

1: Cumberland, Lenowsico, Mount Rogers

2: Alexandria, Arlington, Fairfax, Loudoun

3: Eastern Shore, Three Rivers

4: Chesapeake, Hampton, Norfolk, Portsmouth, Virginia Beach

5: Piedmont, Southside

6: Rappahannock, Rappahannock/Rapidan

7: Chesterfield, Henrico, Richmond

8: Alleghany, Roanoke