Supplement to MI-Environment: Geospatial Patterns for Relative Heat Stress Vulnerability in Michigan

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Category	Original Spatial Unit converted to Census Tract Level	Factor	Data Source
Place	Continuous raster 30 m	% Lack of tree canopy coverage	Homer, C.G., Dewitz, J.A., Yang, L., et al., 2015
	Continuous raster	% Impervious surface	
Temper-ature	10 Climatic regions	Change in projected average seasonal temperature (2041-2070) – (1981-2010)	Great Lakes Integrated Sciences Assessment, Coupled Model Intercomparison Project Phase 3, 2016
		Number of projected hot days over 90 degrees Fahrenheit or 32.2 degrees Celsius (2041-2070)	
		Projected average seasonal temperature (2041-2070)	
People	Block Group	% of the population over 65 and living alone	U.S. Census Bureau, 2012
		% of children under 5 years	
		% of households with no access to a personal vehicle	U.S. Census Bureau, 2013
	County	% of the population obese BMI > 30kg/m^2	Michigan Department of Health and Human Services, 2012

Table S- 1: Comparison of level of spatial resolution by HVI factor

Vulnerability Index	Category of Inequality	Rest of Michigan (Tri-County Excluded, n=1647)	
		Inequality Index	95% CI
Analytic Heat Stress Vulnerability Index (Poverty variable excluded)	Proportion people of color	-0.056	(-0.050,-0.061)***
	Proportion residents living below poverty	-0.074	(-0.068,-0.081)***
	Proportion residents living below twice poverty	-0.081	(-0.075,-0.087)***
	Proportion living in rented households	-0.071	(-0.065,-0.077)***
	Median house value	-0.102	(-0.095,-0.109)***
	Proportion over age 24 without high school completion	-0.068	(-0.062,-0.074)***
	Linguistic Isolation	0.041	(-0.003,0.087)
Temperature Index	Place Index	-0.082	(-0.076,-0.088)***
	People Index (Poverty variable excluded)	-0.018	(-0.013,-0.023)*
Place Index	People Index (Poverty variable excluded)	-0.060	(-0.054,-0.066)***

* 0.1<p<0.05, ** 0.05<p<0.001, *** p<0.001

Table S- 2: Inequality curve analysis significance tests of heat exposure for individual and cumulative indicators of vulnerability within Michigan that excludes the Detroit metropolitan area to remove any bias from the state's largest metropolitan area (Michigan, n=2813 census tracts)

Vulnerability Index	Category of Inequality	Tri-County(n=1166)	
		Inequality Index	95% CI
Analytic Heat Stress Vulnerability Index (Poverty variable excluded)	Proportion people of color	-0.114	(-0.107,-0.121)***
	Proportion residents living below poverty	-0.134	(-0.126,-0.141)***
	Proportion residents living below twice poverty	-0.145	(-0.137,-0.153)***
	Proportion living in rented households	-0.116	(-0.109,-0.123)***
	Median house value	-0.171	(-0.163,-0.180)***
	Proportion over age 24 without high school completion	-0.112	(-0.105,-0.119)***
	Linguistic Isolation	-0.029	(-0.024,-0.034)
Temperature Index	Place Index	-0.163	(-0.155,-0.171)***
	Analytic People Index (Poverty variable excluded)	-0.190	(-0.181,-0.199)***
Place index	Analytic People Index (Poverty variable excluded)	-0.193	(-0.184,-0.202)***

* 0.1<p<0.05, ** 0.05<p<0.001, *** p<0.001

Table S- 3: Inequality curve significance tests of heat exposure for individual and cumulative indicators of vulnerability within the Detroit metropolitan area (Michigan, n=2813 census tracts)

Significance tests of inequality in heat vulnerability exposure for individual and cumulative indicators of vulnerability (Urban vs Rural)					
		Urban(n=2347)		Rural (n=466)	
Vulnerability Index	Category of Inequality	Inequality Index	95% CI	Inequality Index	95% CI
Analytic Heat Stress Vulnerability Index (Poverty variable excluded)	Proportion people of color	-0.120	(-0.112,-0.127)***	0.038	(-0.170, 0.039)
	Proportion residents living below poverty	-0.114	(-0.106,-0.121)***	-0.026	(-0.296,0.243)
	Proportion residents living below twice poverty	-0.122	(-0.114,-0.129)***	-0.030	(-0.303,0.243)
	Proportion living in rented households	-0.108	(-0.101,-0.115)***	0.011	(-0.221,0.243)
	Median house value	-0.156	(-0.148,-0.164)***	-0.058	(-0.362,0.246)
	Proportion over age 24 without high school completion	-0.113	(-0.106,-0.12)***	-0.033	(-0.309,0.244)
	Proportion linguistic isolation	0.090	(-0.750, 0.929)	0.025	(-1.074,1.124)
Temperature Index	Place Index	-0.115	(-0.108,-0.123)***	-0.050	(-0.345,0.245)
	Analytic People Index (Poverty variable excluded)	-0.056	(-0.050,-0.062)***	-0.005	(-0.253,0.243)
Place Index	Analytic People Index (Poverty variable excluded)	-0.119	(-0.112,-0.126)***	-0.034	(-0.312,0.244)

* 0.1<p<0.05, ** 0.05<p<0.001, *** p<0.001

Table S- 4 Inequality curve significance tests of heat vulnerability exposure for individual and cumulative indicators of vulnerability comparing Michigan's urban and rural areas (Michigan, n=2813 census tracts)

	(A)		(B)		(C)	
	Michigan (2813 census tracts) n= (2722-2767)		Rest Michigan (1647 census tracts) n= (1577-1604)		Tri-County (1166 census tracts) n= (1145-1163)	
Variable	Mean (SD)	Min - Max	Mean (SD)	Min - Max	Mean (SD)	Min - Max
Analytic Heat Stress Vulnerability Index	51.8 (12.1)	15.0 - 85.0	46.1 (10.2)	15.0 - 79.0	59.7 (10.0)	30.0 - 85.0
Place Index	46.5 (20.2)	8.0 - 100.0	35.6 (16.0)	8.0 - 100.0	61.5 (15.3)	21.0 - 100.0
Percent Lack of Tree Canopy	38.1 (17.1)	0.0 - 83.5	47.1 (14.1)	0.0 - 83.5	25.7 (12.7)	0.0 - 59.7
Percent Impervious Surface Coverage	29.1 (23.2)	0.0 - 93.5	17.2 (18.7)	0.0 - 93.0	45.5 (18.5)	0.7 - 93.4
Temperature Index	65.2 (15.0)	2.0 - 100	59.1 (16.8)	2.0 - 100.0	73.6 (4.5)	59.0 - 82.0
Average Heat Index	92.1 (20.7)	0.0 - 100.0	86.3 (25.8)	0.0 - 100.0	100.0 (0.0)	100.0 - 100.0
Extreme Heat Index	56.3 (14.8)	0.0 - 100.0	50.1 (16.2)	0.0 - 100.0	64.9 (6.0)	44.7 - 76.6
Analytic People index	43.8 (13.8)	0.0 - 100.0	43.5 (13.1)	0.0 - 94.0	44.2 (14.8)	5.0 - 100.0
Obesity Prevalence	52.9 (20.9)	0.0 - 100.0	55.0 (21.6)	0.0 - 100.0	50.0 (19.6)	19.6 - 63.7
Percent 65+ Living Alone	25.3 (13.6)	0.0 - 100.0	24.5 (12.5)	0.0 - 78.1	26.3 (15.0)	0.0 - 100.0
Percent <5 Years Old	27.3 (12.1)	0.0 - 100.0	27.0 (11.7)	0.0 - 100.0	27.7 (12.7)	0.0 - 88.4
Percent No Personal Transportation	8.9 (9.8)	0.0 - 100.0	7.2 (7.7)	0.0 - 100.0	11.2 (11.8)	0.0 - 69.9
Population Vulnerability Indicator from American Community Survey (2008-2012)						
% People of color	24 (29.7)	0.0 - 100.0	14.1 (19)	0.0 - 99.5	37.7 (35.8)	0.0 - 100.0
% age 25 and older with < High School	12.3 (8.8)	0.0 - 83.3	11.2 (7.2)	0.0 - 83.3	13.9 (10.4)	0.0 - 67.1
% Living in rented households	28.3 (21.1)	0.0 - 100.0	26.0 (20.4)	0.0 - 100.0	31.4 (21.6)	0.0 - 100.0
Median house value	129,083.6 (69,660.3)	12,500.0 - 674,900.0	128,722.0 (56,514.0)	12,500.0 - 639,600.0	129,581.6 (84,507.2)	13,400.0 - 674,900.0
% below poverty line	18.2 (14.9)	0.0 - 100.0	17.3 (13.5)	0.0 - 100.0	19.3 (16.6)	0.0 - 100.0
% below twice poverty line	37.1 (19.9)	0.0 - 100.0	37.0 17.6)	0.0 - 100.0	37.3 (22.8)	0.0 - 100.0
Linguist isolation: 5 years+ living in households where no one age 18 and older speaks English	0.3 (0.9)	0.0 - 11.2	0.2 (0.7)	0.0 - 11.2	0.4 (1.1)	0.0 - 10.9

1: Comparisons significant at the 0.05 level are indicated by ***

Table S- 5: Descriptive statistics for Analtyic HVI, Place, Temperature, People indices and social vulnerability factors for all Michigan census tracts, all Michigan census tracts excluding the Detroit metropolitan area (rest of Michigan), and only those census tracts within the Detroit metropolitan area (n = 2813)

	Pairwise test for comparisons		
	Tukey's Studentized Range (HSD)[1] p-values[2]		
	Area[3]		
Factor	(A) vs (B)	(A) vs (C)	(B) vs (C)
Analytic Heat Stress Vulnerability Index	**	**	**
Place Index	**	**	**
Percent Lack of Tree Canopy	**	**	**
Percent Impervious Surface Coverage	**	**	**
Temperature Index	**	**	**
Average Heat Index	**	**	**
Extreme Heat Index	**	**	**
Analytic People index			
Obesity Prevalence	**	**	**
Percent 65+ Living Alone			**
Percent <5 Years Old			
Percent No Personal Transportation	**	**	**
Population Vulnerability Indicator from American Community Survey 2008-2012			
% People of color		**	**
% age 25 and older with < High School		**	**
% Living in rented households		**	**
Median House value			
% below poverty line			**
% below twice poverty line			
Linguist isolation : % 5 and older living in households where no one age 18 and older speaks English	**	**	**

[1]This test controls the Type I experiment-wise error rate.
[2]Comparisons significant at the p<0.05 level are indicated by **
[3]Area (A) Michigan (2813 census tracts), Area (B) Rest Michigan (1647 census tracts), Area (C) Tri-County Detroit (1166 census tracts)

Table S- 6: Pairwise comparisons of descriptive statistics for heat stress, people, place, temperature, and social vulnerabilities between all Michigan census tracts, all Michigan census tracts excluding the Detroit metropolitan area, and only those census tracts within the Detroit metropolitan area (n=2813)

Pairwise t-test using Tukey's studentized range comparing (A) the whole state of Michigan to (B) the Rest of Michigan or to (C) the Tri-County Detroit Metro area show that there are significant differences at the 95% confidence level of means of the aggregate Analytic Health Stress Vulnerability Index as well as some of its components such as Place and Temperature. The People dimension of the cumulative index had some of its components significantly different when comparing (C) the Tri-County Detroit Metro Area to (B) the Rest of Michigan.

Eigenvalues of the Correlation Matrix using SAS FACTOR procedure

Factor	Eigenvalue	Difference	Proportion	Cumulative
1 Place	2.61709993	1.67996582	0.6543	0.6543
2 Temperature	0.93713411	0.49167356	0.2343	0.8886
3 People (poverty excluded)	0.44546055	0.44515514	0.1114	0.9999
4	0.00030541	0.0001	1.0000	

Table S- 7: Principal component analyses of Place, Temperature and Analytic People indices

Figures S-1 to S-10: Inequality Curves for the Rest of Michigan, Excluding Metropolitan Detroit

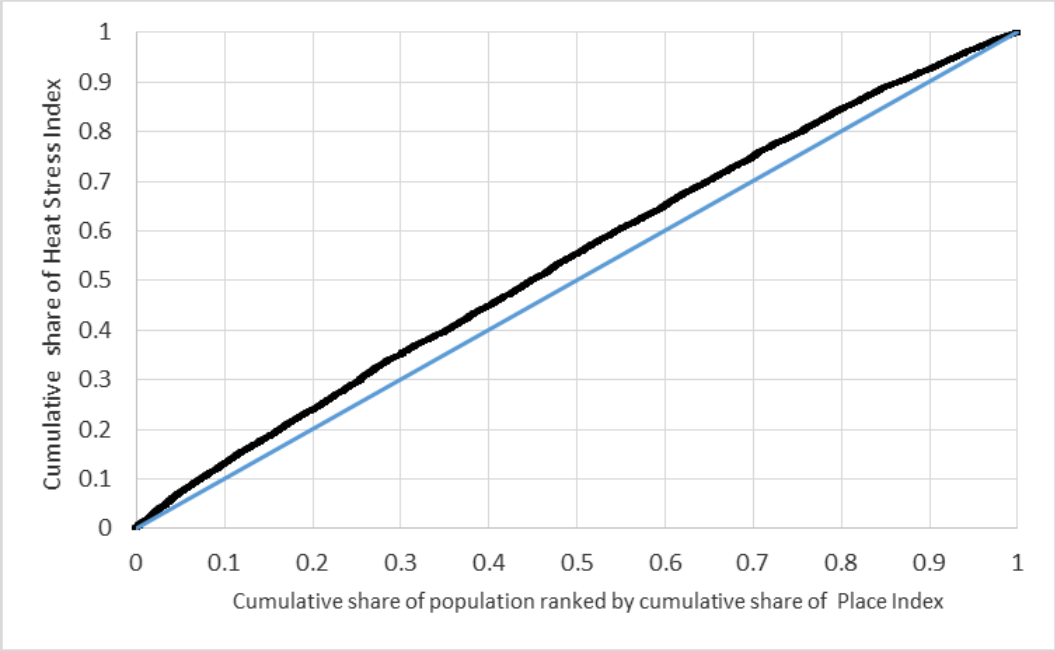

Fig. S- 1: Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Place Index for all Michigan geographies excluding the Detroit metropolitan area

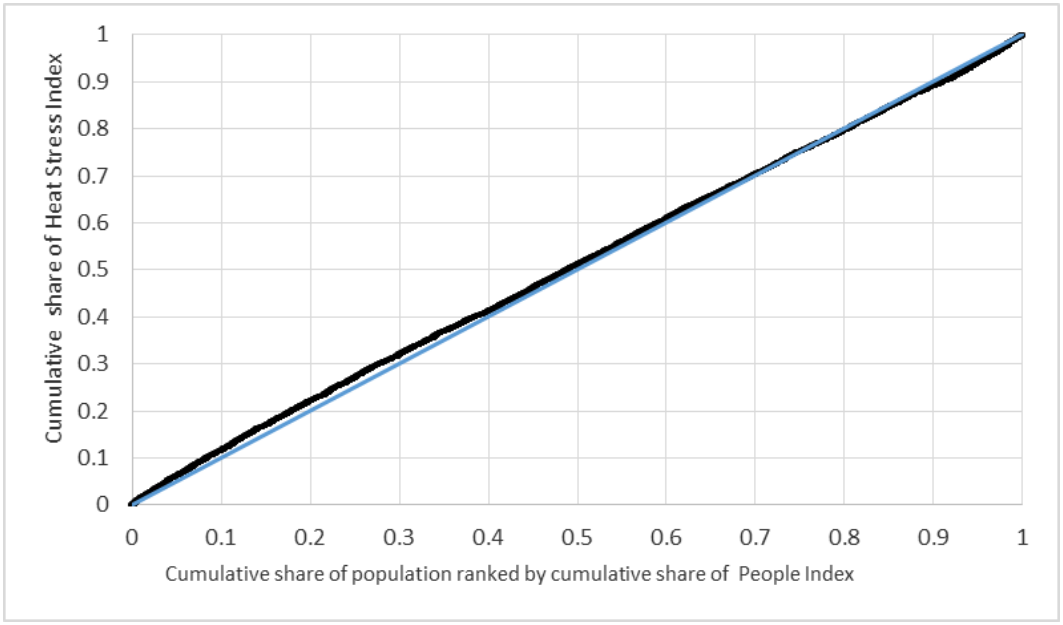

Fig. S- 2: Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Analytic People Index for all Michigan geographies excluding the Detroit metropolitan area

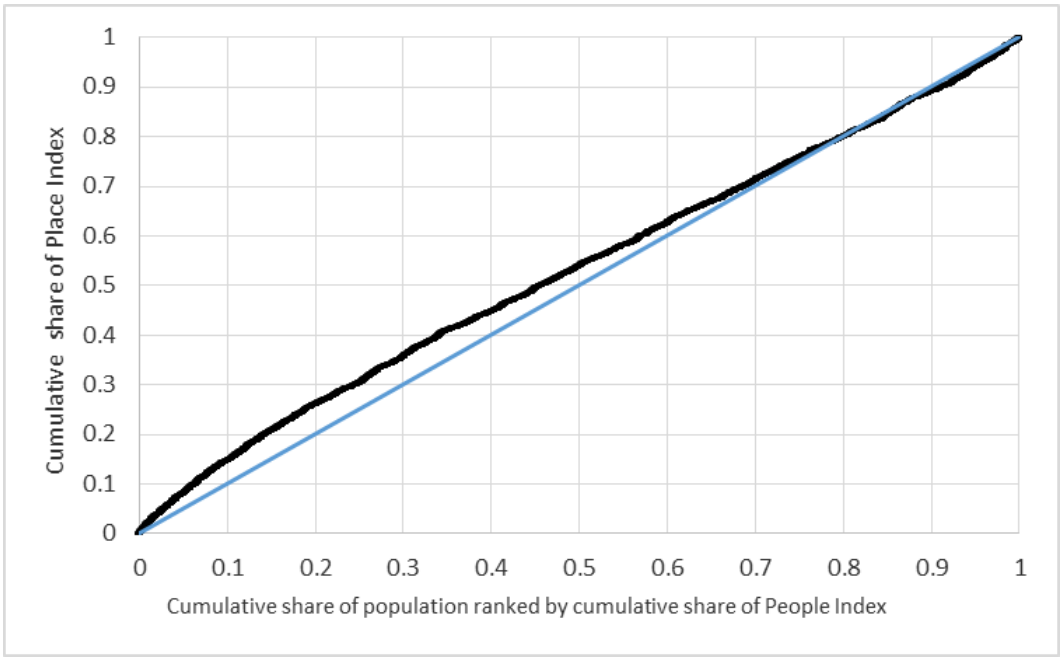

Fig. S- 3: Inequality curve showing the relative distribution of inequality between the Place Index and the Analytic People Index for all Michigan geographies excluding the Detroit metropolitan area

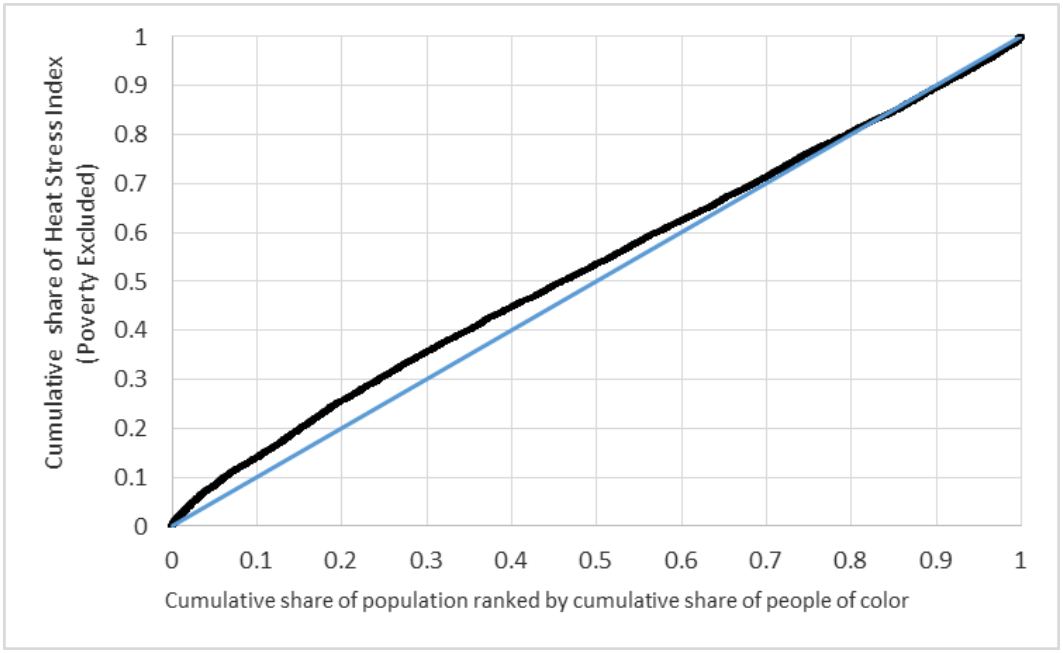

Fig. S- 4: Inequality curve showing the relative distribution of inequality between the Analytic HVI and race for all Michigan geographies excluding the Detroit metropolitan area

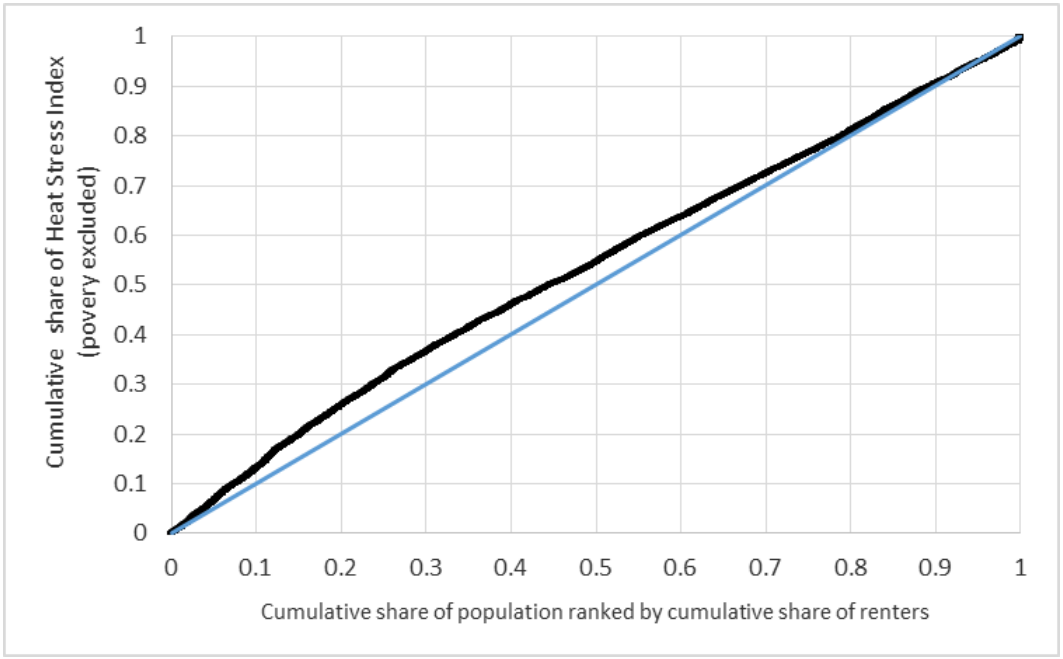

Fig. S- 5: Inequality curve showing the relative distribution of inequality between the Analytic HVI and renter populations for all Michigan geographies excluding the Detroit metropolitan area

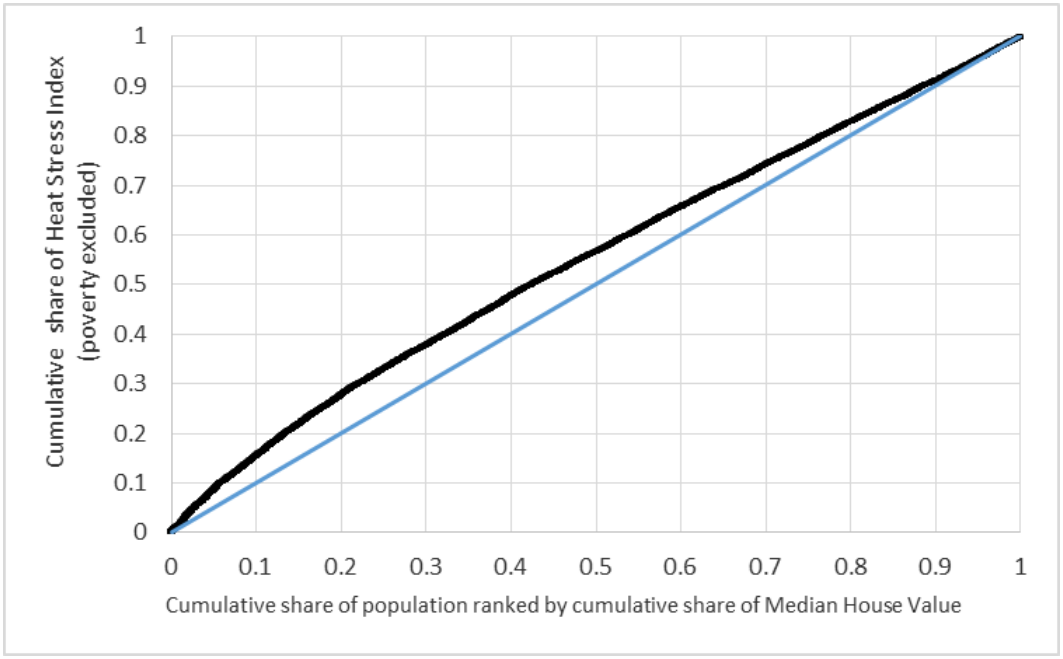

Fig. S- 6: Inequality curve showing the relative distribution of inequality between the Analytic HVI and median home value for all Michigan geographies excluding the Detroit metropolitan area

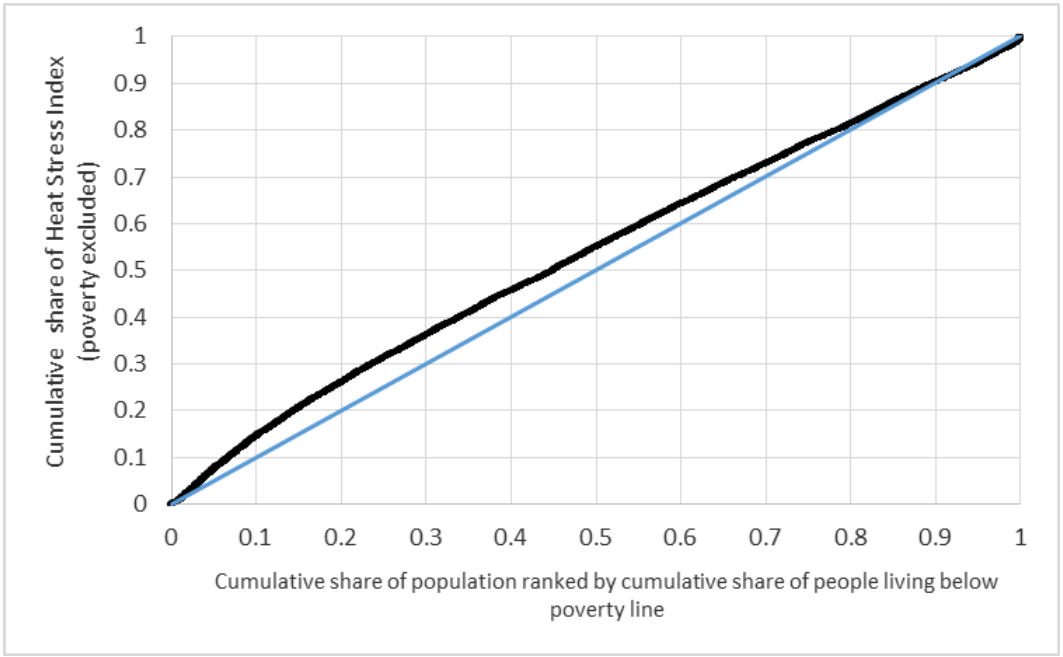

Fig. S- 7: Inequality curve showing the relative distribution of inequality between the Analytic HVI and poverty for all Michigan geographies excluding the Detroit metropolitan area

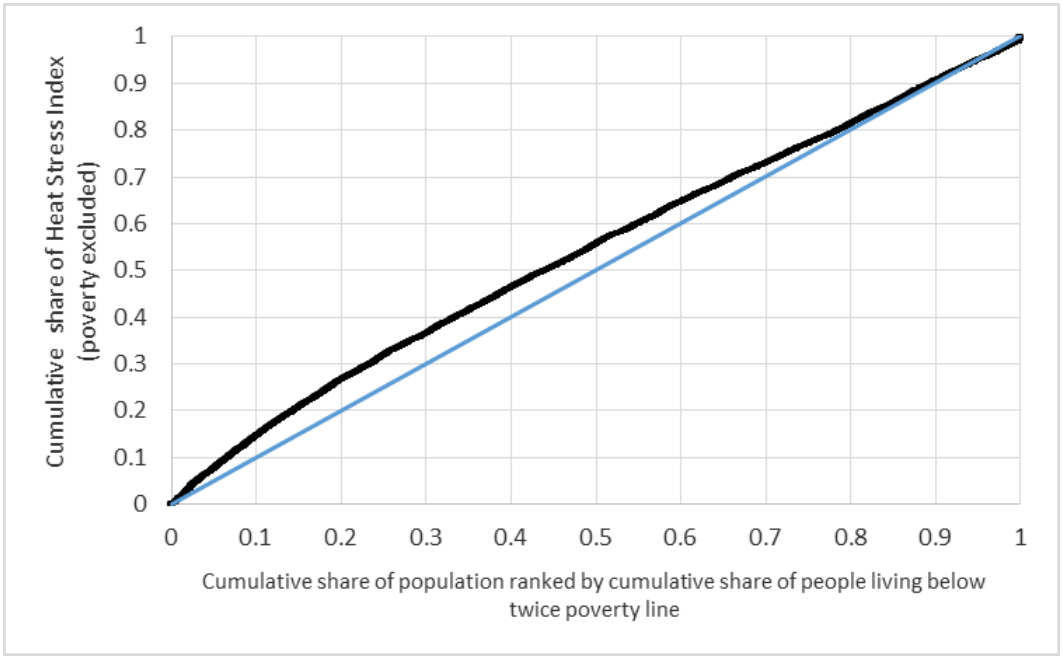

Fig. S- 8: Inequality curve showing the relative distribution of inequality between the Analytic HVI and severe poverty for all Michigan geographies excluding the Detroit metropolitan area

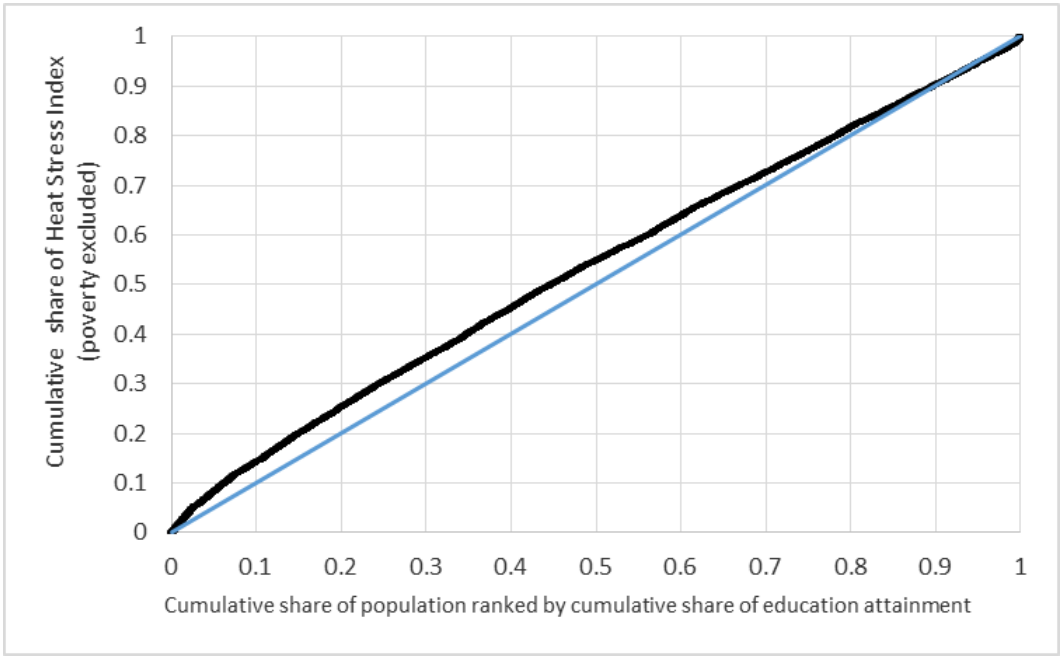

Fig. S- 9: Inequality curve showing the relative distribution of inequality between the Analytic HVI and education for all Michigan geographies excluding the Detroit metropolitan area

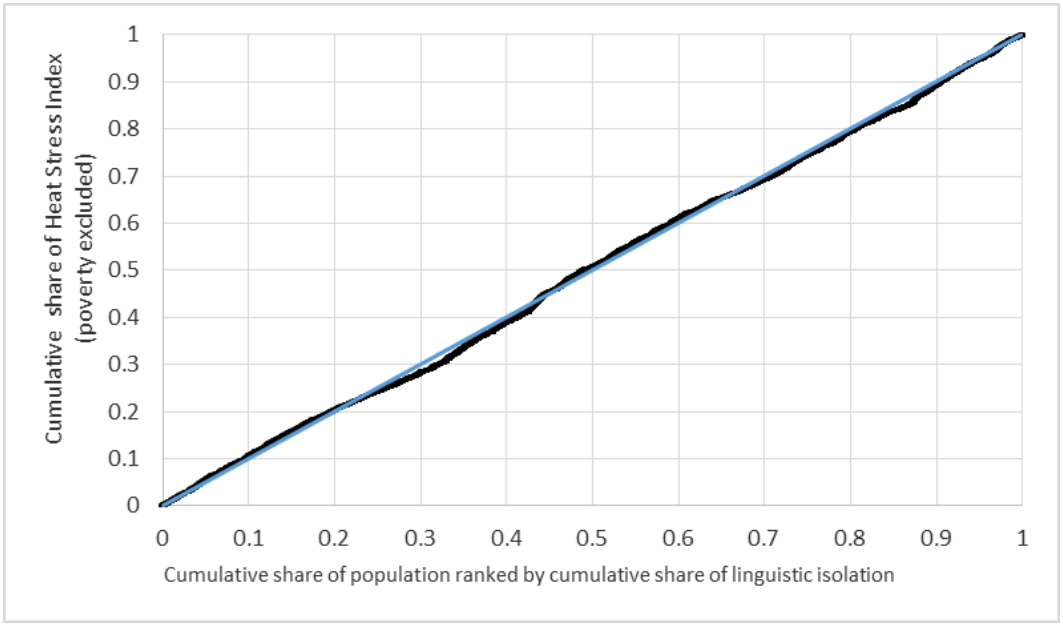

Fig. S- 10: Inequality curve showing the relative distribution of inequality between the Analytic HVI and linguistic isolation for all Michigan geographies excluding the Detroit metropolitan area

Figures S-11 to S-20: Inequity Curves for Tri-County Metropolitan Detroit Only

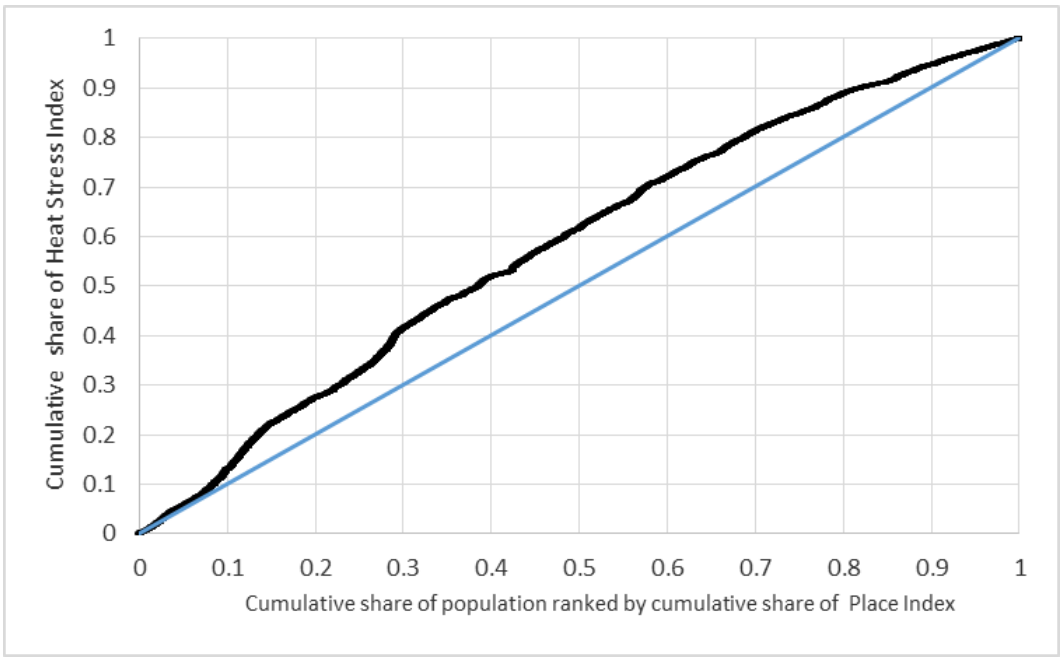

Fig. S- 11 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Place Index for the Detroit metropolitan area only

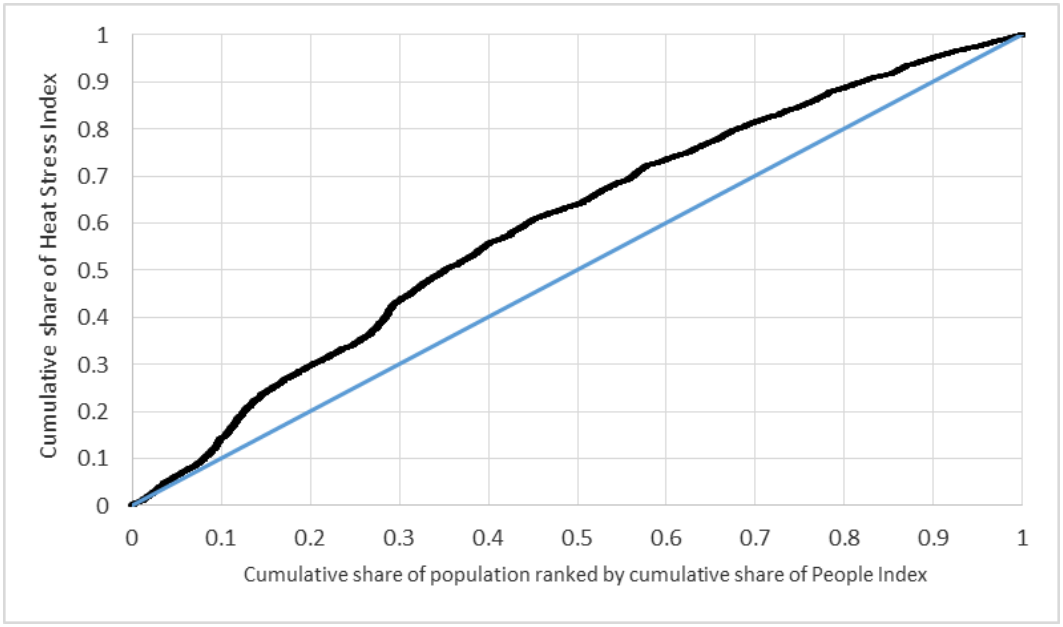

Fig. S- 12 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Analytic People Index for the Detroit metropolitan area only

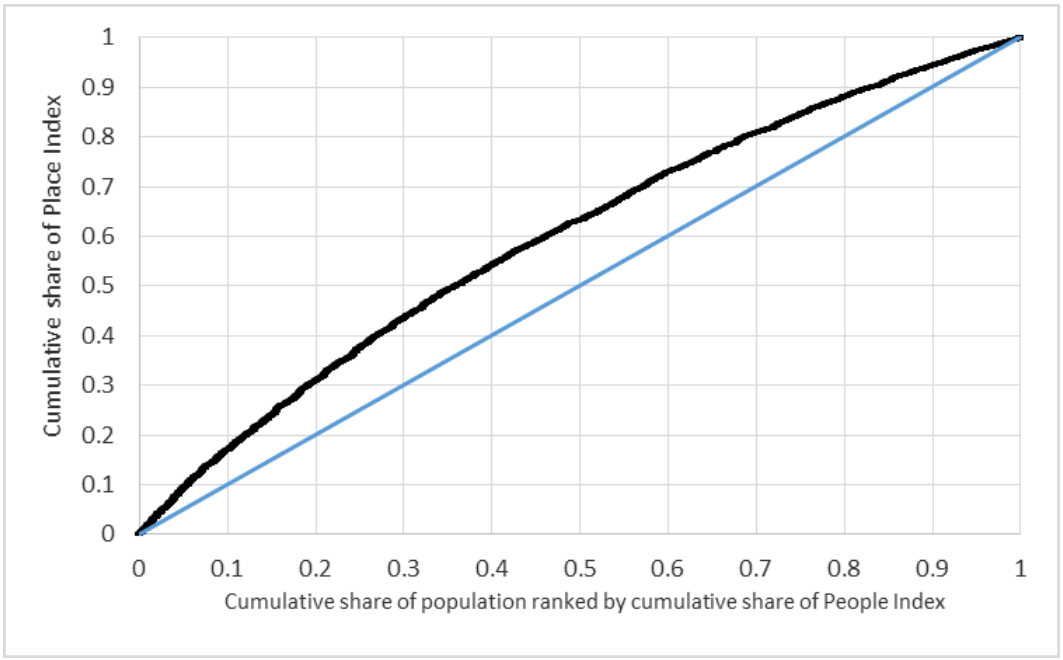

Fig. S- 13 Inequality curve showing the relative distribution of inequality between the Place Index and the Analytic People Index for the Detroit metropolitan area only

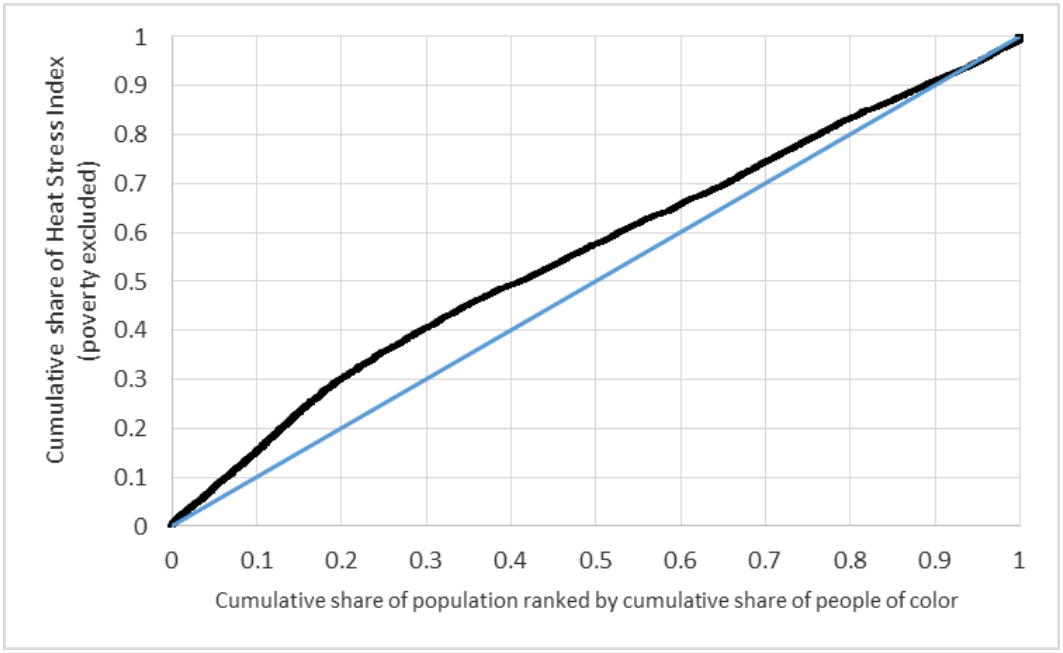

Fig. S- 14 Inequality curve showing the relative distribution of inequality between the Analytic HVI and race for the Detroit metropolitan area only

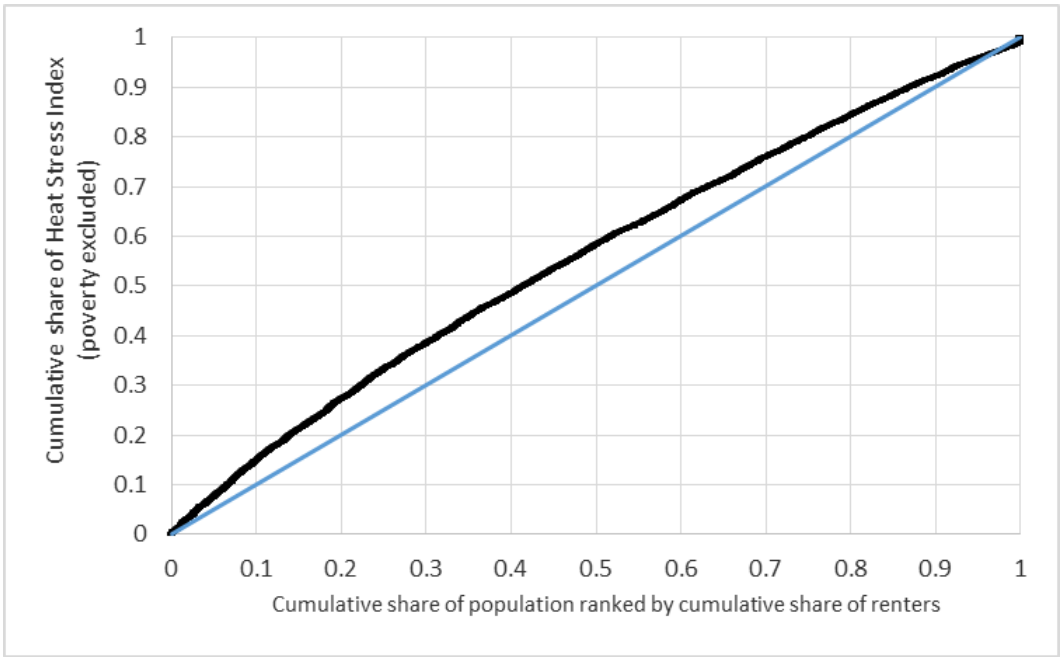

Fig. S- 15 Inequality curve showing the relative distribution of inequality between the Analytic HVI and renter population for the Detroit metropolitan area only

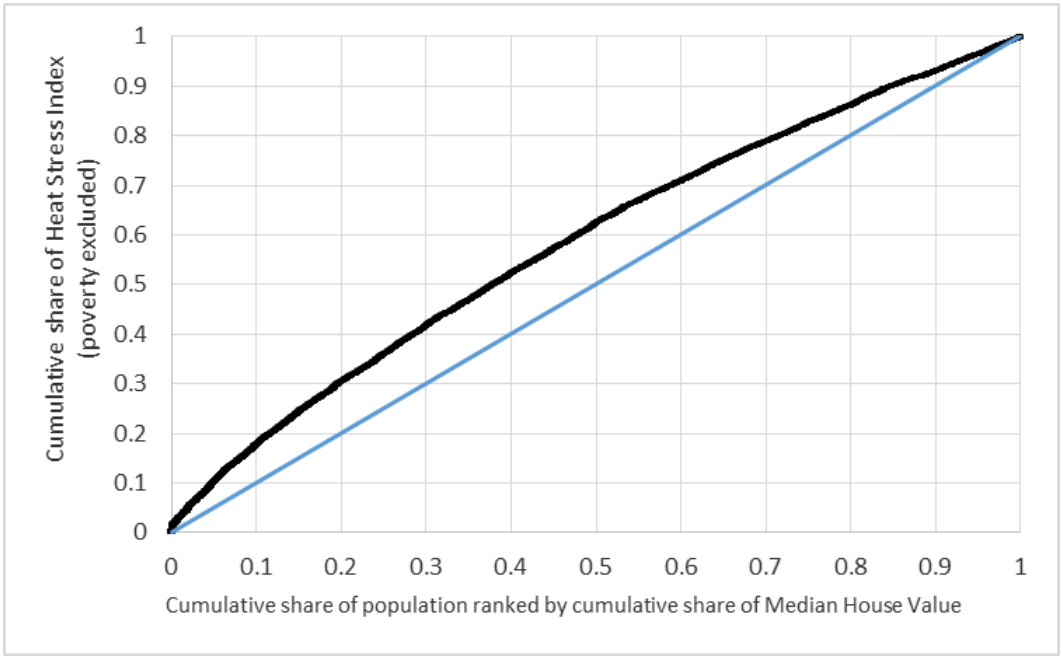

Fig. S- 16 Inequality curve showing the relative distribution of inequality between the Analytic HVI and median home value for the Detroit metropolitan area only

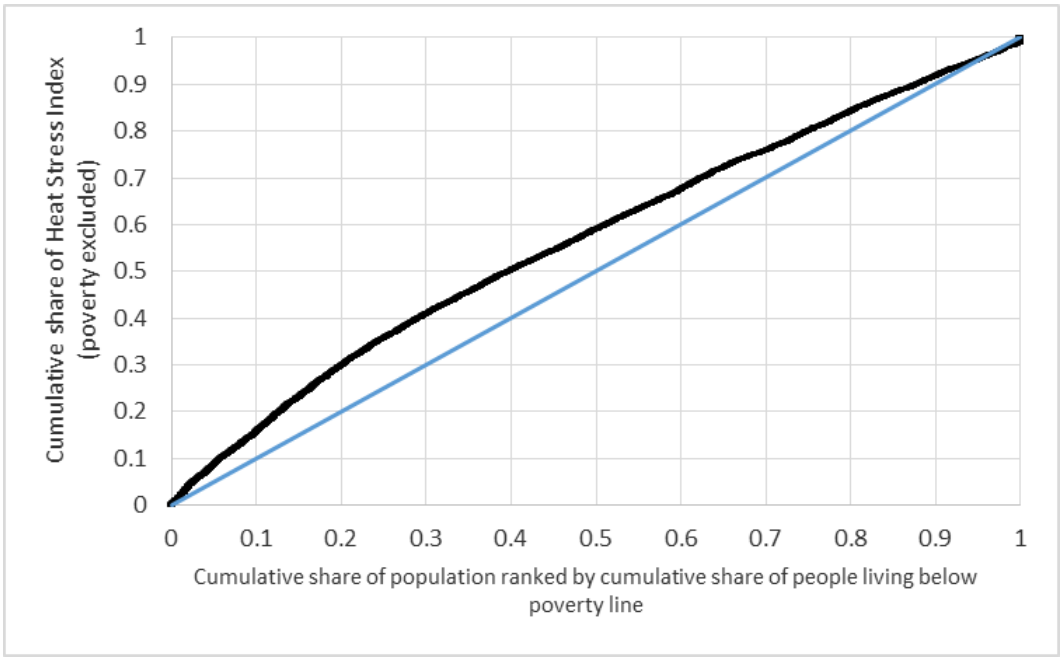

Fig. S- 17 Inequality curve showing the relative distribution of inequality between the Analytic HVI and poverty for the Detroit metropolitan area only

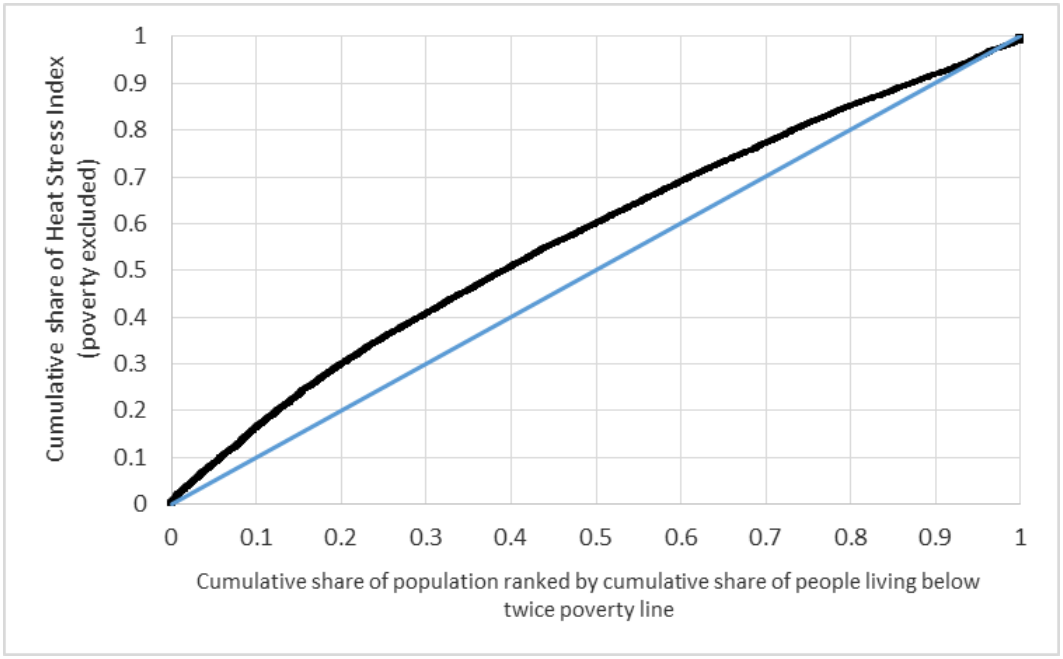

Fig. S- 18 Inequality curve showing the relative distribution of inequality between the Analytic HVI and severe poverty for the Detroit metropolitan area only

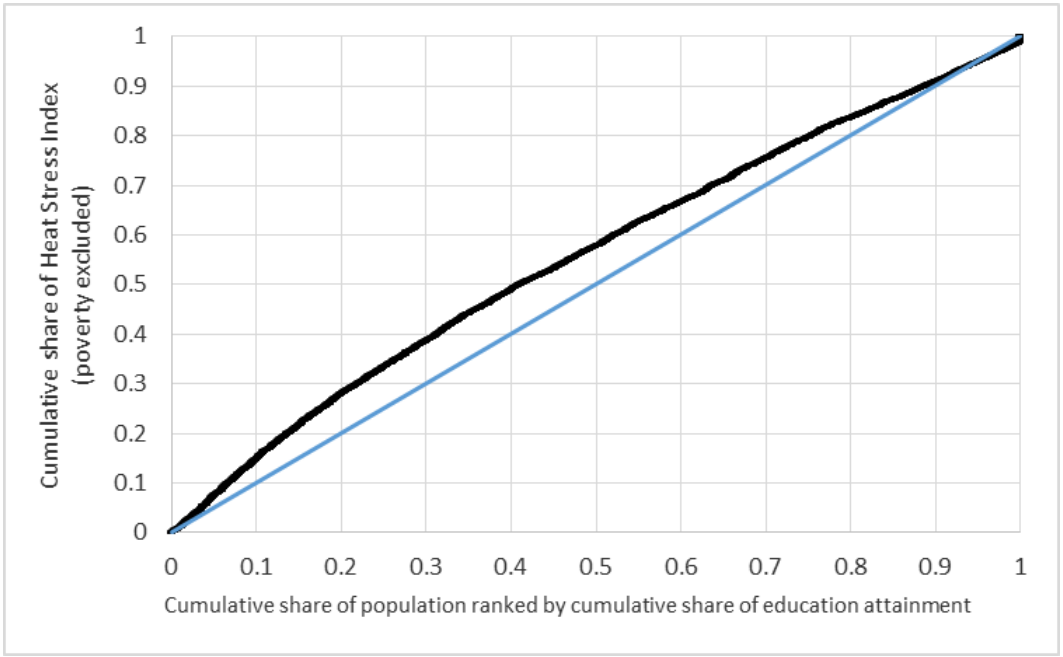

Fig. S- 19 Inequality curve showing the relative distribution of inequality between the Analytic HVI and education for the Detroit metropolitan area only

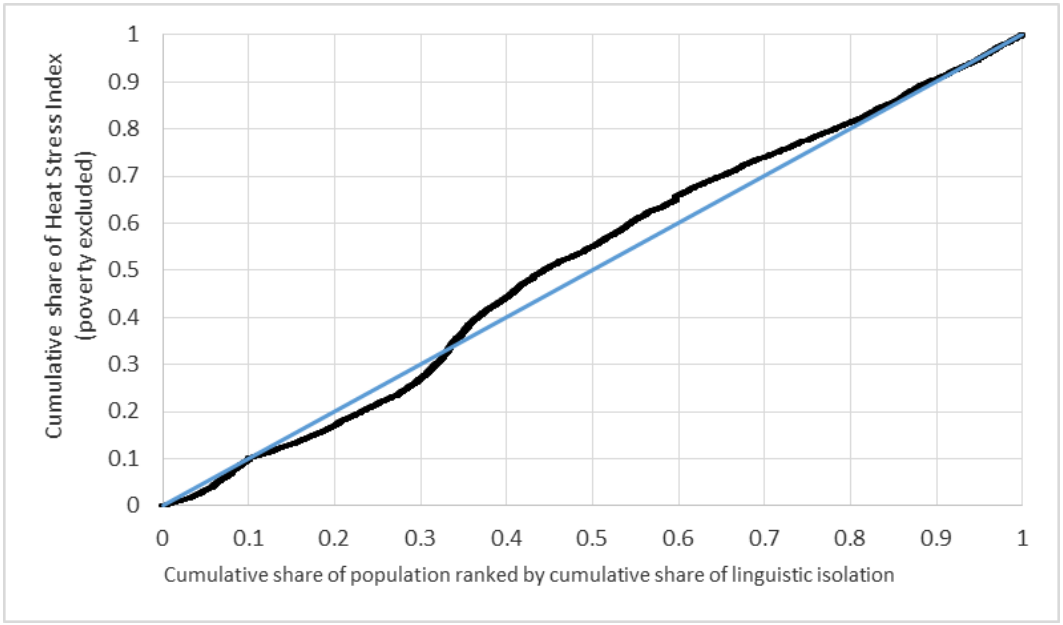

Fig. S- 20 Inequality curve showing the relative distribution of inequality between the Analytic HVI and linguistic isolation for the Detroit metropolitan area only

Figures S-21 to S-30: Inequality Curves for Michigan's Urban Geographies Only

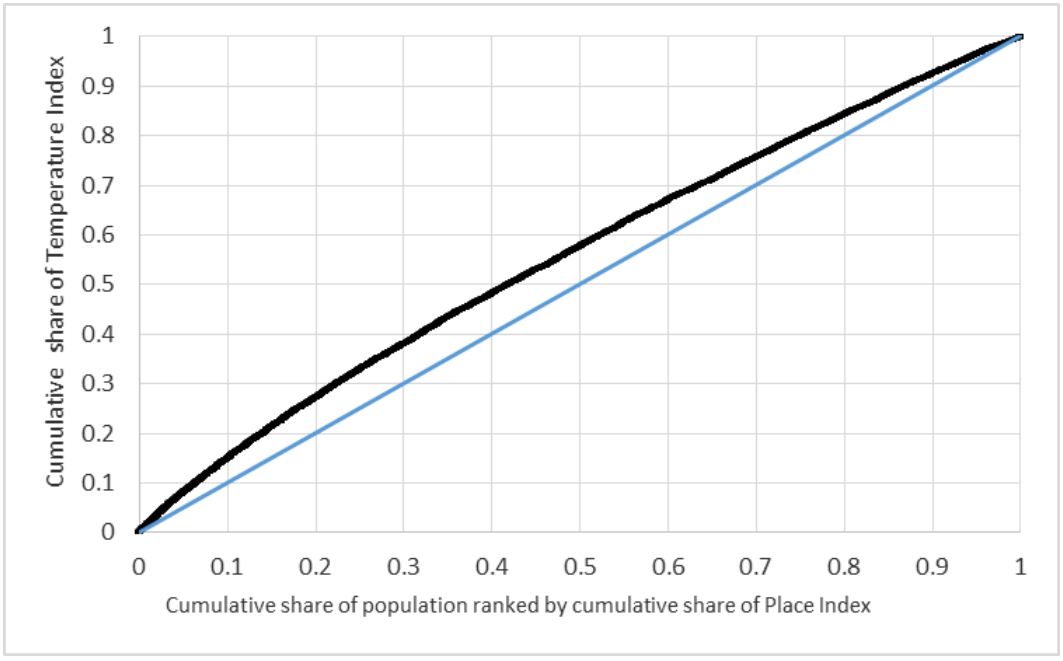

Fig. S- 21 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Place Index for Michigan's urban geographies only

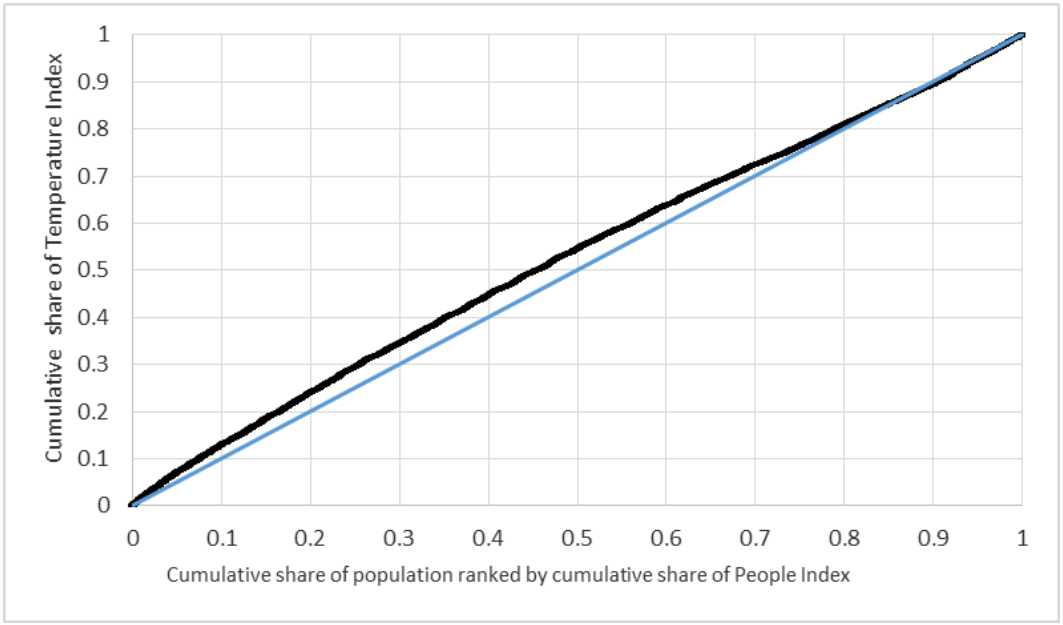

Fig. S- 22 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Analytic People Index for Michigan's urban geographies only

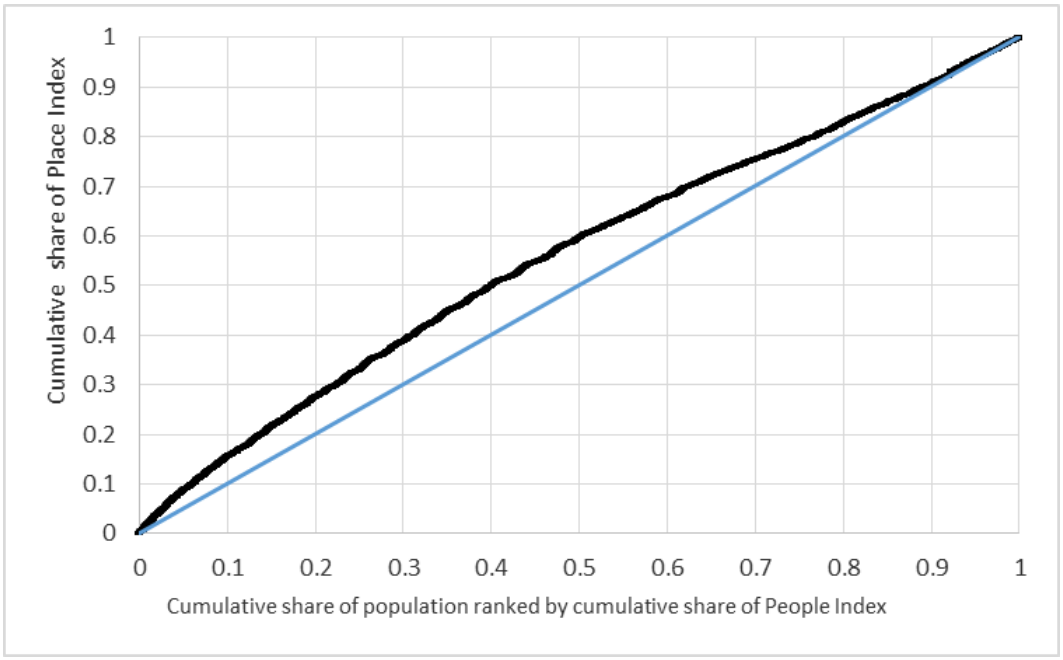

Fig. S- 23 Inequality curve showing the relative distribution of inequality between the Place Index and the Analytic People Index for Michigan's urban geographies only

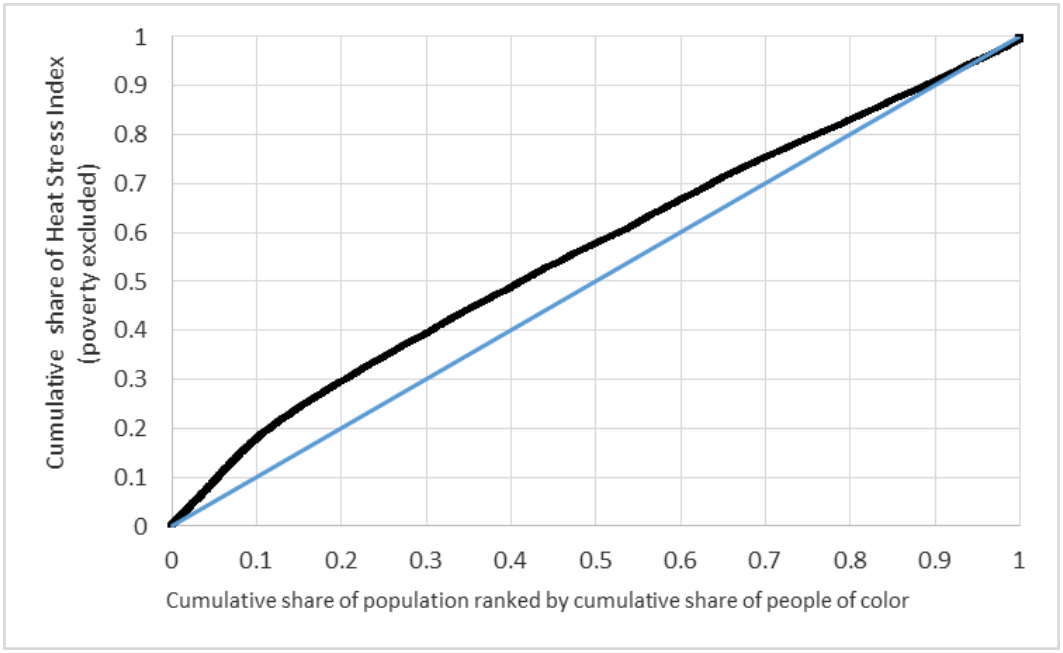

Fig. S- 24 Inequality curve showing the relative distribution of inequality between the Analytic HVI and race for Michigan's urban geographies only

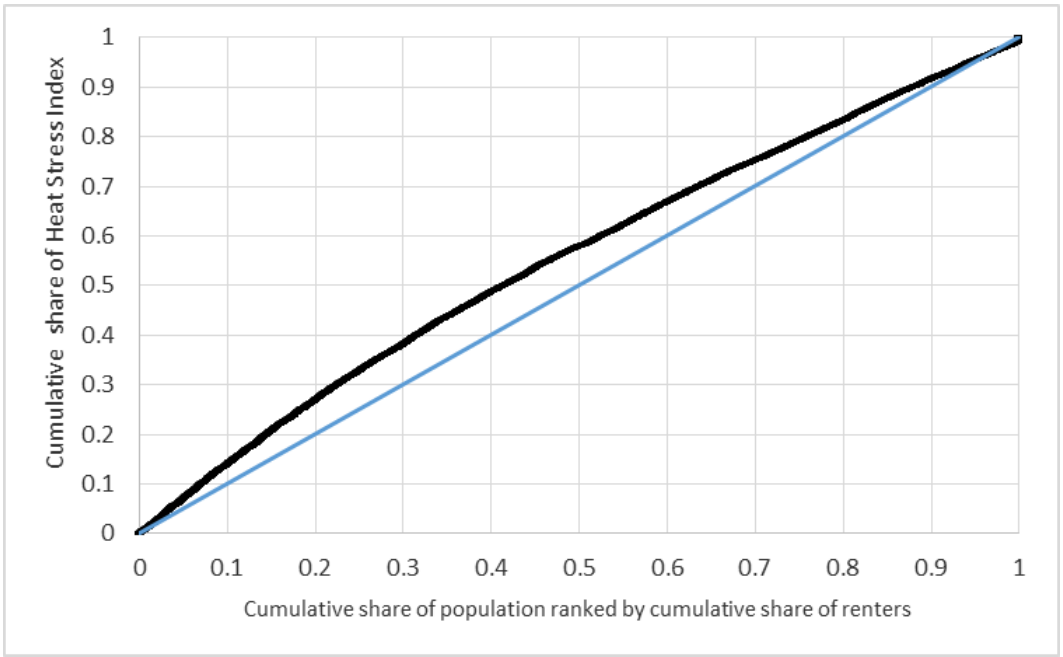

Fig. S- 25 Inequality curve showing the relative distribution of inequality between the Analytic HVI and renter population for Michigan's urban geographies only

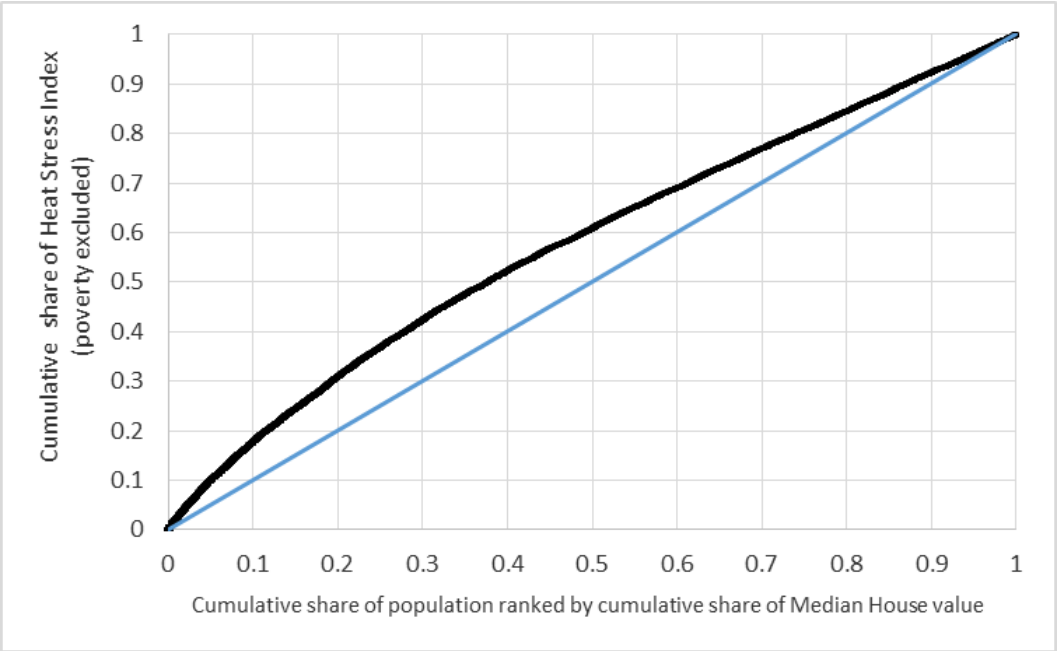

Fig. S- 26 Inequality curve showing the relative distribution of inequality between the Analytic HVI and median home value for Michigan's urban geographies only

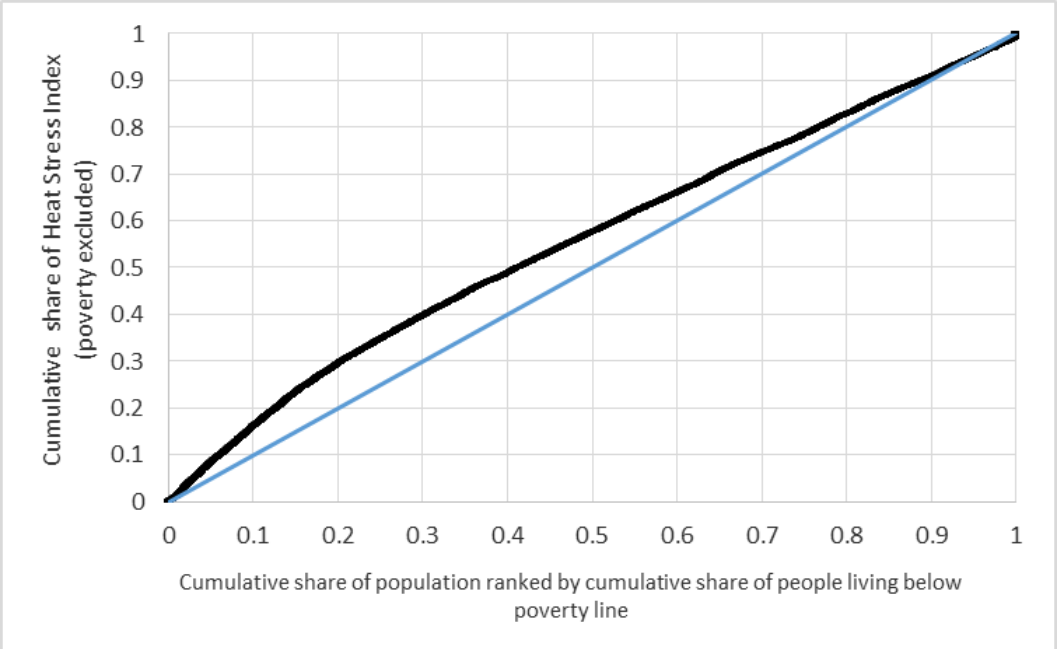

Fig. S- 27 Inequality curve showing the relative distribution of inequality between the Analytic HVI and poverty for Michigan's urban geographies only

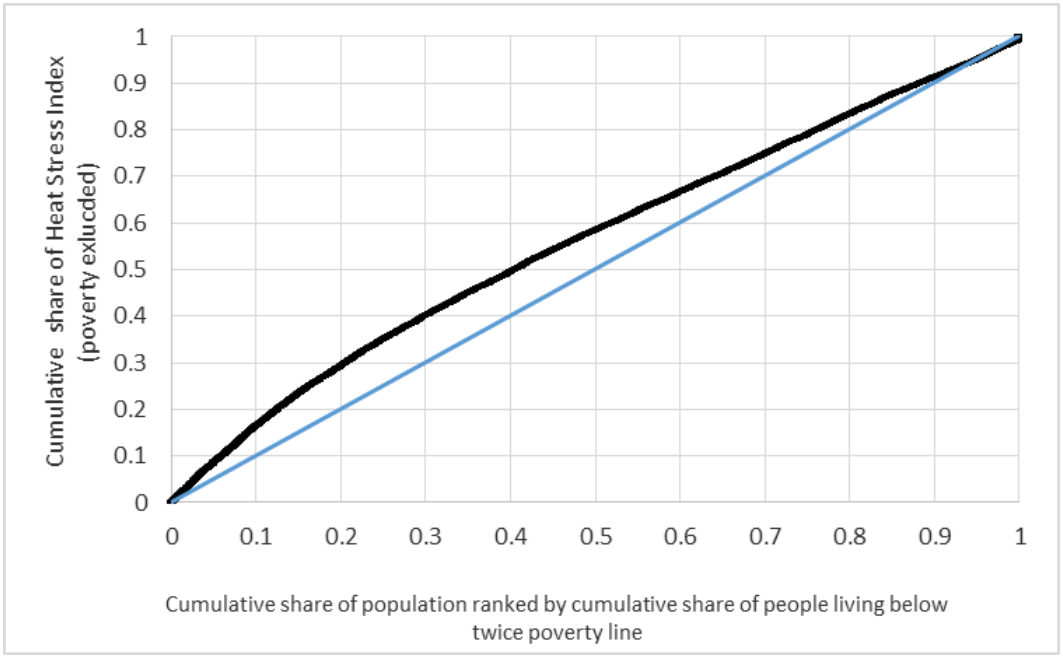

Fig. S- 28 Inequality curve showing the relative distribution of inequality between the Analytic HVI and severe poverty for Michigan's urban geographies only

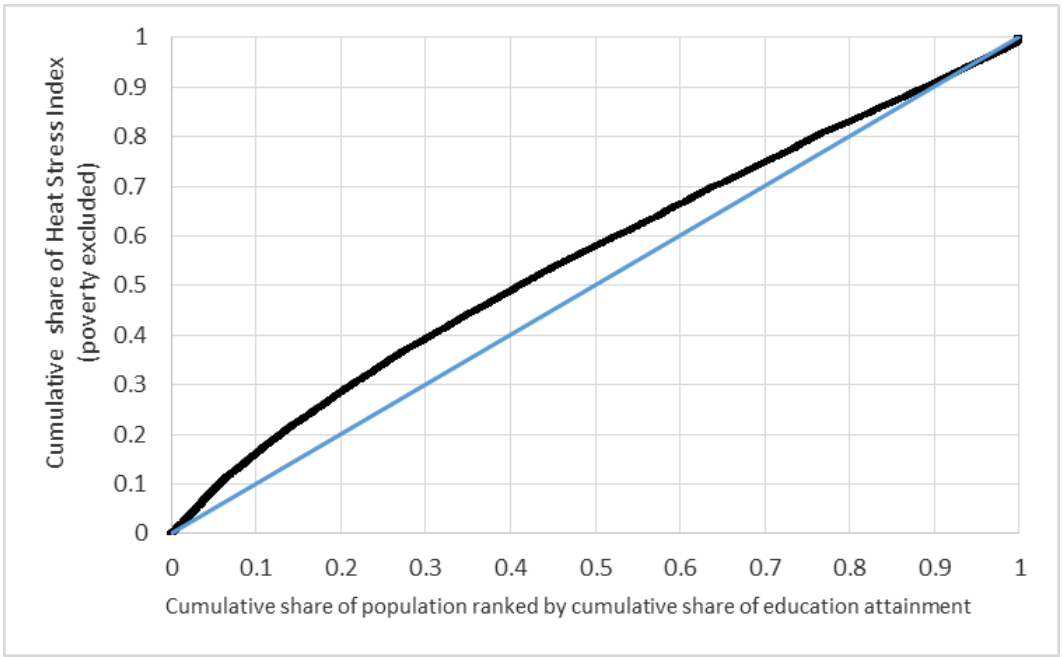

Fig. S- 29 Inequality curve showing the relative distribution of inequality between the Analytic HVI and education for Michigan's urban geographies only

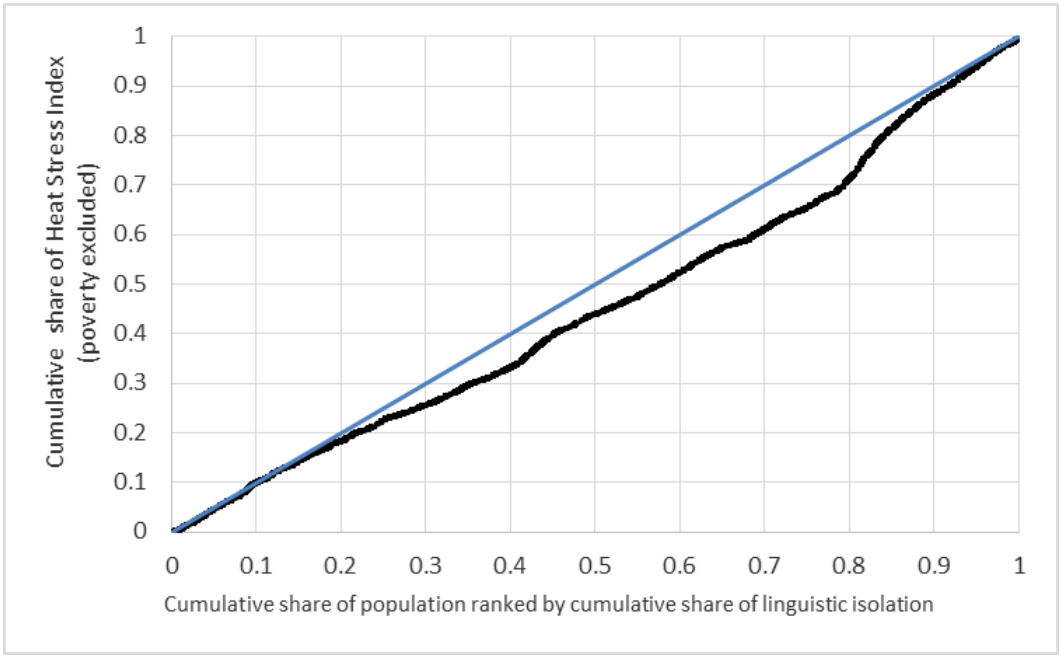

Fig. S- 30 Inequality curve showing the relative distribution of inequality between the Analytic HVI and linguistic isolation for Michigan's urban geographies only

Figures S-31 to S-40: Inequality Curves for Michigan's Rural Geographies Only

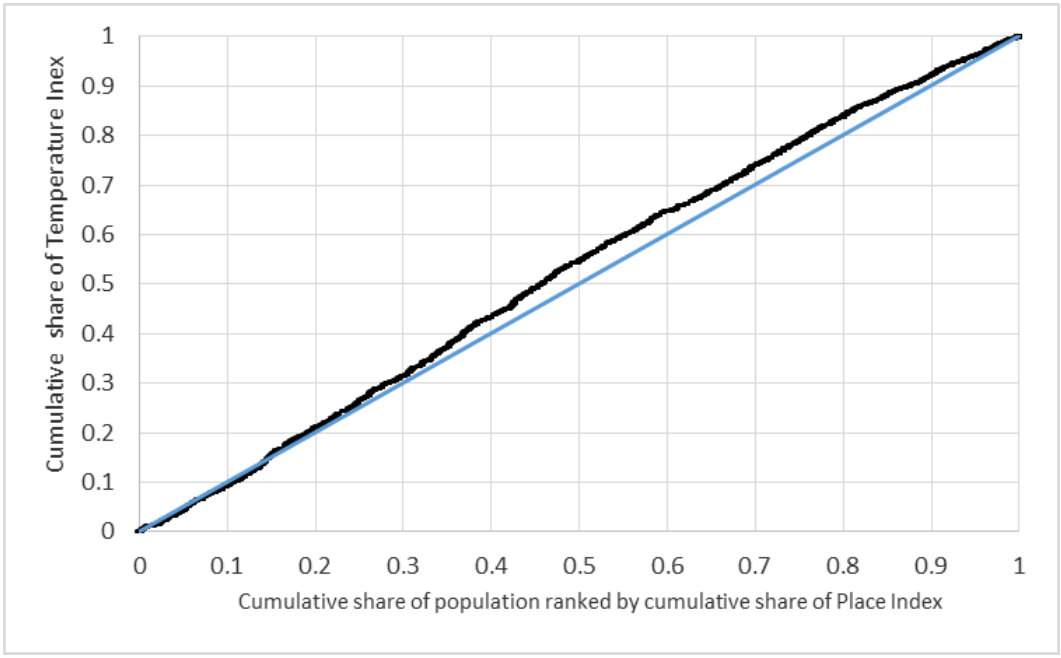

Fig. S- 31 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Place Index for Michigan's rural geographies only

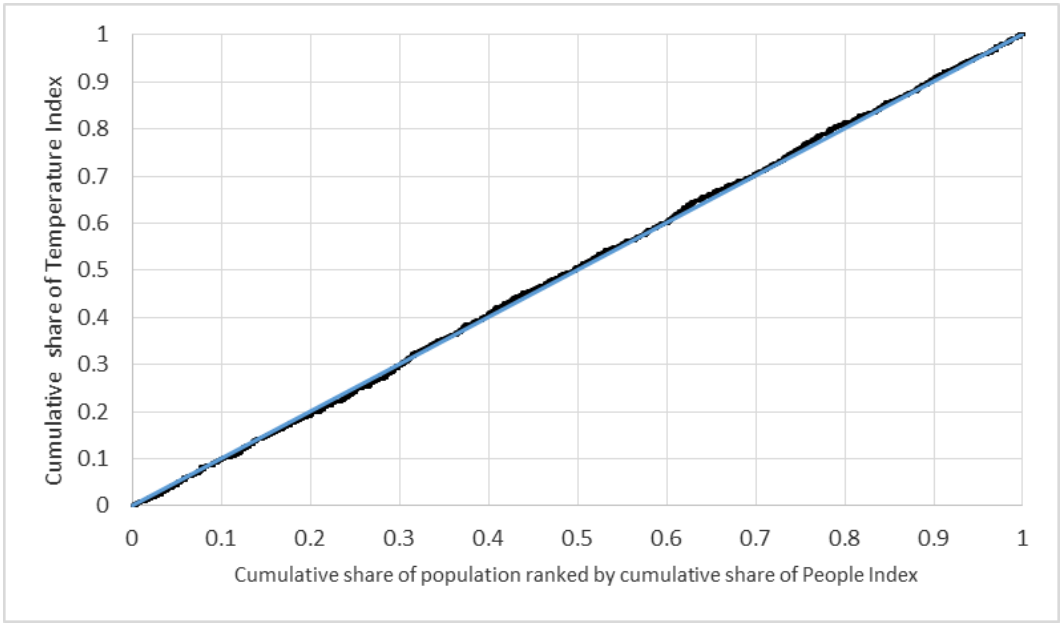

Fig. S- 32 Inequality curve showing the relative distribution of inequality between the Analytic HVI and the Analytic People Index for Michigan's rural geographies only

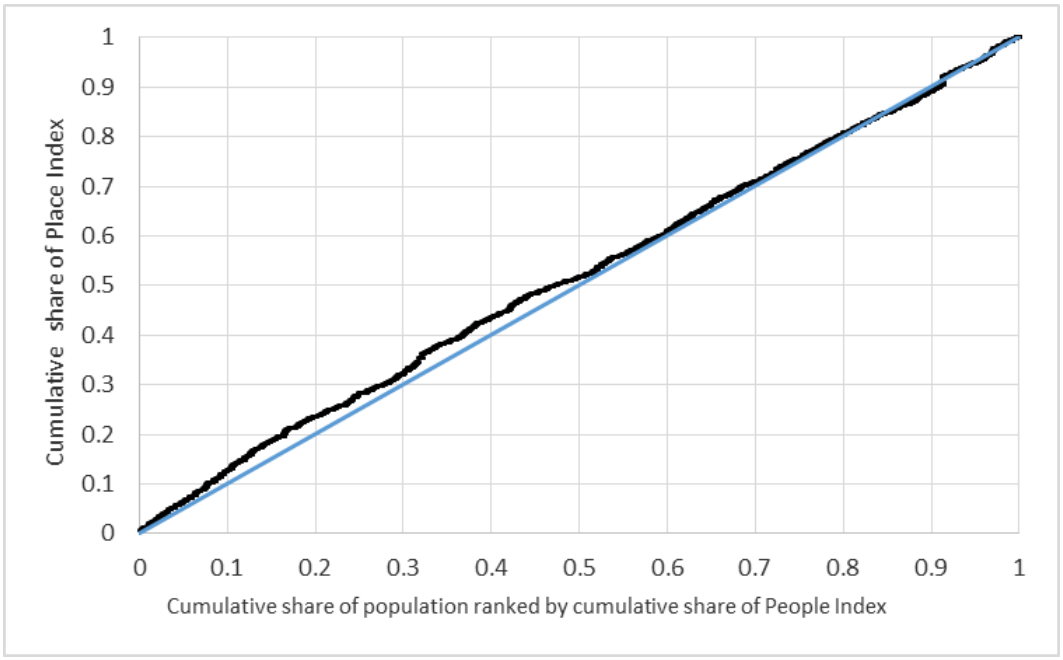

Fig. S- 33 Inequality curve showing the relative distribution of inequality between the Place Index and the Analytic People Index for Michigan's rural geographies only

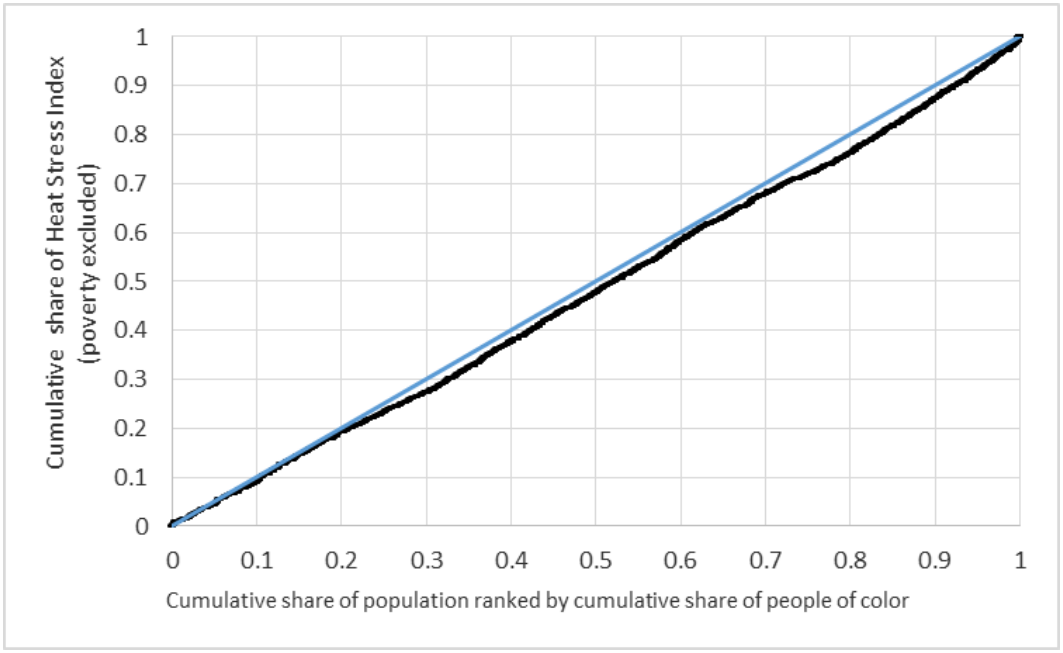

Fig. S- 34 Inequality curve showing the relative distribution of inequality between the Analytic HVI and race for Michigan's rural geographies only

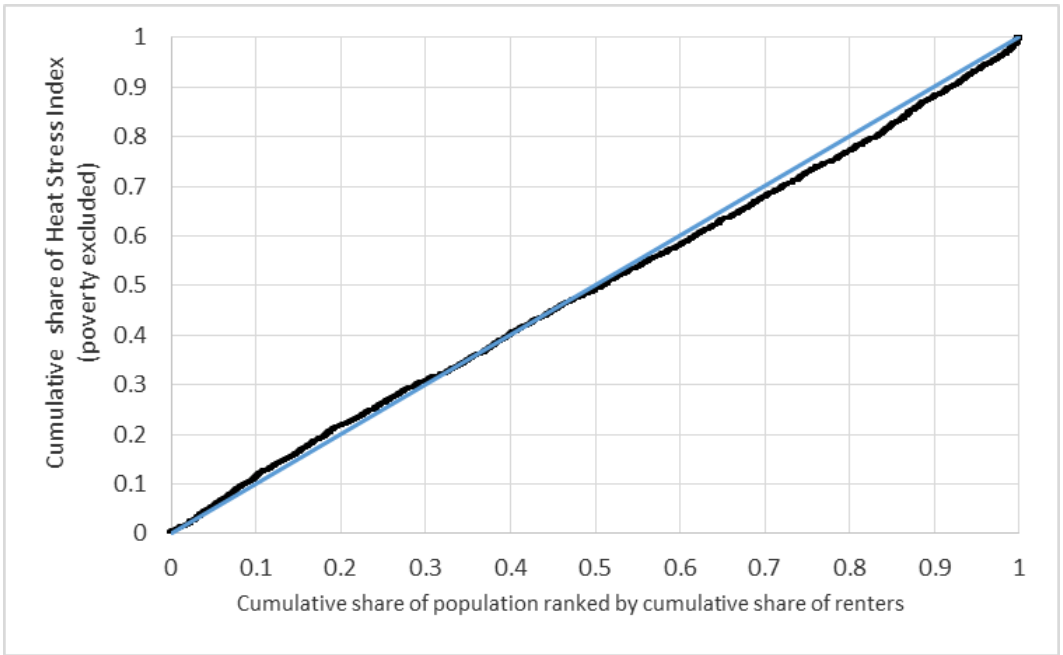

Fig. S- 35 Inequality curve showing the relative distribution of inequality between the Analytic HVI and renter population for Michigan's rural geographies only

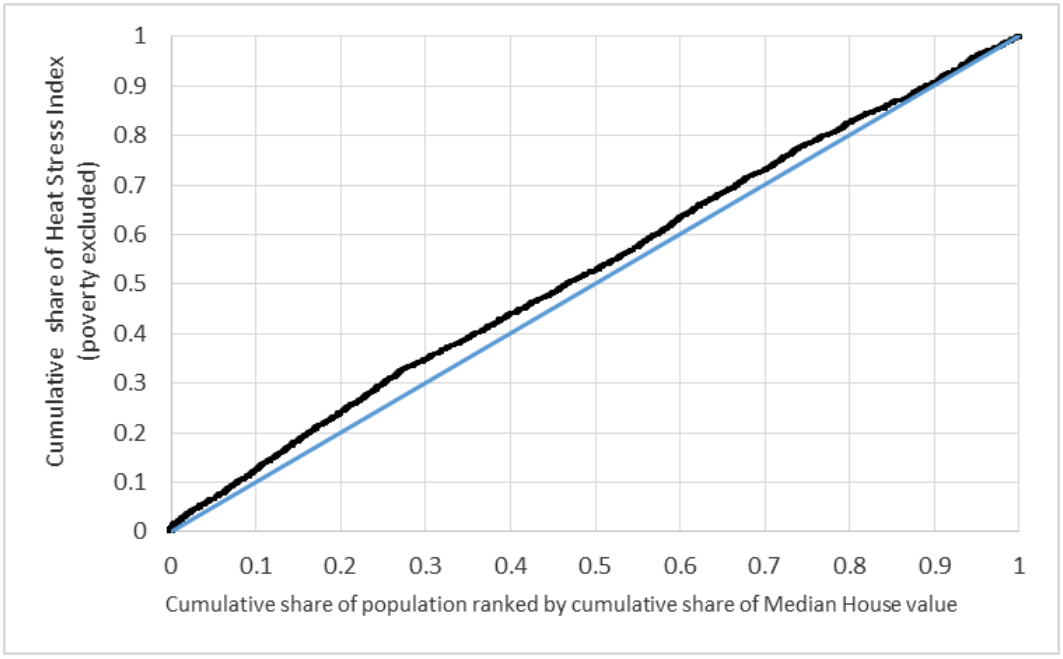

Fig. S- 36 Inequality curve showing the relative distribution of inequality between the Analytic HVI and median home value for Michigan's rural geographies only

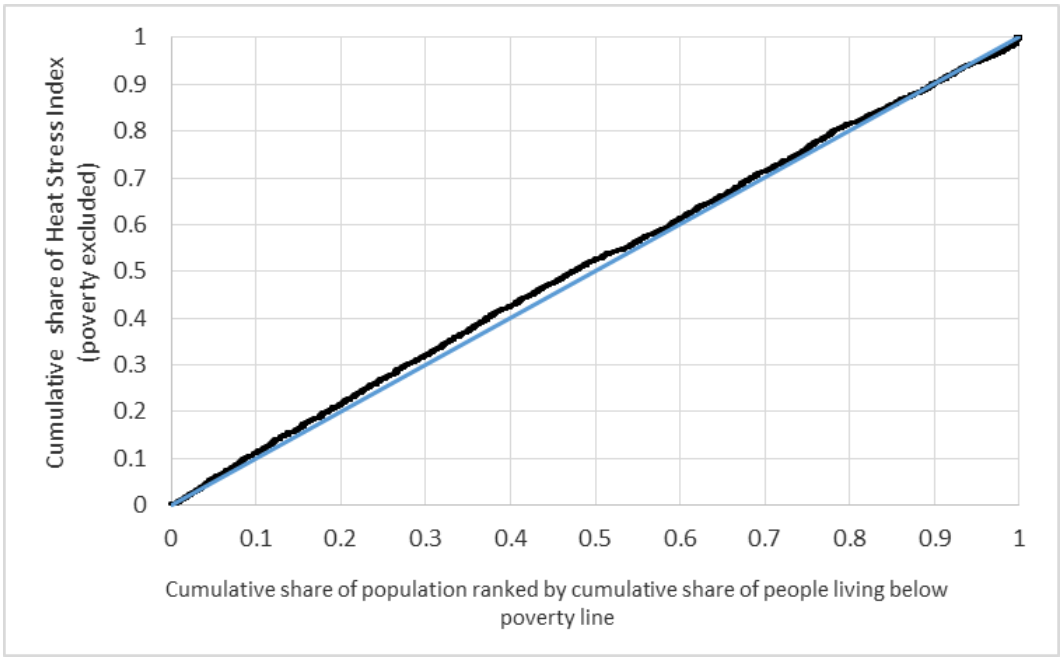

Fig. S- 37 Inequality curve showing the relative distribution of inequality between the Analytic HVI and poverty for Michigan's rural geographies only

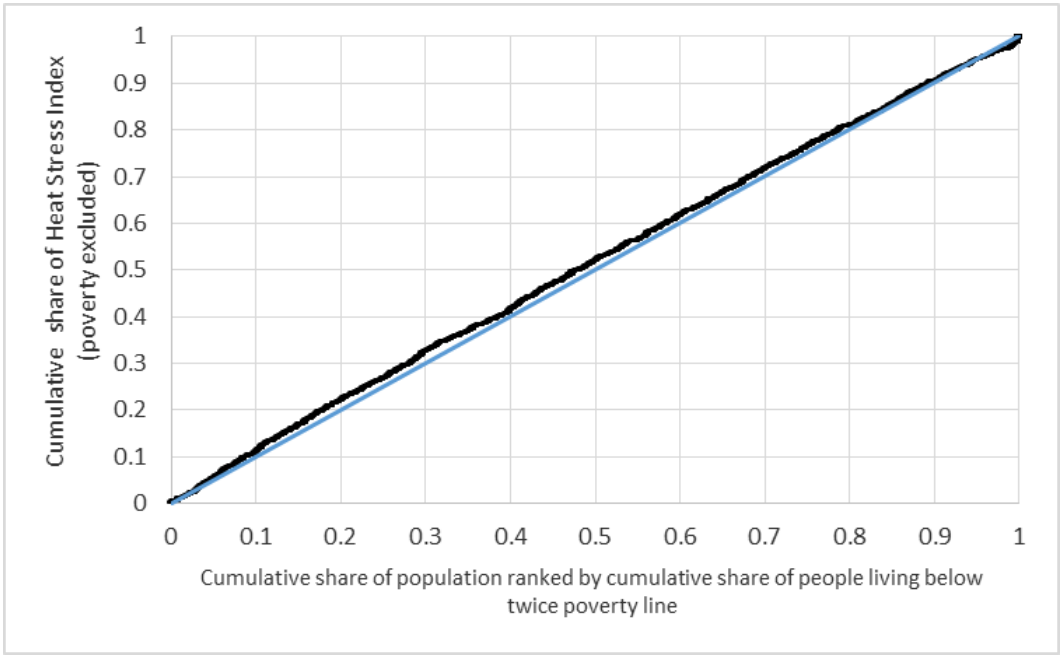

Fig. S- 38 Inequality curve showing the relative distribution of inequality between the Analytic HVI and severe poverty for Michigan's rural geographies only

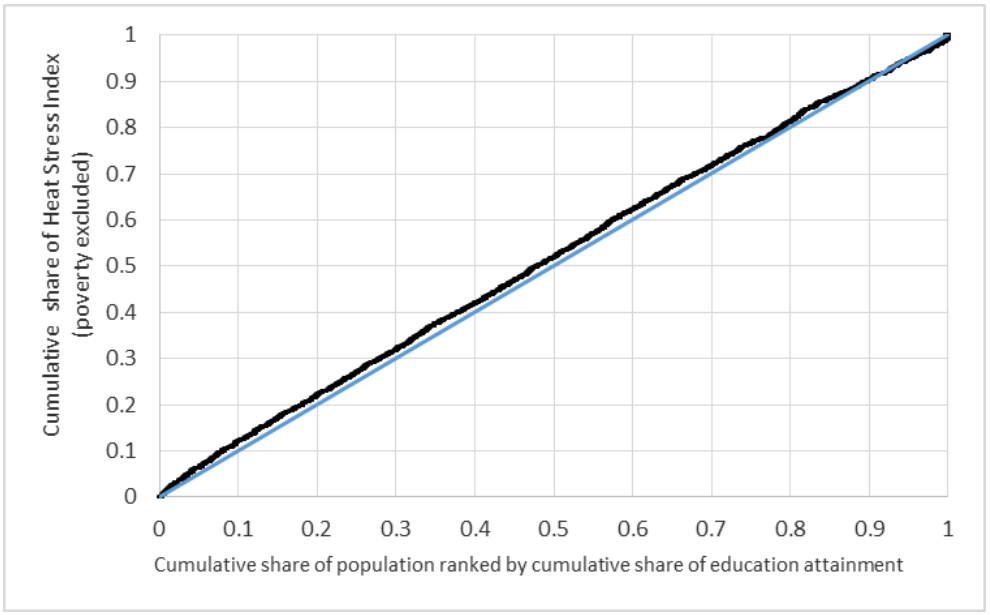

Fig. S- 39 Inequality curve showing the relative distribution of inequality between the Analytic HVI and education for Michigan's rural geographies only

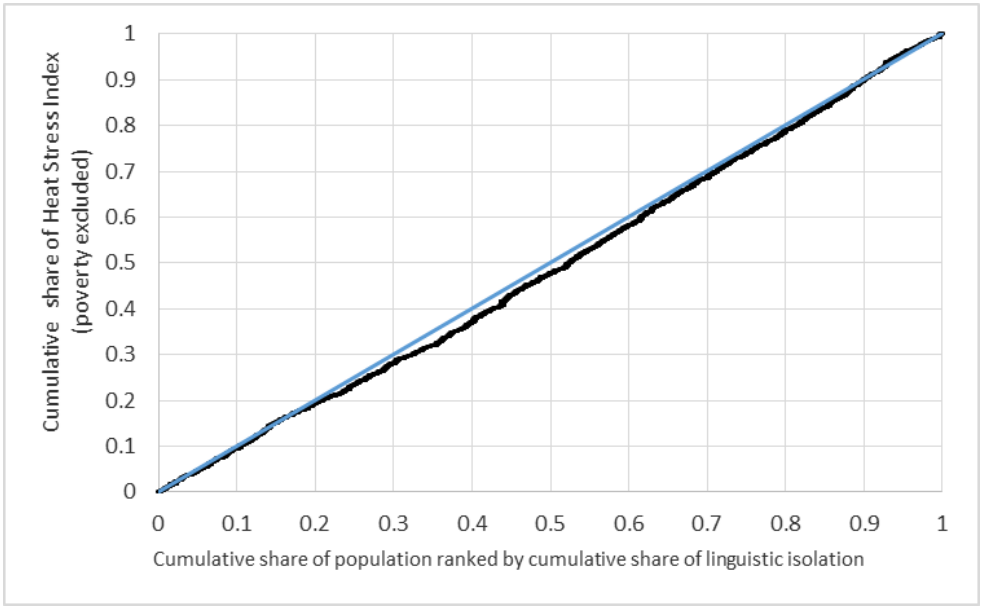

Fig. S- 40 Inequality curve showing the relative distribution of inequality between the Analytic HVI and linguistic isolation for Michigan's rural geographies only