Socioeconomic Patterns and Environmental Greenness in Relation to County-Level All-Cause Mortality Rates in Kentucky

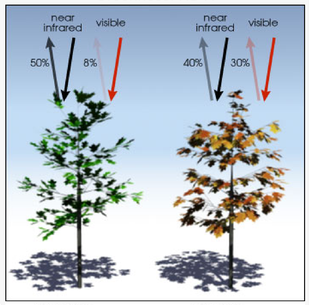
Lyndsey Blair, MPH[1], Johnnie Newton, MS[1], Natalie C. DuPré, ScD[1]

[1]University of Louisville School of Public Health and Information Sciences, Department of Epidemiology and Population Health

INTRODUCTION

- Kentucky has the fifth highest death rate in the United States.
- Exposure to natural vegetation (also called greenness) such as trees, parks, shrubs, grasses, etc. has been associated with several health benefits.
- The Normalized Difference Vegetation Index (NDVI) is a commonly used and objective measure of natural vegetation estimated from satellites. Its values range from -1 to 1, where values closer to 1 reflect greener areas.
- For a 0.1 increase in NDVI, multiple studies have shown that living in greener areas is associated with lower mortality; however these studies often adjust for single proxies of socioeconomic status (SES), which may explain some of the observed association between greenness and health outcomes.
- The relationship between SES factors and greenness has not been well described.
- Our objective is to determine the relationship between county-level NDVI and all-cause mortality and cause-specific mortality in Kentucky, controlling for SES patterns rather than individual SES determinants.

Greenness: NDVI



Earthobservatory.nasa.gov

METHODS

Ecologic Design at the County level:

- Exposure: 5-year annual NDVI (2010-2014) within 120 Kentucky counties were linked to county-level SES, demographic and housing factors from the 2010-2014 American Community Survey.
- Outcome: county-level age adjusted all-cause mortality and cause-specific rates from the Center of Disease Control and Prevention.

Statistical Analyses:

- Table 1 presents NDVI and selected ACS variables by quartiles of age-adjusted all-cause mortality rate per 100,000.
- We used Principal Components (PC) analyses to identify 3 patterns of 11 socioeconomic factors (see Table 2)
- Poisson regression was used to estimate Relative Risks (RR) and 95% confidence intervals (CI) of age-adjusted all-cause mortality rates for a 0.1 unit increase in NDVI, adjusting for SES patterns, sex, smoking and obesity and compared to models with single SES markers (i.e., percent below poverty and Gini) (Figure 3).

RESULTS

Figure 1. Kentucky Average All-Cause Mortality by County, 2015-2018

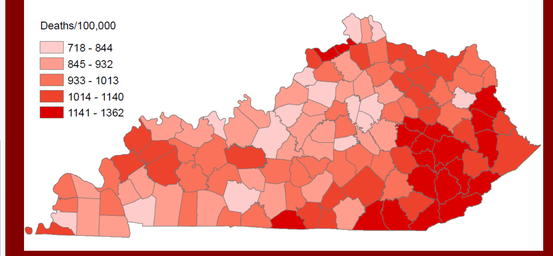


Figure 2. Kentucky 5-year Annual Average NDVI by County, 2010-2014

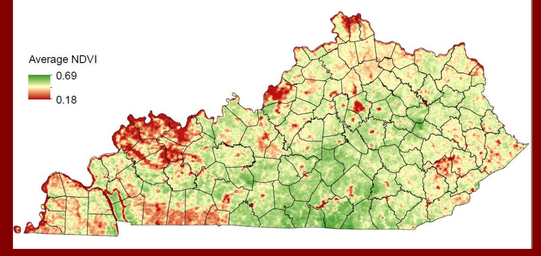
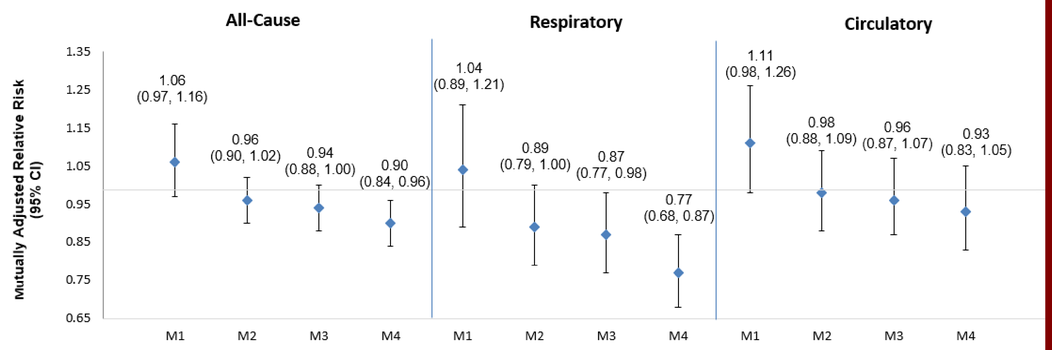


Figure 3. Age-Adjusted Relative Risks of All-Cause Mortality and Cause-Specific Mortality (95% CI) for a 0.1 unit increase in NDVI



Model 1: adjusted for age and %female
Model 2: model 1 + smoking and obesity
Model 3: model 2 + Gini and Poverty
Model 4: model 2 + PC1, PC2, and PC3

Table 1. 2010-2014 County-Level Characteristics, % (SD), by Quartiles of Mortality rates per 100,000

	Mortality Quartile 1	Mortality Quartile 4
Median # of Deaths per 100,00 (Min-Max)	848.1 (718.4 - 895.9)	1181.2 (1088.1-1361.6)
Median NDVI (Min-Max)	0.58 (5.07-6.27)	0.59 (0.49 - 0.623)
Female	50.5 (1.6)	50.0 (1.9)
White	92.0 (5.6)	96.6 (5.1)
Employed	55.2 (7.7)	39.7 (7.0)
In Food Benefit Program	15.6 (5.9)	30.4 (7.2)
Below Poverty	16.4 (5.0)	29.3 (6.1)
Average Gini	0.44 (0.04)	0.47 (0.025)
Uninsured	12.4 (2.8)	15.9 (1.6)
Married Families	52.7 (6.6)	50.0 (4.4)
High School Graduates	84.9 (5.5)	72.0 (4.8)
Disability	15.9 (3.9)	26.0 (5.1)
SMOCAPI >35%	19.0 (3.7)	26.4 (6.4)
Family Households	69.3 (6.0)	68.7 (3.4)
Age, mean (SD)	39.1 (3.5)	40.3 (1.8)
Smokers	20.4 (2.1)	25.9 (2.4)
Obese	34.2 (3.1)	37.5 (2.8)

Table 2. Principal Component (PC) Loadings

	PC1	PC2	PC3
Cumulative Percent Explained	**54.1**	**73.3**	**79.9**
White	0.336	0.648	-0.288
Employed	-0.899	-0.163	0.038
In Food Benefit Program	0.925	0.096	-0.079
Below Poverty	0.942	-0.045	0.012
Average GINI	0.680	-0.347	-0.118
Uninsured	0.607	-0.079	0.736
Married Families	-0.439	0.831	0.112
High School Graduates	-0.906	-0.218	-0.096
Disability	0.862	0.222	-0.175
SMOCAPI >35%	0.803	0.063	-0.027
Family Households	-0.234	0.856	0.169

SUMMARY & DISCUSSION

•Three principal components explained 80% of the SES variation.

- NDVI was inversely associated with all-cause mortality after adjusting for individual SES variables (RR=0.94 95%CI 0.88, 1.00); however, associations became stronger when adjusting for SES patterns (RR=0.90 95%CI 0.84, 0.96).
- Associations between NDVI and respiratory mortality were stronger when adjusting for SES patterns (RR=0.77 95% CI 0.68, 0.87) rather than individual SES markers (RR=0.87 06%CI 0.77, 0.98) and circulatory morality (RR adjusted for SES patterns (RR=0.93 95%CI 0.83, 1.05; RR adjusted for individual SES markers= 0.96 95%CI (0.87,1.07)

•We observed greenness benefits for Kentucky mortality rates that became more apparent after adjustment for SES patterns.

•Future studies of work and health should consider the complexities of SES confounding analysis of natural vegetation and health.

ACKNOWLEDGEMENTS

- This work was supported by a grant from the Jewish Heritage Fund for Excellence Pilot Grant Program at the University of Louisville, School of Medicine.