

ECONOMIC INSECURITY AND MORTALITY IN THE UNITED STATES

by

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ABSTRACT

Background

The field of social epidemiology has grappled with the measurement of macrosocial, upstream factors and the assessment of their impact on health. Economic insecurity is one such determinant of health that has been understudied in the public health literature.

Objectives

The goal of this dissertation was to develop and validate a novel determinant of health, economic insecurity, and assess its association with mortality, tobacco smoking, and heavy and binge drinking.

Methods

In aim 1, county-level indicators of economic insecurity were drawn from the US Census and Federal Reserve Bank for seven states in the north-Atlantic and Midwest regions of the US in the year 2000 based on our theoretical framework. We used confirmatory factor analysis to assess our measurement model and evaluate model fit. We validated this model using county-level indicators of socioeconomic status, social disruption, and mortality outcomes. In aim 2, we expanded this measurement model to all counties in all states in the US for the years 2000 and 2010. We then estimated the association between the change in economic insecurity between 2000 and 2010 and the rate of change in mortality due to suicide, drug and alcohol poisoning, and chronic liver disease and in midlife mortality (ages 45-54) from 2001-05 to 2011-15, using linear regression

models. Finally, in Aim 3 we test the association between change in economic insecurity and trends in three health behaviors from 2002 to 2012: cigarette smoking, binge drinking, and heavy drinking using ecological longitudinal models.

Results

The five indicators of percent unemployed, percent not in labor force, percent employed in the service sector, percent of income spent on rent, and percent with subprime credit rating (credit score below 660) produced a measurement model of county economic insecurity with adequate fit. Counties with elevated economic insecurity in either or both 2000 and 2010 had larger increases in suicide, poisoning, and chronic liver disease mortality than counties with low insecurity in both time periods, and larger increases in all-cause, midlife mortality. Counties with high economic insecurity in both 2000 and 2010 also had slower declines in smoking among both men and women. Higher economic insecurity, however, appears to be associated with lower levels of drinking.

Conclusions

Measuring and validating upstream determinants of health is challenging. Future work should 1) explore other health outcomes sensitive to economic insecurity and 2) explore policy interventions that may reduce economic insecurity in counties or ameliorate its effects.

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CHAPTER 1: INTRODUCTION

Overview

The goal of this dissertation is to describe the measurement and evaluation of a novel population risk factor, county economic insecurity. We assessed a measurement model for county economic insecurity using confirmatory factor analysis, and used this model to estimate a summary measure of economic insecurity in US counties. We then explored the association of economic insecurity with mortality rates at the county level. Last, we explored the association between economic insecurity and trends in three health behaviors: smoking, heavy drinking, and binge drinking. This chapter introduces theoretical construct of economic insecurity, our motivation for measuring it at the population-level, and the health outcomes hypothesized to be influenced by economic insecurity.

Economic Insecurity

Economic insecurity: a new feature of the American landscape

Economic insecurity is the degree of instability in economic conditions in a community. Economic insecurity captures volatility in economic conditions, the financial buffer protecting communities from economic shocks, adverse events, and other losses in revenue, as well as the risk of downward mobility in socioeconomic status (1-3). Communities with high economic insecurity may exhibit high levels of perceived or real job insecurity (i.e., mass layoffs, business closings), high cost of housing and other living expenses relative to average

wages, low or reduced social and administrative services from local government at times of increased need from residents, and disruptions to social networks as residents leave for better economic opportunity (Figure 1.1).

Hacker posits that economic insecurity is now a defining feature of the American economy due to shifting responsibility—for worker education and training, health insurance, retirement pensions and other “risks”—from businesses and the government to workers (2). The decline of the manufacturing sector has also been implicated in the rise of economic insecurity due to the loss of “good” jobs for workers, especially those with no college education. These jobs have been replaced with service work, which involves more involuntary part time work, inconsistent scheduling/hours of paid work, and reduced fringe benefits including absent or reduced health insurance coverage and retirement benefits (4). Other explanations for the rise in economic insecurity include the globalization of the economy and the automation of some prior manual work processes, the decline of the bargaining power of workers, and a trend toward lower spending on social services (5-9).

Economic insecurity is a community-level phenomenon

In this dissertation, we will measure economic insecurity at the level of the US county. Counties are the primary division of US states, and carry out social and health services, economic development programs, maintenance of public spaces and roads, and zoning planning (10, 11). State and local tax revenue is affected by economic downturns or other declines in economic conditions

through effects on income and property values which generate real estate taxes (12). We hypothesize that counties are important mediators between national and state level policies and individual health effects (Figure 1.1). Additionally, counties are more policy-relevant than other geographic units because they generally have some degree of self-governance and ability to enact policies and programs that could benefit economic conditions and health. We also wish to capture “net effects”: we believe that economic insecurity affects entire communities. For example, job loss affects not only those who lose their jobs, but may also have harmful effects on health by increasing the perception of economic insecurity, or by lowering tax revenue through decreased income, reducing money available for key services (12-14). Although an individual or household may not be experiencing economic insecurity themselves (at the individual level), county economic insecurity could affect an individual through changes to services at the county level or changes in social networks as friends and family leave for work opportunities. Economic uncertainty may be broadcast through a community through social networks or media coverage and therefore may affect individuals beyond their individual level of economic insecurity (15).

Measuring economic insecurity at the county level is a departure from much of the literature on economic insecurity, which considers household or individual level economic insecurity (13, 16-20). Previous area-level measures of economic insecurity include a country-level measure incorporating risks of poverty (due to old age, unemployment, and illness) and moderators of these

risks (social service protections) (21), using occupational class composition as a proxy for economic insecurity (22), and unemployment or job instability as a proxy for economic insecurity (23).

Economic insecurity is distinct from socioeconomic status

Economic insecurity represents the degree of instability of economic conditions in a community, while related constructs such as socioeconomic status focus on absolute levels of socioeconomic position and often treat these as immutable. One important dimension missing from measures of socioeconomic status is the likelihood that a community will remain in a given level of socioeconomic status. Weakening job prospects may drain a community of skilled workers; even a small number of foreclosures may drive down housing values. Improving and/or high socioeconomic status can coexist with economic insecurity. For example, unconventional gas extraction (fracking) in Pennsylvania may be paradoxically raising community socioeconomic status, in the form of rapidly increasing incomes with the influx of new jobs, and simultaneously raising economic insecurity as this new industry creates instability in housing, unpredictable changes in the timing and availability of work, and uneven growth across communities (24, 25).

Socioeconomic status is typically measured by income and education, but these are not satisfactory measures of economic insecurity. Economic insecurity can occur at every level of socioeconomic status, and presents a more complete picture of community forecasts and outlook regarding future stability than income,

education, or other common measures of socioeconomic status (19). For example, income alone belies a recent finding that 23% of households reported spending more than they earned in the 2014 (26). Additionally, changes in indicators of economic insecurity appear to be at least partially independent of traditional measures of SES: despite an increase in the percent of the workforce with a college education since the 1980s, the percent of jobs offering benefits such as health insurance and retirement plans has decreased (6).

The potential health effects of economic insecurity: an “epidemic of despair”?

In 2015, Case and Deaton reported an increase in mortality among middle-aged (45-54 years old), non-Hispanic White men and women between 1999 and 2013—the first such increase in decades (27). This increase is partially attributed to increases in poisoning, suicide, and chronic liver disease deaths, the so-called “deaths of despair”, and Case and Deaton speculate that these increases in mortality are due to economic insecurity (27). Shiels and colleagues look more closely at mortality patterns in the US, and find that this increase in mortality is highest among young White women and American Indians. Black, Asian, and Hispanic men and women had decreasing mortality during this time period (1999-2014) (28). Mortality due to suicide and accidents, and to a lesser extent, chronic liver disease and cirrhosis, is on the rise in both white men and women, ages 25-64 in 2011-2014 compared to 1999-2002, while increases in

chronic disease are declining (28). Shiels and colleagues again cite changing levels of economic insecurity as the cause of these mortality increases (28).

Economic insecurity, as measured by the unemployment rate and rate of business failures, has previously been associated with mortality due to heart disease (23). Job insecurity and job loss has also been associated with increased mortality, though these studies have generally studied these factors as individual-level risks (8, 14, 29, 30).

Mechanisms through which economic insecurity may affect mortality

We hypothesize that economic insecurity will affect mortality through changes to the services counties are able to provide to residents, changes in the availability and types of work, and selective migration that alters social networks. Ultimately, these changes will lead to increased stress and changes to health behaviors. Counties facing decreased tax revenue may respond by reducing services such as unemployment benefits, welfare spending, and drug and alcohol treatment programs. Prior to the 2014 Affordable Care Act, unemployment or transition to part-time work would leave many people without health insurance, increasing insecurity through increased medical costs to both individuals and uncompensated care in county hospitals, and potentially reducing access to healthcare (31, 32).

Preliminary evidence links indicators of individual economic insecurity to poor health outcomes through changes in employment. A meta-analysis by Virtanen and colleagues of cardiovascular cohort studies demonstrated a

statistically significant effect of job insecurity on coronary heart disease, independent of socio-demographic factors (30). Job insecurity is also associated with poorer self-rated health, depression and anxiety, and substance abuse among individuals (29, 33). Insecure occupational class and increases in the probability of becoming unemployed were linked to weight gain in working age men (16, 22). Job loss has also been associated with increased weight gain, when compared to those who remain employed, but not among those who retire (34). Changes in the global labor market starting in the 1970s have led to changes in the types of jobs that are available, with a move toward temporary and part-time, “precarious” employment (35). Job insecurity and precarious forms of employment may affect health through lower income, unsafe or substandard working conditions, and chronic stress (35, 36).

Stress may lead to changes in the way individuals approach health behaviors. Adolescents with more positive expectations of their lives (measured by expectation of going to college and living to age 35) were more likely to engage in health promoting behaviors (e.g., less smoking and eating fast food, more physical activity) (37). Economists refer to this as a change in “time preference” (38). Komlos and colleagues suggest that time preference, “the rate at which a person is willing to trade current pleasure for future pleasure”, has been decreasing, evidenced by a decline in personal savings and an increase in debt, and that this has led to an increase in obesity (39).

Previous work measuring economic insecurity

Measurement of economic insecurity at the level of the individual frequently assesses individuals' perception of their financial security or job security, likelihood of becoming unemployed, or financial resources available in the event of a financial shock or sudden drop in income (18-20, 30, 40, 41). Financial security, as measured through "liquid wealth" or "cash on hand", was predictive of life satisfaction, independent of earnings, investments, debt, spending, employment and demographic factors (42).

The unemployment rate is frequently used as an area-level proxy for economic insecurity (23). Other measures include business closings and layoffs, and occupation (14, 22, 23, 43). Osberg developed an index of economic insecurity comprised of risks of poverty (due to old age, health, single-headed household, and job loss) and corresponding social protections (21). While previous measures of economic insecurity suggest a link with health outcomes, they are limited by 1) use of single indicators to measure economic insecurity, a multidimensional construct; and/or 2) lack of theoretical consideration of the correct geographic scale for measuring economic insecurity.

Mortality in the United States

This dissertation will examine two county-level mortality outcomes: "deaths of despair" (mortality due to suicide, drug and alcohol poisoning, and chronic liver disease), and, among middle-aged Americans, all-cause mortality.

Overall, the age-adjusted death rate for Americans was 728.8 per 100,000 in 2016 (44). The leading causes of death in 2016 were heart disease, cancer, unintentional injuries, and chronic lower respiratory disease (44). With a few exceptions, mortality has generally been decreasing since the early 1900s (45). Strong social patterning has been observed in mortality and life expectancy: those with higher income live longer and have experienced more gains in life expectancy in recent years (46). Mortality rates are higher among men and Black persons, and lowest among Hispanic women. Mortality is higher among older persons, but mortality is increasing among younger age groups: 15-24, 25-34, 35-44 and 55-64 year olds all had higher mortality rates in 2016 compared to 2015.

Mortality due to drug poisoning more than doubled between 1999 and 2013, as of 2013, the rate of drug poisoning mortality was 13.8 per 100,000. Rates of suicide mortality decreased slightly over this time period from 13.2 in 1999 to 12.6 per 100,000 in 2013. Mortality due to chronic liver disease and cirrhosis was 10.2 per 100,000. These causes of death are relatively small—for comparison, rates of mortality due to heart disease are 214.5 per 100,000—but these deaths are largely preventable and more common among younger Americans. Suicide contributes 401.6 years lost before 75 per 100,000 people under 75, poisoning contributes 430.9, and chronic liver disease 176.9 (47).

There is substantial geographic variation in rates of mortality and premature mortality (47); premature mortality is more common in the South (48).

Across race and sex-groups, county-level rates of educational attainment, occupation, marital status, and poverty are associated with higher rates of premature mortality (48). Mortality rates are also higher in nonmetropolitan counties (47).

Cigarette and Alcohol Consumption in the United States

In addition to the mortality outcomes, this dissertation will explore the association between economic insecurity and three health behaviors: cigarette smoking, binge drinking, and heavy drinking.

Risk Factors for Cigarette Smoking

At the county-level, there is a large variation in rates of smoking and the rate of decline in smoking over time, even within the same state (49). The Midwest and the South have the highest rates of smoking. Smoking is also higher in counties with lower median income (49).

At the individual level, smoking is more common among men, American Indian/Alaska natives, people who did not complete high school or who hold a GED, and those living below the poverty line. Serious psychological distress is also a risk factor for smoking (50).

Health Consequences of Smoking

Tobacco use is the second leading cause of death in the US, the leading cause of preventable death, and causes almost 1 in 5 deaths (51, 52). Although

rates of cigarette smoking have been declining for several decades, about 17% of Americans are current smokers (53).

Risk Factors for Alcohol Consumption

Alcohol consumption is very common, 70% of US adults report consuming alcohol in the past year, and 27% report binge drinking (consuming more than 4 drinks for women or five for men on a single occasion) in the past year (54). Binge and heavy drinking (drinking, on average, more than 1 drink per day for women or 2 drinks per day for men) vary substantially by county; binge and heavy drinking is highest in the northern states in the West and Midwest, and among younger adults and men (55, 56).

Health Consequences of Alcohol

Alcohol and drug abuse combined are the 8th leading cause of death (51). Alcohol consumption is a risk factor for mortality due to injuries such as motor-vehicle accidents and violence, and chronic conditions such as liver disease, some cancers, and cardiovascular disease (57). Alcohol may also increase the risk of suicide, especially in the context of declining economic conditions; Kaplan and colleagues found that about 20% of suicide deaths involve alcohol and that this number increased following the Great Recession (58).

Population Health Approaches to Mortality

The goal of this dissertation is to explain recent trends in mortality and related health behaviors using one potential population risk factor, county

economic insecurity. Our primary concern is to explain county-level rates of mortality and two health behaviors that may be mechanisms in the relationship between county economic insecurity and mortality. As eloquently stated by physician and social epidemiologist Geoffrey Rose, the determinants of the health of individuals is a distinct question from the determinants of health for individuals:

“...for what distinguishes the two groups is nothing to do with the characteristics of individuals, it is rather a shift of the whole distribution—a mass influence acting on the population as a whole. To find the determinants of prevalence and incidence rates, we need to study the characteristics of populations, not characteristics of individuals” (59).

We hypothesize that county economic insecurity is one such “mass influence”. It is important to study mortality and potential drivers of premature mortality as population-level phenomena that result from population-level risk factors. Within a geographic unit, population-level exposures will not be detected because they are ubiquitous, thus individual approaches to premature mortality may leave an incomplete picture of the true drivers of the epidemic (59, 60). Understanding determinants of health across populations and over time and intervening on these population-level determinants represents the most efficient strategy to end the recent reversal in declining mortality rates.

Specific Aims

Aim 1: Develop and validate a new measure of community economic insecurity using confirmatory factor analysis with secondary data at the level of the U.S. county.

Aim 2: Describe the association between county economic insecurity and county-level mortality due to suicide, drug and alcohol poisoning, and alcoholic liver disease.

Aim 3: Examine the association of community economic insecurity on trends in heavy and binge drinking, and smoking.

Objectives of the Dissertation

The goal of this project is to foster understanding of one macroeconomic determinant of population health, economic insecurity. To date, most research on economic insecurity has focused on the level of the individual and does not capture higher-level trends in economic insecurity. This work assessed a new measurement model of economic insecurity, and then evaluate the association of economic insecurity on mortality, cigarette smoking, and alcohol consumption. The first chapter provides an overview of economic insecurity, previous measurement efforts, and the epidemiology of the health outcomes that will be assessed. The second chapter details the assessment of the measurement model for economic insecurity. The third chapter evaluates the contribution of economic insecurity to two recent trends in mortality: 1) an increasing rate of mortality among middle-aged Americans; and 2) higher rates of death due to suicide, drug and alcohol poisoning, and chronic liver disease. Lastly, we explore potential mechanisms for the relationship between economic insecurity and increased mortality: two health behaviors: cigarette smoking and alcohol consumption.

References

1. Hacker JS. Understanding Economic Insecurity: The Downward Spiral of the Middle Class. *Communities & Banking* 2011;25-28.
2. Hacker JS. *The Great Risk Shift: The New Economic Insecurity and the Decline of the American Dream*. Revised and Expanded ed. New York: Oxford University Press; 2006.
3. Western B, Bloome D, Sosnaud B, Tach L. Economic Insecurity and Social Stratification. *Annual Review of Sociology* 2012;38(1):341-359.
4. Henley J, Lambert S. Unpredictable Work Timing in Retail Jobs: Implications for Employee Work-Life Conflict. *Industrial & Labor Relations Review* 2014 67.
5. Schmitt J. Labor markets and economic inequality in the United States since the end of the 1970s. *Int J Health Serv* 2005;35(4):655-73.
6. Schmitt J, Jones J. *Where Have All the Good Jobs Gone?: Center for Economic and Policy Research*; 2012.
7. Schmitt J. *Low-wage Lessons: Center for Economic and Policy Research*; 2012 January 2012.
8. Patel PC, Devaraj S, Hicks MJ, Wornell EJ. County-level job automation risk and health: Evidence from the United States. *Soc Sci Med* 2018;202:54-60.
9. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health* 2014;35:229-53.
10. Osypuk T, Galea S. What level macro? Choosing appropriate levels to assess the relation between space and population health. In: S G, editor. *Macrosocial determinants of population health*. New York, NY: Springer; 2007. p. 399-436.
11. National Association of Counties. *Counties Matter*. In; 2016.
12. Gordon T. *State and Local Budgets and the Great Recession*. In: Brookings Institute; 2012.
13. Catalano R. The health effects of economic insecurity. *Am J Public Health* 1991;81(9):1148-52.
14. Carlson K. Fear itself: The effects of distressing economic news on birth outcomes. *J Health Econ* 2015;41:117-32.
15. Doms M, Morin N. *Consumer Sentiment, the Economy, and the News Media: Federal Reserve Bank of San Francisco*; 2004.
16. Smith TG, Stoddard C, Barnes MG. *Why the Poor Get Fat: Weight Gain and Economic Insecurity: Washington State University*; 2007.
17. Barnes MG, Smith TG. Tobacco Use as Response to Economic Insecurity Evidence from the National Longitudinal Survey of Youth. *The B.E. Journal of Economic Analysis Policy* 2009;9(1).
18. Bossert W, D'Ambrosio C. Measuring Economic Insecurity. *International Economic Review* 2013;54(3):1017-1030.

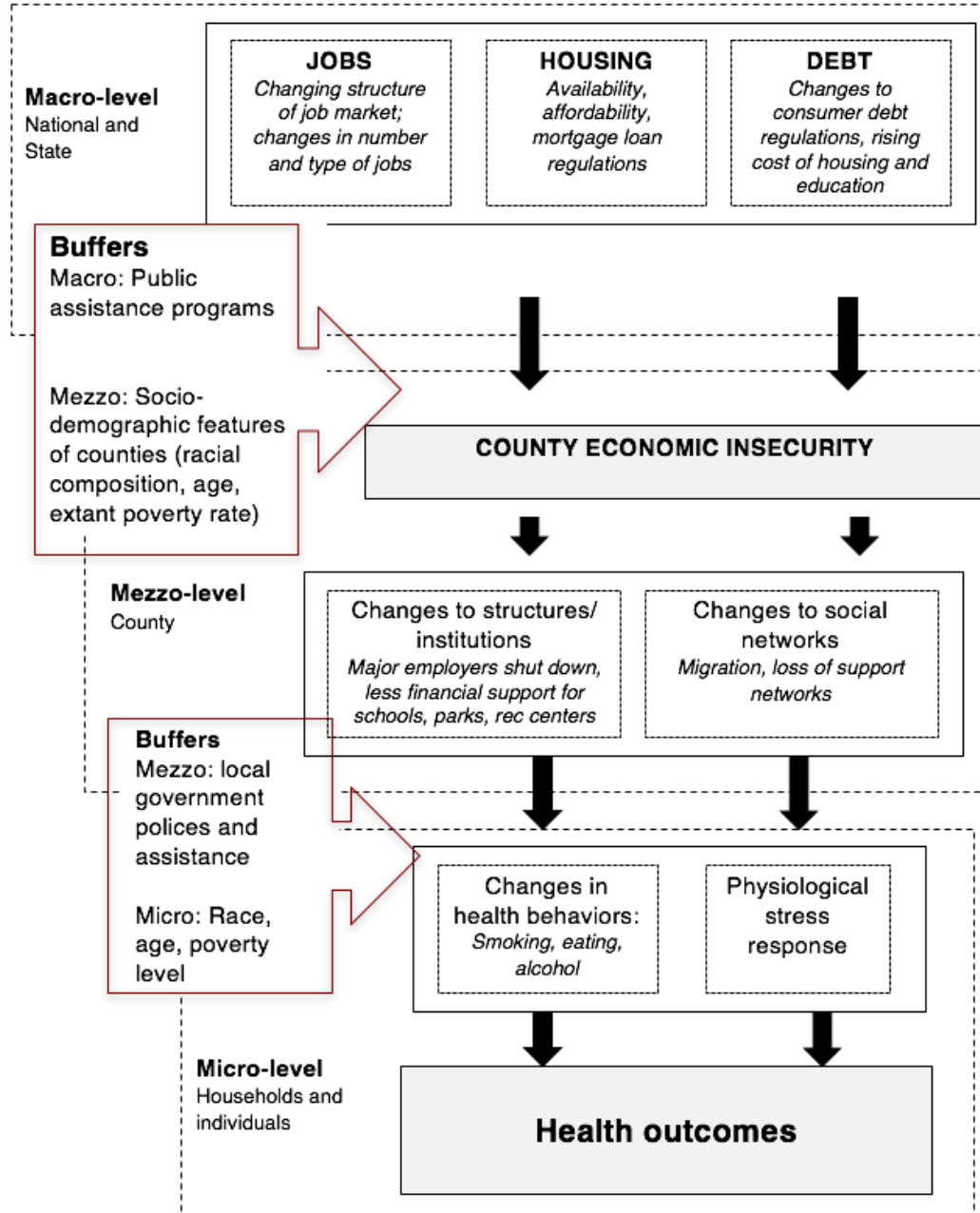
19. McMahon S, Horning J. Living Below the Line: Economic Insecurity and America's Families. Washington, DC: Wider Opportunities for Women; 2013.
20. Watson B, Osberg L. Healing and/or breaking? The mental health implications of repeated economic insecurity. *Soc Sci Med* 2017;188:119-127.
21. Osberg L. Measuring Economic Security in Insecure Times: New Perspectives, New Events, and the Index of Economic Well Being. Ottawa, Canada: Center for the Study of Living Standards; 2009 December 2009.
22. Ulijaszek SJ. Do adult obesity rates in England vary by insecurity as well as by inequality? An ecological cross-sectional study. *BMJ Open* 2014;4(5):e004430.
23. Brenner MH. Economic Change, Alcohol Consumption and Heart Disease Mortality in Nine Industrialized Countries. *Social Science and Medicine* 1987;25(2):119-132.
24. Schafft K. Busted Amidst the Boom: The Creation of New Insecurities and Inequalities within Pennsylvania's Shale Gas Boomtowns. In; 2015.
25. Barth JM. The economic impact of shale gas development on state and local economies: benefits, costs, and uncertainties. *New Solut* 2013;23(1):85-101.
26. Report on the Economic Well-Being of U.S. Households in 2014. Washington, DC: BOARD OF GOVERNORS OF THE FEDERAL RESERVE SYSTEM; 2015 May 2015.
27. Case A, Deaton A. Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. *Proc Natl Acad Sci U S A* 2015.
28. Shiels MS, Chernyavskiy P, Anderson WF, Best AF, Haozous EA, Hartge P, et al. Trends in premature mortality in the USA by sex, race, and ethnicity from 1999 to 2014: an analysis of death certificate data. *The Lancet* 2017.
29. De Witte H, Pienaar J, De Cuyper N. Review of 30 Years of Longitudinal Studies on the Association Between Job Insecurity and Health and Well-Being: Is There Causal Evidence? *Australian Psychologist* 2016;51(1):18-31.
30. Virtanen M, Nyberg ST, Batty GD, Jokela M, Heikkila K, Fransson EI, et al. Perceived job insecurity as a risk factor for incident coronary heart disease: systematic review and meta-analysis. *BMJ* 2013;347:f4746.
31. Schaller J, Stevens AH. Short-run effects of job loss on health conditions, health insurance, and health care utilization. *J Health Econ* 2015;43:190-203.
32. Wishner J, Solleveld P, Rudowitz R, Paradise J, Antonisse L. A Look at Rural Hospital Closures and Implications for Access to Care: Three Case Studies: The Henry J. Kaiser Family Foundation; 2016.
33. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, LeWinn K, et al. The health effects of economic decline. *Annu Rev Public Health* 2011;32:431-50.
34. Monsivais P, Martin A, Suhrcke M, Forouhi NG, Wareham NJ. Job-loss and weight gain in British adults: Evidence from two longitudinal studies. *Soc Sci Med* 2015;143:223-231.

35. Benach J, Muntaner C. Precarious employment and health: developing a research agenda. *J Epidemiol Community Health* 2007;61(4):276-7.
36. Cawley J. An economy of scales: A selective review of obesity's economic causes, consequences, and solutions. *J Health Econ* 2015;43:244-68.
37. McDade TW, Chyu L, Duncan GJ, Hoyt LT, Doane LD, Adam EK. Adolescents' expectations for the future predict health behaviors in early adulthood. *Soc Sci Med* 2011;73(3):391-8.
38. Averett SL, Smith JK. Financial hardship and obesity. *Econ Hum Biol* 2014;15:201-12.
39. Komlos J, Smith PK, Bogin B. Obesity and the Rate of Time Preference: Is There a Connection? *Journal of Biosocial Science* 2004;36(2):209-219.
40. Rohde N, Tang KK, Osberg L, Rao P. The effect of economic insecurity on mental health: Recent evidence from Australian panel data. *Soc Sci Med* 2016;151:250-258.
41. Carroll CD. Macroeconomic Expectations of Households and Professional Forecasters. *Quarterly Journal of Economics* 2003;118:269-298.
42. Ruberton PM, Gladstone J, Lyubomirsky S. How Your Bank Balance Buys Happiness: The Importance of "Cash on Hand" to Life Satisfaction. *Emotion* 2016.
43. Platt S. Unemployment and Suicidal Behaviour: A Review of the Literature. *Social Science and Medicine* 1984;19(2):93-115.
44. Kochanek KD, Murphy SL, Xu J, Arias E. Mortality in the United States, 2016. *NCHA Data Brief* 2017(293).
45. Tejada VB, Bastian B, Arias E, et al. Mortality trends in the United States, 1900–2015. In: *Statistics*. NCfH, editor.; 2017.
46. Chetty R, Stepner M, Abraham S, Lin S, Scuderi B, Turner N, et al. The Association Between Income and Life Expectancy in the United States, 2001-2014. *JAMA* 2016;315(16):1750-66.
47. National Center for Health Statistics. *Health, United States, 2014: With Special Feature on Adults Aged 55–64*. Hyattsville, MD; 2015.
48. Cullen MR, Cummins C, Fuchs VR. Geographic and racial variation in premature mortality in the U.S.: analyzing the disparities. *PLoS One* 2012;7(4):e32930.
49. Dwyer-Lindgren L, Mokdad A, Srebotnjak T, Flaxman A, Hansen G, Murray C. Cigarette smoking prevalence in US counties: 1996-2012. *Population Health Metrics* 2014;12(5).
50. Jamal A, Phillips E, Gentzke AS, Homa DM, Babb SD, King BA, et al. Current Cigarette Smoking Among Adults — United States, 2016. *MMWR Morb Mortal Wkly Rep* 2018;678:53-59.
51. U. S. Burden of Disease Collaborators, Mokdad AH, Ballestros K, Echko M, Glenn S, Olsen HE, et al. The State of US Health, 1990-2016: Burden of Diseases, Injuries, and Risk Factors Among US States. *JAMA* 2018;319(14):1444-1472.

52. Centers for Disease Control and Prevention. Health Effects of Cigarette Smoking. In; 2017.
53. Centers for Disease Control and Prevention. Trends in Current Cigarette Smoking Among High School Students and Adults, United States, 1965–2014. In; 2016.
54. National Insititute on Alcohol Abuse and Alcoholism. Alcohol Facts and Statistics. In; 2017.
55. Dwyer-Lindgren L, Flaxman AD, Ng M, Hansen GM, Murray CJ, Mokdad AH. Drinking Patterns in US Counties From 2002 to 2012. *Am J Public Health* 2015;105(6):1120-7.
56. Nelson DE, Naimi TS, Brewer RD, Bolen J, Wells HE. Metropolitan-Area Estimates of Binge Drinking in the United States. *American Journal of Public Health* 2004;94(4):663-671.
57. Stahre M, Roeber J, Kanny D, Brewer RD, Zhang X. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. *Prev Chronic Dis* 2014;11:E109.
58. Kaplan MS, Huguet N, Caetano R, Giesbrecht N, Kerr WC, McFarland BH. Economic contraction, alcohol intoxication and suicide: analysis of the National Violent Death Reporting System. *Inj Prev* 2015;21(1):35-41.
59. Rose G. Sick Individuals and Sick Populations. *International Journal of Epidemiology* 1985;14(1):32-38.
60. Dutton DJ, McLaren L. How important are determinants of obesity measured at the individual level for explaining geographic variation in body mass index distributions? Observational evidence from Canada using Quantile Regression and Blinder-Oaxaca Decomposition. *J Epidemiol Community Health* 2016;70(4):367-73.

Figures

Figure 1.1. Conceptual Framework for the association between Economic Insecurity and Health



CHAPTER 2: MEASURING ECONOMIC INSECURITY IN US COUNTIES

Abstract

Few studies have attempted to measure economic insecurity using a multidimensional, theory-driven approach. We aimed to evaluate a measurement model of county economic insecurity and assess its construct validity. Indicators were drawn from the 2000 US Census and Federal Reserve Bank based on our theoretical framework. Validity was assessed by examining associations with demographic and socioeconomic variables, and all-cause, and cause-specific mortality from the CDC. We used confirmatory factor analysis to test our measurement model based on 8 indicators and to create a scale of county economic insecurity in 2000 for the 320 counties in Pennsylvania and the surrounding states: Maryland, Delaware, West Virginia, New York, New Jersey, and Ohio. County-level indicators included in the final model were percent not in labor force, unemployed, in service jobs, with subprime credit rating, and percent of income spent on rent. We calculated the correlation between economic insecurity and county-level variables (socioeconomic status and deprivation, social disruption, and mortality). Our model fit the observed data well (Comparative Fit Index=0.961, Tucker Lewis Index=0.922, standardized root mean square residual=0.033). The county-level economic insecurity score (standardized mean 0, range -2.055 to 2.837) was moderately associated with completing high school ($r=-0.60$) and income ($r=-0.68$), but correlations with population density, age, and percent black were low ($r = 0.30, 0.14, 0.14$, respectively). Economic insecurity in 2000 was moderately associated with all-cause and heart disease mortality in 2001 ($r=0.47$ and 0.45 , respectively). Our

work suggests that economic insecurity 1) can be measured as a multidimensional, theory-based construct at the county level, 2) is more strongly associated with all-cause mortality than single measures such as percent unemployed, and 3) is distinct from related measures of socioeconomic status and deprivation.

Introduction

Defining the construct: What is economic insecurity?

Economic insecurity is the degree of instability in economic conditions in a community. Economic insecurity captures the dynamics of real and perceived volatility in economic conditions, the financial buffer protecting communities from economic shocks, adverse events, and other losses in revenue, as well as the risk of downward mobility as evidenced by changing socioeconomic status (1-3). Communities at both end of the socioeconomic spectrum can be either stable or unstable. In contrast, related concepts such as socioeconomic status and socioeconomic deprivation focus on more constant and absolute levels of socioeconomic position. These studies most often focus on communities with the lowest levels of socioeconomic status.

One important dimension missing from measures of socioeconomic status is the likelihood that a person or community will remain in a given level of socioeconomic status. Weakening job prospects may drain a community of skilled workers; even a small number of foreclosures may drive down housing values. Improving and/or high socioeconomic status can coexist with economic insecurity. For example, areas experiencing rapid increases in average income may experience housing shortages and sharp increases in housing prices, creating economic insecurity for those not directly benefiting from rising wages (4). Therefore, economic insecurity and socioeconomic deprivation are separate, and may independently and jointly influence population health. However, little

attention has been paid to economic insecurity in the public health literature (5-8).

Trends in Economic Insecurity in the US

Markers of economic insecurity in the US have been rising since the late 1970s. For example, the percentage of workers with “precarious” employment has been increasing in the US (9); underemployment and part-time work have been increasing for decades, and union membership, job tenure, and jobs offering benefits such as health insurance and retirement plans are decreasing (9-13). Housing costs have been rising for both renters and homeowners, but adjusting for inflation, average wages have not risen since the 1970s (14, 15). While some of these factors have been evaluated for their impact on health outcomes, few studies have attempted to measure economic insecurity using a theory-based, multidimensional approach.

Previous measures of economic insecurity

Measures of individual or household economic insecurity typically focus on average wage, perception of job security or economic conditions, probability of unemployment, or the extent of financial resources available in case of economic shock or sudden decrease in income (6-8, 16-19). Ecological measures of economic insecurity include the unemployment rate, business closings and layoffs, and occupation (20-23). Osberg developed an index of country-level economic insecurity comprised of risks of poverty (due to old age, health, single-headed household, and job loss) and corresponding social protections (3). While

these studies are promising, they are limited by 1) use of single indicators to measure economic insecurity, a multidimensional construct; and/or 2) lack of theoretical consideration of the correct geographic scale for measuring economic insecurity.

Preliminary evidence on economic insecurity and health

Studies measuring economic insecurity using single indicators of unemployment or job instability have found ecological associations between higher levels of insecurity and higher rates of suicide (20). At the country level, Brenner found that economic insecurity as measured by business closings and unemployment was associated with deaths due to heart disease (21). Economic insecurity at the country level has also been associated with obesity (24). States with higher rates of layoffs have higher rates of suicide (25). Ulijaszek and colleagues used proportion of the population in different social classes defined by occupation as a proxy for economic insecurity, and found higher obesity rates in local authority areas with higher rates of insecure social classes (22).

Economic insecurity as a county-level measure

Although economic insecurity can exist at both the area and individual levels, we focus on economic insecurity at level of the US county. While individual-level measures of economic insecurity only capture the direct effects, county-level economic insecurity captures aggregate effects, such as the observed association between neighborhood concentration of foreclosures on cardiovascular risk factors among those not experiencing foreclosure (26, 27),

and birth outcomes due to perceived economic insecurity among households not directly affected by changing conditions (23). Although an individual or household may not be directly experiencing economic insecurity, county economic insecurity could affect an individual through changes to services at the county level, declining housing values, economic growth or contraction, or disruptions in social networks as friends and family emigrate for work opportunities. Economic uncertainty may diffuse through a community through social networks or media coverage and therefore may effect individuals beyond their individual circumstances (19, 28).

Additionally, counties have administrative and governance functions that allow them to create and moderate levels of economic insecurity through policies and programs promoting economic development, zoning, and provision of public assistance, making the county a policy-relevant unit for research and intervention. Counties are the primary division of US states, and carry out social and health services, economic development programs, maintenance of public spaces and roads, and zoning planning (29, 30). Therefore, counties are the locus of public health, economic, and entitlement program policy and provision. Counties are more policy-relevant than other geographic units because they generally have some degree of self-governance and have the ability to enact policies and programs that could benefit the economic conditions and health of their citizens.

Conceptualizing economic insecurity at the county level also allows us to focus on upstream causes and consequences of economic insecurity. County-level economic insecurity is driven by state and national policies that affect the labor, housing, and financial markets (Figure 2.1). In turn, county economic insecurity alters the resources counties have for infrastructure and public assistance, and alters the social makeup of communities as families move in and out for job opportunities. These changes may alter health behaviors of individuals and lead to stress responses, and may ultimately affect population health. County-level economic insecurity may manifest as a shifting or unpredictable job market, with full-time manufacturing jobs replaced by part-time service work. Similarly, counties experiencing high economic insecurity may see growth in the cost of living or housing prices that outpace growth in wages.

Objectives

Our goal was to develop a theory-based, multi-dimensional measure of economic insecurity at the US county level for use in public health research in a variety of outcomes. The objectives of this study were to: 1) assess a measurement model for county data using confirmatory factor analysis; 2) use this model to estimate a factor-based summary measure, 3) evaluate the construct validity of this new measure through correlations of county economic insecurity with other similar contextual measures such as socioeconomic status and deprivation and mortality rates. To our knowledge, this is the first measure of

economic insecurity created at the level of the US county for use in public health studies.

Methods

Our goal was to evaluate a measurement model of county economic insecurity using confirmatory factor analysis in the year 2000. Because this was part of a larger project investigating the determinants of childhood obesity in Pennsylvania (31-34), we used data from 320 counties in Pennsylvania and the surrounding states of Maryland, Delaware, New Jersey, New York, Ohio, and West Virginia.

Data Sources

To evaluate a measurement model of economic insecurity at the county level, we needed indicators that fit our conceptual model and were measured at or could be mapped to US counties, and that were available for the seven states in our study population in the year 2000. We searched for indicators in a variety of sources: state and local government agencies, federal agencies such as the Census Bureau, Bureau of Labor Statistics, and the Department of Housing and Urban Development, electronic court records, surveys, and privately-operated databases. Supplement table 1 presents the indicators that we located and considered for this model, and Table 1 provides detail about the five indicators that were included in our final model.

All-cause, age-adjusted mortality rates for each county were obtained from the CDC Wonder database for the year 2001 (35). We also downloaded cause-specific mortality rates for the top 3 causes of death in 2001: heart disease (ICD-10 I00-I09, I11, I13, I20-151), cancer (ICD-10 C00-C97), and stroke (ICD-10 I60-69) (36). Demographic indicators (age, racial composition, population density) and indicators of socioeconomic status (median income, percent graduating college, percent with less than high school education), deprivation (percent with no car, percent on public assistance, percent below poverty line), and social disruption (single parent households, household moving in to county since 1990, vacant houses) for the year 2000 were selected from the 2000 Census for each county.

Confirmatory Factor Analysis

Confirmatory factor analysis is useful when the construct of interest is not directly observable, there is a strong theoretical justification for the construct, and when a numeric estimate representing the magnitude of the latent construct is needed for future work (37). Using multiple indicators is also preferable to single-indicator measures because it reduces measurement error and allows multiple domains of the construct to be represented. Confirmatory factor analysis also has the advantage of starting from a strong theoretical hypothesis about the construct in question—this allows us to test a measurement hypothesis through the modeling process.

To evaluate our theory of measurement, we carried out confirmatory factor analysis. We first identified potential indicators from our theoretical framework (Figure 2.1). Specifically, we searched for items (observed variables) that would be influenced by economic insecurity (the latent variable) in the subdomains of employment, housing, and debt. To differentiate our measure from existing measures of socioeconomic status, we avoided measures of income or poverty. The eight indicators hypothesized to be most relevant based on our theoretical framework were: percent of those not in the labor force, percent unemployed, percent of household income spent on rent (among renters only), percent of household income spent on housing costs (among home owners only), number of permits for construction of new residential buildings, percent of housing units occupied by the owner, percent of those employed in the service sector, and percent of those with a subprime credit rating (credit score below 660).

Next, we evaluated the distribution of each indicator truncating extreme values (> 99th percentile) to address non-normality (details in Table 2.1). After these transformations, all indicators were approximately normally distributed and were included in the model as continuous variables.

Third, we began to model a single factor confirmatory factor analysis with the 8 indicators listed above. Three indicators were dropped due to poor model fit: percent of housing units occupied by the owner (2000 Census), percent of income spent on housing costs among home owners (2000 Census) and new permits for residential construction (Census Manufacturing, Mining and

Construction Statistics). The variance of the latent variable was constrained to 1; all other indicator variances were unconstrained. This improves the interpretability of the model because factor scores are standardized. In the resulting model, path coefficients can be interpreted as standardized regression coefficients (the change in that indicator per standard deviation change in the latent variable). Final model selection was based on the optimization of fit statistics. To assess model fit, we used the Comparative Fit Index (CFI, 0.95 or higher), the Tucker Lewis Index (TLI, 0.95 or higher), and standardized root mean square residual (< 0.08) (38).

After an iterative modelling process, the final measurement model was comprised of 5 indicators from the 2000 Census and the Federal Reserve Bank of New York: percent of those not in the labor force, percent unemployed, percent of household income spent on rent, percent employed in the service sector, and percent with a subprime credit rating (39, 40). More information on final indicators is included in Table 2.1. The unemployment rate was chosen because this is commonly used in health research. Percent of those not in the labor force is a complementary indicator that includes those not working and not looking for work, as well people who are retired, students, and “discouraged workers” who wish to be employed but who are not seeking employment because they do not believe there are available jobs (41). Percent of household income spent on rent captures the financial strain posed by housing costs. Percent employed in the service sector indicates precarious work in terms of

hours, consistency, hourly wages, job tenure and benefits offered (9, 42-44). Finally, percent of the county with a subprime credit score is a proxy for debt management and spending that exceeds income. Credit scores are numeric estimates of the likelihood that debts will be paid on time. Credit scores below 660 are considered fair to poor and are indicative of late payments, high credit utilization, outstanding debt, and events such as repossession, foreclosure, and bankruptcy (45).

Finally, we calculated factor scores for each county based on the best fitting measurement model. The factor scores are a numeric estimate of the magnitude of economic insecurity in each county. Factor scores were standardized with a mean of 0 and a standard deviation of 1. Continuous factor scores were included in all correlations and validation analyses. For discrete analyses, tertiles were used (Table 2.2). This analysis was carried out in STATA and MPLUS, using the runmplus package (46).

Construct Validation

Given that there is no standard measure of economic insecurity, we compared the performance of our measure to the unemployment rate, a commonly used proxy for economic insecurity, in predicting all-cause mortality in 2001. We also examined the association of economic insecurity with the top 3 causes of death in 2001: heart disease, cancer, and stroke (36). We hypothesized that heart disease would have the strongest correlation with

economic insecurity because of previous work connecting unemployment and economic conditions to heart disease (5, 21).

We calculated the correlation of our measure with indicators of socioeconomic deprivation and social disruption. Pearson correlation coefficients were calculated for variables that were normally distributed and appeared to have an approximately linear association with county economic insecurity. Spearman correlation coefficients were calculated for variables that did not meet these criteria.

We hypothesized that economic insecurity would be moderately correlated with traditional measures of socioeconomic deprivation because these concepts overlap, but represent different underlying constructs. Therefore, we expected to see a moderate negative correlation between county economic insecurity and education (percent with less than a high school diploma, percent with a high school diploma, and percent with college degree). Because economic insecurity places more people at risk for poverty, we expected a negative correlation with income (median income and percent with income below the poverty line). We hypothesized that county economic insecurity would be associated with social disruption, so we expected to see a negative correlation between county economic insecurity and single parent households, vacant housing units, and residential stability (the percent of households who moved into the county between 1990 to 2000). We also examined the correlation of insecurity with median age, racial composition, and population density to evaluate whether

demographic factors (median age, percent non-Hispanic white, percent non-Hispanic black, and population density) were influencing the measure.

Lastly, we compared classification of counties by economic insecurity versus median household income. Each measure was divided into tertiles of high, medium, and low, and classification of counties was examined between these two measures.

Results

All 320 counties in the seven states in our study area were included. Mean, standard deviation, and range of each of the five final indicators is shown in Table 2.1. Figure 2.2 shows the results of our final confirmatory factor analysis. No correlated measurement errors were estimated. This model had a root mean square error of 0.109 (95% CI: 0.068, 0.155), a Comparative Fit Index (CFI) of 0.961, Tucker Lewis Index (TLI) of 0.922, and standardized root mean square residual of 0.033. Standardized factor loadings ranged from 0.441 (SE = 0.051) for the percentage of the county with a subprime credit rating to 0.817 (SE = 0.031) for the unemployment rate. Factor scores estimating county economic insecurity in each county ranged from -2.055 to 2.837, with a mean of 0 (SD = 0.92).

Table 2.2 compares counties overall and by tertile of economic insecurity. Compared to counties in the lowest tertile (i.e., those experiencing the lowest levels of insecurity), counties in the highest tertile of economic insecurity had

larger population densities, lower percentages finishing high school and college, lower median incomes and higher percentages of households living below the poverty line. Median age and racial composition were similar between counties with high, medium, and low county economic insecurity. Counties experiencing high economic insecurity had more vacant homes than low or medium insecurity counties.

The average age-adjusted all-cause mortality rate in all counties for the year 2001 was 894 deaths per 100,000 individuals (SD=102). Counties with higher insecurity had higher age-adjusted rates of all-cause, heart disease, and cancer mortality. Similar rates of mortality due to stroke were observed for high, medium, and low insecurity counties.

The results of the validation analyses are presented in Table 2.3 and Figure 2.3. Table 2.3 presents correlation coefficients between county economic insecurity, indicators of socioeconomic status, deprivation, and social disruption, and demographic factors. For comparison, these correlations are shown between county unemployment and these factors. County economic insecurity was associated with a lower percentage of adults completing high school ($r = -0.60$) and lower median household income ($r = -0.68$). County economic insecurity was also moderately to highly associated with three indicators of community deprivation: correlation with the percent of households without a car was 0.65, 0.71 with the percent of households using public assistance, and 0.79 with percent of households below the poverty line. Each of these associations was

stronger between county economic insecurity than with unemployment alone. Indicators of social disruption were moderately associated with county economic insecurity: higher economic insecurity was associated with more single parent households ($r = 0.37$) and less migration of families into the county ($r = -0.26$). County economic insecurity had a low association with population density ($r = 0.30$), percent of residents who are black ($r = 0.14$), median age ($r = 0.14$) and percent of the county that completed college or above ($r = -0.34$).

County economic insecurity was moderately associated with all-cause mortality ($r = 0.47$), and had a higher association with all-cause mortality than unemployment alone ($r = 0.34$). Figure 2.3 illustrates this correlation and highlights patterns by state. County economic insecurity was associated with higher mortality due to heart disease ($r = 0.45$), and to a lesser extent with mortality due to cancer ($r = 0.27$), with no association seen for death due to stroke ($r = -0.07$).

Table 2.4 shows the agreement between tertiles of economic insecurity and median household income. 62% of counties were classified in the corresponding tertile by economic insecurity and median household income. Discrepancies in rankings were the highest among middle-income counties: 36% of medium income counties were classified as high insecurity, for example.

Discussion

The objective of this paper was to use confirmatory factor analysis to assess a theory-driven, multidimensional measurement model of county economic insecurity in our study area comprised of PA and the six surrounding US states for the year 2000. To our knowledge, this is the first measure of economic insecurity at the county level for use in health research. Our model combining information from the county-level indicators of percent not in labor force, percent unemployed, percent of income spent on rent, percent in service jobs, and percent with subprime credit rating demonstrated acceptable fit in all 320 counties in Pennsylvania, Maryland, Delaware, New Jersey, New York, Ohio, and West Virginia. We found that higher county economic insecurity was associated with higher rates of all-cause mortality and mortality due to heart disease.

County economic insecurity was associated with all-cause mortality and heart disease mortality, but was not associated with stroke mortality and had a small association with cancer mortality. Our finding regarding heart disease is consistent with previous work linking insecurity as measured by unemployment with heart disease deaths (21). Heart disease may be more sensitive to stress caused by economic insecurity, and those living in insecure counties may alter their behaviors based on their economic outlook (47).

County economic insecurity scores from this model were associated with a range of socioeconomic, community deprivation, and social disruption indicators.

As expected, county economic insecurity was associated with traditional measures of socioeconomic status, like education and income, and had larger associations with indicators of deprivation. While these results suggest some overlap between county economic insecurity and county socioeconomic status and deprivation, we also demonstrated that economic insecurity and socioeconomic status, as measured by median income, uniquely classify counties: 38% of counties would be reclassified by tertile of economic insecurity as compared to tertile of median income.

This measure answers the call for theory-driven measures and provides a new measurement tool for economic insecurity, an area of increasing interest in public health (48, 49). This tool can be used to 1) track change in economic insecurity over time and 2) evaluate the health effects of economic insecurity at the county level. This tool represents a methodological advancement compared to previous studies of economic insecurity which have often used single indicators of unemployment or probability of unemployment as a proxy measure of insecurity. Scales created by confirmatory factor analysis also have the benefits of explicitly testing a measurement theory, covering multiple domains of a construct, and reducing measurement error as compared to single indicator measures.

This measure of county economic insecurity may have theoretical overlap with other measures of area-level socioeconomic deprivation. Compared to measures of deprivation, we think measuring county economic insecurity is

preferable because 1) economic insecurity can occur at all levels of socioeconomic status, as we have demonstrated, and thus may have harmful effects on a wider portion of the population; 2) indicators of economic insecurity have community-wide effects, which helps to uncover mechanisms between economic insecurity and health; and 3) indicators of economic insecurity have more obvious and perhaps politically feasible solutions than indicators of socioeconomic status.

One limitation of this work is that we were not able to identify some indicators suggested by our conceptual framework. For example, based on research from economics, we would have preferred to include indicators of household or community debt (ratio of debt to income, average credit card debt, bankruptcy rates), foreclosure and eviction rates, and plant closings and layoffs. However, this information is not available at the county level. This work highlights the need for high quality data for geographic areas smaller than states.

Any composite measure comes with a causal inference tradeoff: it is harder to conceptualize the specific intervention that is motivated by a composite exposure compared to a single indicator measure. However, it is still conceivable that policies or other interventions could either affect county economic insecurity directly or ameliorate its effects. There is evidence that social welfare policies can mitigate the effects of economic conditions on health (50-53), and these policies are often enacted at the county level. Effective policies would target the

latent construct (economic inequality) and not specific indicators (e.g., percentage of service workers).

We measured economic insecurity in 2000. Starting in the year 2000 allows for future work that can further validate this measure with measures of population morbidity and mortality using changes across time. For example, we could examine economic insecurity and its association with mortality before, during, and after the Great Recession.

Conclusion

We evaluated a novel measurement model designed to summarize multiple indicators, reduce random measurement error, and quantify a theoretically important latent variable, economic insecurity, at the county level for use in future health studies. To evaluate this model, we used data from 320 counties surrounding the Mid-Atlantic region of the United States for the year 2000. After finalizing a model that fit the data adequately, we generated a summary scale score based on 5 readily available indicators. This measure was associated with, but distinct from, several measures of socioeconomic status, and moderately predictive of all-cause mortality in 2001. Future work should continue to validate this measure, assess its utility over time, and explore its relationship with other health outcomes.

Tables

Table 2.1 Indicators of county economic insecurity in 2000

Indicator	Source	Definition	Transforma	Mean (SD)	Range
Unemployment (%)	2000 Census	Employment status for total population 16 years and over	Truncated to 99 th percentile	3.6 (1.1)	1.5 – 8.2
Not in labor force (%)	2000 Census	Not in labor force for total population 16 years and over ¹	Truncated to 99 th percentile	39.1 (6.5)	24.5 – 67.6
Percent of income spent on rent (%)	2000 Census	Median gross rent as a percentage of household income in 1999 among specified renter-occupied housing units paying cash rent	Truncated to 99 th percentile	24.7 (2.5)	17.2 – 36.6
Employed in service occupations (%)	2000 Census	Percent of the employed civilian population 16+ years in service occupations ²	Truncated to 99 th percentile	15.7 (2.6)	9.3 – 30.3
Subprime credit rating (%)	Equifax Consumer Credit Panel/Federal Reserve Bank of New York	The percent of nationally representative sample with a credit score below 660(54)	None	29.3 (4.4)	17.3 – 45.1

¹Among the population of those 16 and older, individuals are classified as in the labor force (i.e. employed or unemployed but actively seeking work) or not in the labor force. Those not in the labor force include those who have not actively sought employment in the last month, students, homemakers, retired workers, those who are institutionalized, and (during the off season) seasonal workers.

² Service occupations includes healthcare support, protective services, food preparation and serving, maintenance/grounds cleaning, and personal care and service occupations (55).

Table 2.2 Characteristics of counties in 2000 overall and by tertiles of county economic insecurity

	Low Insecurity (n = 107)	Moderate Insecurity (n = 108)	High Insecurity (n = 105)	All counties (N = 320)
Economic insecurity, mean (SD)	-0.97 (0.39)	-0.05 (0.21)	1.04 (0.56)	0.00 (0.92)
Indicators of County Economic Insecurity, mean (SD)				
Not in labor force, %	33.5 (3.6)	39.1 (4.3)	44.8 (5.8)	39.1 (6.5)
Unemployed, %	2.6 (0.5)	3.5 (0.5)	4.6 (0.9)	3.6 (1.1)
Income spent on rent, %	23.1 (2.1)	24.5 (1.9)	26.4 (2.4)	24.7 (2.5)
Employed in service sector, %	13.3 (1.4)	15.6 (1.2)	18.1 (2.4)	15.7 (2.6)
Subprime credit rating, %	27.5 (3.9)	29.1 (3.9)	31.5 (4.4)	29.3 (4.4)
Demographic Characteristics, mean (SD)				
Population Size, n	212,181 (280,286)	184,718 (270,064)	154,862 (388,248)	184,105 (316,634)
Population density, people per square mile	499 (760)	1064 (6471)	1322 (5251)	960 (4832)
Median age, years	37 (2)	38 (2)	38 (3)	38 (2)
Black, %	4.3 (5.4)	6.5 (8.5)	5.4 (10.3)	5.4 (8.3)
White, %	90.0 (9.2)	88.8 (11.9)	89.0 (17.3)	89.3 (12.2)
Socioeconomic status, mean (SD)				
Less than high school, %	16.8 (5.4)	19.2 (3.6)	24.6 (6.9)	20.2 (6.3)
High school grad and above, %	83.2 (5.4)	80.8 (3.4)	75.4 (6.9)	79.8 (6.3)
College grad and above, %	21.1 (10.7)	17.5 (7.6)	14.6 (5.7)	17.7 (8.6)
Median income, \$	\$48,197 (\$11,574)	\$38,046 (\$6,319)	\$31,178 (\$5,776)	\$39,187 (\$10,944)
Deprivation, mean (SD)				
Households receiving public assistance, %	2.0 (0.7)	2.9 (0.80)	4.3 (2.0)	3.1 (1.6)
Households below the poverty line, %	5.4 (2.3)	8.3 (2.0)	13.2 (5.1)	4.7 (1.6)
Households with no car, %	6.5 (3.2)	9.4 (7.1)	12.1 (8.8)	9.4 (7.1)
Social Disruption, mean (SD)				
Single parent households, %	8.5 (1.5)	9.6 (1.8)	9.9 (2.8)	9.3 (2.2)
Households that moved into the county since 1990, %	58.1 (5.5)	55.0 (5.7)	54.7 (5.3)	56.0 (5.7)
Vacant homes, %	8.0 (6.8)	12.1 (7.9)	17.8 (13.5)	12.6 (10.6)
Mortality rate (age-adjusted) per 100,000 in 2001, mean (SD)				
All-cause mortality	847 (74)	891 (83)	946 (119)	894(102)
Heart disease mortality	252 (34)	273 (37)	292 (47)	272 (43)
Cancer mortality	189 (26)	198 (23)	205 (32)	197 (28)
Stroke mortality	56 (13)	55 (13)	55 (14)	55 (13)

* Non-Hispanic

Table 2.3 Pearson correlation coefficients for county economic insecurity, demographic, socioeconomic factors, and all-cause and cause-specific mortality rates

	County Economic Insecurity	County Unemployment
Demographic factors		
Population density ¹ , people per square miles	0.30	-0.23
Median age, years	0.14	0.01
Black ¹ , %	0.14	0.001
Traditional SES indicators		
Did not complete high school, %	-0.60	-0.46
High school or higher, %	-0.60	-0.46
College or higher, %	-0.34	-0.19
Median household income, \$	-0.68	-0.54
Social Disruption indicators		
Single parent household, %	0.37	0.40
Households that moved into county since 1990 ¹ , %	-0.26	-0.19
Vacant housing units ¹ , %	0.55	0.44
Community Deprivation Indicators		
Households without a car, %	0.65	0.60
Households using public assistance, %	0.71	0.65
Households below the poverty line, %	0.79	0.67
Age-Adjusted Mortality per 100,000 in 2001²		
All-cause mortality (n=320)	0.47	0.34
Heart disease mortality (n=316)	0.45	0.37
Cancer mortality (n=310)	0.34	0.25
Stroke mortality (n=244)	-0.07	-0.10

¹ Spearman correlation coefficients were estimated when variables were not normally distributed.

² The CDC suppresses death rates when fewer than 10 deaths are reported. Therefore, there are some counties with no data on cause-specific mortality.

Table 2.4 Discordance between tertiles of economic insecurity and median household income in 2000, N (%)

	Low income	Medium Income	High Income
Low Insecurity	2 (3%)	14 (14%)	91 (58%)
Medium Insecurity	7 (10%)	48 (49%)	53 (34%)
High Insecurity	58 (87%)	35 (36%)	12 (8%)

Table 2.4 Caption: Of the 320 counties, 197 (62%) were ranked in the same tertile by economic insecurity and median household income (represented by the bolded cells).

Figures

Figure 2.1 Conceptual framework for the association between economic insecurity and health

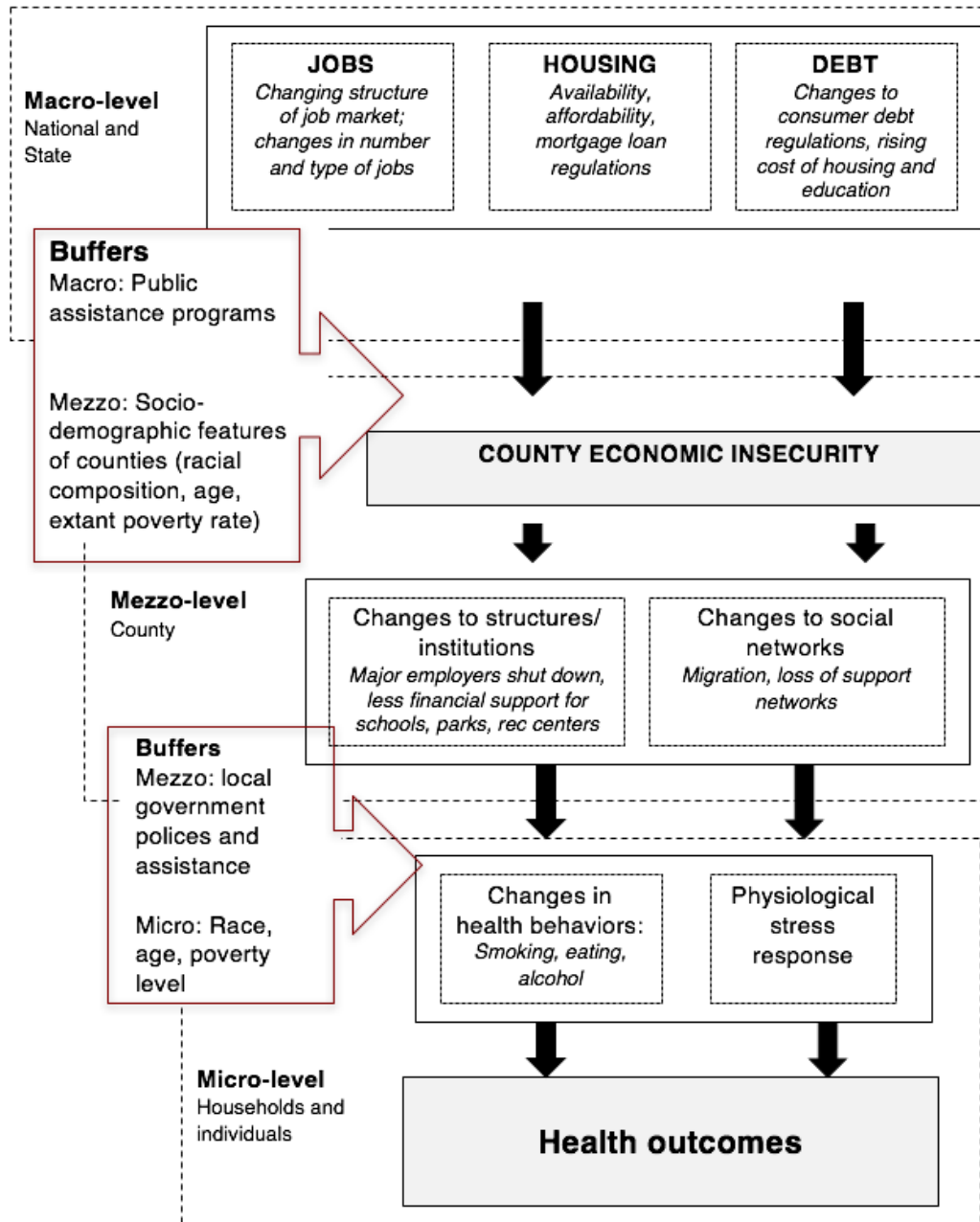


Figure 2.1 Caption: Figure 2.1 is the conceptual framework for research on the association between county economic insecurity and health. County economic insecurity is driven by state

and national policies that affect the labor, housing, and financial markets. In turn, county economic insecurity alters the resources counties have for infrastructure and public assistance, and alters the social makeup of communities as families move in and out for job opportunities. These changes alter health behaviors of individuals and lead to stress responses, ultimately affect population health.

Figure 2.2 County economic insecurity in 2000, final measurement model

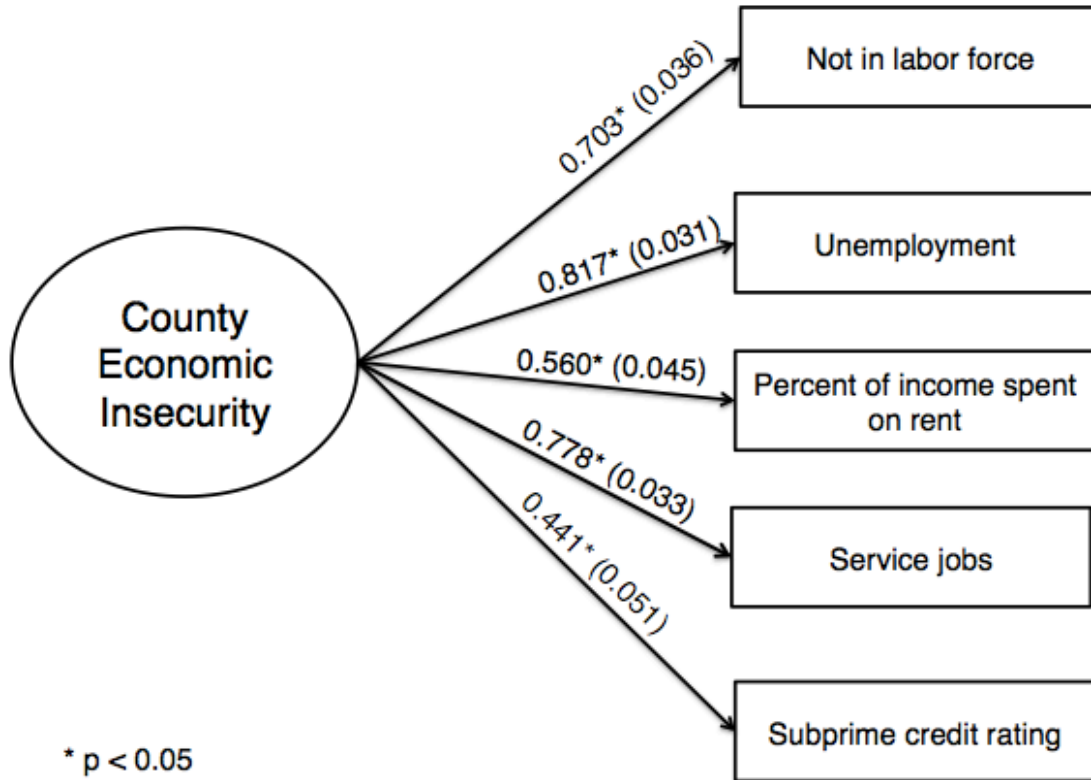


Figure 2.2 Caption: Figure 2.2 depicts the final measurement model for county economic insecurity. This model had a root mean square error of 0.109 (95% CI: 0.068, 0.155), a comparative fit index of 0.961, Tucker Lewis index of 0.922, and standardized root mean square residual of 0.033). In this model, county economic insecurity is a latent construct that drives the values of each of the five indicators. Standardized factor loadings and standard errors are presented here: each path coefficient represents the change in that indicator per standard deviation change in the latent variable.

Figure 2.3 Scatterplot and loess prediction of county economic insecurity in 2000 vs. all-cause mortality in 2001

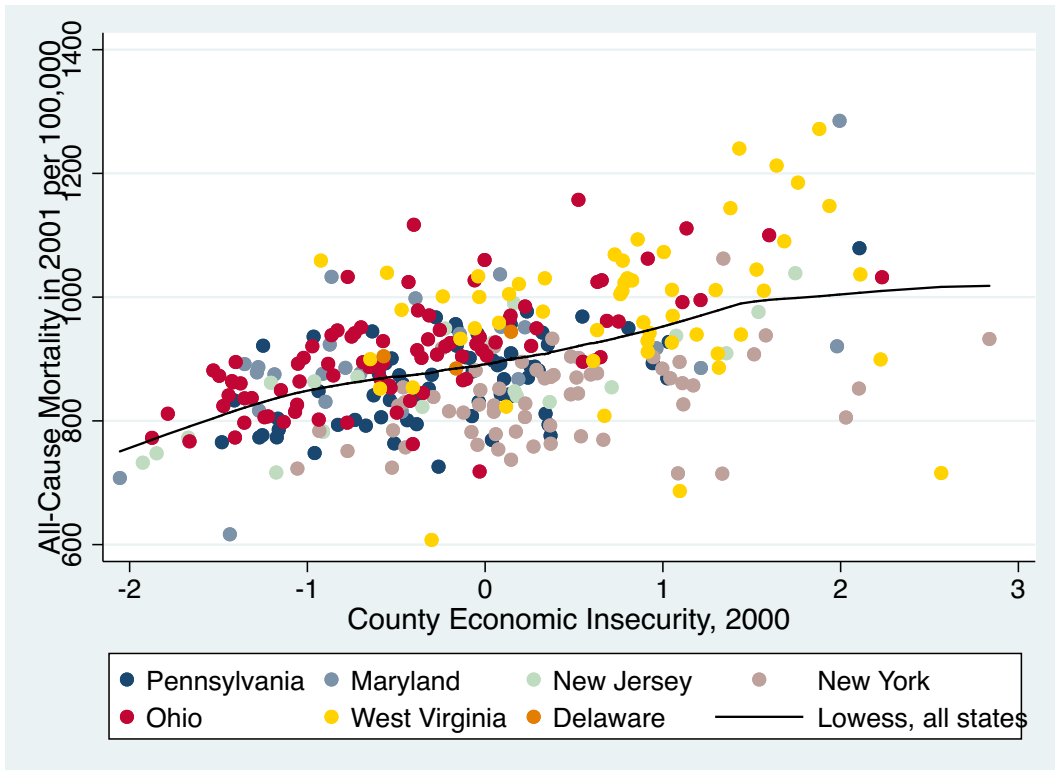


Figure 2.3 Caption: For each of the 320 counties included in this analysis, county economic insecurity is plotted against all-cause mortality per 100,000 persons. A loess line predicts the all-cause mortality rate for a given level of county economic insecurity for all 7 states.

References

1. Western B, Bloome D, Sosnaud B, Tach L. Economic Insecurity and Social Stratification. *Annual Review of Sociology* 2012;38(1):341-359.
2. Hacker JS. Understanding Economic Insecurity: The Downward Spiral of the Middle Class. *Communities & Banking* 2011:25-28.
3. Osberg L. Measuring Economic Security in Insecure Times: New Perspectives, New Events, and the Index of Economic Well Being. Ottawa, Canada: Center for the Study of Living Standards; 2009 December 2009.
4. Schafft K. Busted Amidst the Boom: The Creation of New Insecurities and Inequalities within Pennsylvania's Shale Gas Boomtowns. In; 2015.
5. Catalano R. The health effects of economic insecurity. *Am J Public Health* 1991;81(9):1148-52.
6. Rohde N, Tang KK, Osberg L, Rao P. The effect of economic insecurity on mental health: Recent evidence from Australian panel data. *Soc Sci Med* 2016;151:250-258.
7. Smith TG, Stoddard C, Barnes MG. Why the Poor Get Fat: Weight Gain and Economic Insecurity: Washington State University; 2007.
8. Watson B, Osberg L. Healing and/or breaking? The mental health implications of repeated economic insecurity. *Soc Sci Med* 2017;188:119-127.
9. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health* 2014;35:229-53.
10. Labonte R, Stuckler D. The rise of neoliberalism: how bad economics imperils health and what to do about it. *J Epidemiol Community Health* 2015.
11. Samwick AA, Skinner J. How Will 401(k) Pension Plans Affect Retirement Income? *The American Economic Review* 2004;94(1):329-343.
12. Farber HS. Employment Insecurity: The Decline in Worker-Firm Attachment in the United States. Princeton, NJ: Center for Economics Policy Studies and the Industrial Relations, Princeton University; 2008.
13. Schmitt J, Jones J. Where Have All the Good Jobs Gone?: Center for Economic and Policy Research; 2012.
14. Eggers FJ, Moumen F. Trends in Housing Costs: 1985-2005 and the 30-Percent-of-Income Standard: U.S. Department of Housing and Urban Development Office of Policy Development and Research 2008.
15. Mishel L, Gould E, Bivens J. Wage Stagnation in Nine Charts. Washington, DC: Economic Policy Institute; 2015.
16. McMahon S, Horning J. Living Below the Line: Economic Insecurity and America's Families. Washington, DC: Wider Opportunities for Women; 2013.
17. Bossert W, D'Ambrosio C. Measuring Economic Insecurity. *International Economic Review* 2013;54(3):1017-1030.
18. Virtanen M, Nyberg ST, Batty GD, Jokela M, Heikkila K, Fransson EI, et al. Perceived job insecurity as a risk factor for incident coronary heart disease: systematic review and meta-analysis. *BMJ* 2013;347:f4746.

19. Carroll CD. Macroeconomic Expectations of Households and Professional Forecasters. *Quarterly Journal of Economics* 2003;118:269-298.
20. Platt S. Unemployment and Suicidal Behaviour: A Review of the Literature. *Social Science and Medicine* 1984;19(2):93-115.
21. Brenner MH. Economic Change, Alcohol Consumption and Heart Disease Mortality in Nine Industrialized Countries. *Social Science and Medicine* 1987;25(2):119-132.
22. Ulijaszek SJ. Do adult obesity rates in England vary by insecurity as well as by inequality? An ecological cross-sectional study. *BMJ Open* 2014;4(5):e004430.
23. Carlson K. Fear itself: The effects of distressing economic news on birth outcomes. *J Health Econ* 2015;41:117-32.
24. Offer A, Pechey R, Ulijaszek S. Obesity under affluence varies by welfare regimes: the effect of fast food, insecurity, and inequality. *Econ Hum Biol* 2010;8(3):297-308.
25. Classen TJ, Dunn RA. The effect of job loss and unemployment duration on suicide risk in the United States: a new look using mass-layoffs and unemployment duration. *Health Econ* 2012;21(3):338-50.
26. Christine PJ, Moore K, Crawford ND, Barrientos-Gutierrez T, Sanchez BN, Seeman T, et al. Exposure to Neighborhood Foreclosures and Changes in Cardiometabolic Health: Results From MESA. *Am J Epidemiol* 2016.
27. Arcaya M, Glymour MM, Chakrabarti P, Christakis NA, Kawachi I, Subramanian SV. Effects of proximate foreclosed properties on individuals' systolic blood pressure in Massachusetts, 1987 to 2008. *Circulation* 2014;129(22):2262-8.
28. Doms M, Morin N. Consumer Sentiment, the Economy, and the News Media: Federal Reserve Bank of San Francisco; 2004.
29. Osypuk T, Galea S. What level macro? Choosing appropriate levels to assess the relation between space and population health. In: S G, editor. *Macrosocial determinants of population health*. New York, NY: Springer; 2007. p. 399-436.
30. National Association of Counties. *Counties Matter*. In; 2016.
31. Schwartz BS, Bailey-Davis L, Bandeen-Roche K, Pollak J, Hirsch AG, Nau C, et al. Attention deficit disorder, stimulant use, and childhood body mass index trajectory. *Pediatrics* 2014;133(4):668-76.
32. Nau C, Schwartz BS, Bandeen-Roche K, Liu A, Pollak J, Hirsch A, et al. Community socioeconomic deprivation and obesity trajectories in children using electronic health records. *Obesity (Silver Spring)* 2015;23(1):207-12.
33. Schwartz BS, Glass TA, Pollak J, Hirsch AG, Bailey-Davis L, Moran TH, et al. Depression, its comorbidities and treatment, and childhood body mass index trajectories. *Obesity (Silver Spring)* 2016;24(12):2585-2592.
34. Nau C, Ellis H, Huang H, Schwartz BS, Hirsch A, Bailey-Davis L, et al. Exploring the forest instead of the trees: An innovative method for defining obesogenic and obesoprotective environments. *Health Place* 2015;35:136-146.

35. Centers for Disease Control and Prevention. Underlying Cause of Death 1999-2015. In: Statistics NCfH, editor.; 2016.
36. Anderson RN, Smith BL. Deaths: Leading Causes for 2001. National Vital Statistics Reports 2003;52(9):1-88.
37. Bollen KA. Structural Equations with Latent Variables. New York: John Wiley & Sons; 1989.
38. Hu Lt, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. Structural Equation Modeling: A Multidisciplinary Journal 1999;6(1):1-55.
39. Social Explorer and US Census Bureau. Census 2000. In. New York, NY: Social Explorer.
40. Federal Reserve Bank of New York and Equifax Consumer Credit Panel. 2000 Equifax Subprime Credit Population by County (percent). In: FRED.
41. Bureau of Labor Statistics. Labor force characteristics: Not in the labor force. In: Labor Force Statistics from the Current Population Survey. Washington, DC; 2017.
42. Kalleberg AL. Precarious Work, Insecure Workers: Employment Relations in Transition. American Sociological Review 2008;74:1-22.
43. Lambert S, Fugiel P, Henly J. Precarious Work Schedules among Early-Career Employees in the US: A National Snapshot. Chicago: University of Chicago, Social Service Administration; 2014
44. Henley J, Lambert S. Unpredictable Work Timing in Retail Jobs: Implications for Employee Work-Life Conflict. Industrial & Labor Relations Review 2014 67.
45. Experian. What Affects Your Credit Scores? In: Credit Score Basics.
46. Jones RN. runmplus. In; 2017. p. .
47. McDade TW, Chyu L, Duncan GJ, Hoyt LT, Doane LD, Adam EK. Adolescents' expectations for the future predict health behaviors in early adulthood. Soc Sci Med 2011;73(3):391-8.
48. Stein EM, Gennuso KP, Ugboaja DC, Remington PL. The Epidemic of Despair Among White Americans: Trends in the Leading Causes of Premature Death, 1999-2015. Am J Public Health 2017;107(10):1541-1547.
49. Case A, Deaton A. Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. Proc Natl Acad Sci U S A 2015.
50. Cylus J, Glymour MM, Avendano M. Do generous unemployment benefit programs reduce suicide rates? A state fixed-effect analysis covering 1968-2008. Am J Epidemiol 2014;180(1):45-52.
51. Cylus J, Glymour MM, Avendano M. Health effects of unemployment benefit program generosity. Am J Public Health 2015;105(2):317-23.
52. Beckfield J, Bamba C. Shorter lives in stingier states: Social policy shortcomings help explain the US mortality disadvantage. Soc Sci Med 2016.
53. Bilal U, Cooper R, Abreu F, Nau C, Franco M, Glass TA. Economic growth and mortality: do social protection policies matter? Int J Epidemiol 2017;46(4):1147-1156.

54. Lee D, Klaauw Wvd. An Introduction to the FRBNY Consumer Credit Panel: Federal reserve Bank of New York; 2010.
55. Social Explorer and U.S. Census Bureau. 2000 Census of Population and Housing, Summary File 3: Technical Documentation. In; 2002.

CHAPTER 3: ECONOMIC INSECURITY AND DEATHS OF DESPAIR

Abstract

Introduction: Recent research observing increasing mortality in the US has implicated economic insecurity in the rise of “deaths of despair”: suicide, chronic liver disease, and drug and alcohol poisoning. Our objective was to study the association between changes in economic insecurity and increases in mortality due deaths of despair in US counties between 2001-2015.

Methods: This is an ecological longitudinal study of trends in mortality from 2001 to 2015 in US counties. Data for deaths due to suicide, chronic liver disease, and drug and alcohol poisoning for all age groups and for all-cause mortality among middle-aged adults for all counties in the US come from the CDC WONDER database for the years 2001-2005, 2006-2010, and 2011-2015. We extended a previously developed measure of county economic insecurity using indicators from the Census and Federal Reserve Bank to all counties in the US for the years 2000 and 2010. Linear regression models were used to estimate the association of change in economic insecurity with subsequent change in mortality rates.

Results: Counties with elevated economic insecurity in either or both 2000 and 2010 had larger increases in suicide, poisoning, and chronic liver disease mortality than counties with low insecurity in both time periods, and larger increases in all-cause, midlife mortality. Counties that had high economic insecurity in both 2000 and 2010 had 8.3 (95% CI 4.2, 12.5) per 100,000 more deaths of despair among all age groups and 59.0 (95% CI 36.0, 82.1) more

deaths due to any cause among those 45-54 in 2011-2015 compared to 2001-2005 than counties with low economic insecurity in both years.

Conclusion: Economic insecurity may be contributing to increases in mortality due to suicide, chronic liver disease, and drug and alcohol poisonings.

Introduction

After decades of steady declines in mortality rates in the United States (1), recent research has shown a reversal in this trend. Case and Deaton reported an increase in mortality of 2% per year among middle-aged non-Hispanic white persons in the US between 1999 to 2013 (2). This increase in deaths is partially attributable to increases in drug and alcohol poisonings, suicide, and chronic liver disease, referred to as “deaths of despair” (2). In addition, these increases were concentrated in smaller metropolitan and rural areas (3). Overall, unintentional injuries (which include drug and alcohol poisonings), suicides, and chronic liver disease were the fourth, 10th and 12th leading causes of death, respectively. In contrast, among 45-64 year olds, these causes of death were more common, with unintentional injuries, chronic liver disease and suicide being the 3rd, 4th and 8th most common causes of death in that age group, respectively.

One potential explanation for these observations, advanced by both Case and Deaton and Stein and colleagues but not yet formally tested (2, 3), is that economic conditions, particularly financial insecurity and diminishing economic opportunity, may be contributing to these increases in deaths of despair. Economic insecurity is the likelihood of a downward trajectory of income, material resources, and socioeconomic status (4, 5). The increasing “precariousness” of employment, rising cost of living, stagnant wages, decline of the manufacturing sector, and falling economic mobility compared to earlier generations have all been implicated in concerns about the economic security of Americans (6-8).

Decades of shifts in the structure of the US economy may have led to an increase in economic insecurity. In particular, the concentration of deaths of despair in smaller metropolitan areas and rural areas may be related to changes in the labor market and economic conditions, which are more marked outside of large metropolitan areas (9).

In descriptive analyses examining the results of the 2016 presidential election, Monnat showed higher rates of drug, alcohol, and suicide deaths in counties with higher proportions of working class populations and higher economic distress (10). Economic insecurity in these areas may lead to stress and unhealthy coping mechanisms, such as increased alcohol consumption and drug use (11), particularly among middle-aged adults who should be in the peak of their career earnings and therefore may feel the effects of insecurity more acutely. One recent analysis found that the economic stressors of the Great Recession increased blood pressure and glucose levels, particularly among middle-aged adults and homeowners (12). Heavy drinking, binge drinking, and other high risk drinking behaviors, as well as illegal drug use have been increasing nationally and are associated with increased mortality (13-15). Simultaneously, economic insecurity reduces the material resources of communities to respond to perceived threats. Furthermore, reduced spending on social welfare programs, for example, may lead to reductions in social services, including drug and alcohol treatment programs (16, 17).

Given the concurrent trends in increasing economic insecurity and mortality, we hypothesize that economic insecurity may be associated with increased rates of mortality, including midlife mortality and deaths of despair (suicide, drug and alcohol poisoning, and chronic liver disease). Our primary objective was to evaluate the association between county economic insecurity and county-level rates of mortality due to suicide, drug and alcohol poisoning, and chronic liver disease in the US. Secondarily, we examined the association between economic insecurity and rates of all-cause mortality in midlife (ages 45-54). To do this, we characterized the change in county-level economic insecurity across 2000 to 2010, the decade previously observed to have increasing mortality rates, and evaluated its association with changes in these mortality outcomes over the time period 2001-2015.

Methods

Previously, we developed a measure of economic insecurity in 2000 in the Middle-Atlantic region at the level of the US county. In this paper, we expand our measure of economic insecurity to all US counties and to the year 2010, so that we can examine the association of change in economic insecurity across the decade 2000 to 2010 with subsequent changes in mortality rates due to suicide, drug and alcohol poisoning, and chronic liver disease.

County Economic Insecurity

We developed a scale representing county economic insecurity, which is described in detail in Chapter 2. Briefly, we used confirmatory factor analysis to develop a model of economic insecurity in 2000 in the 320 counties in Pennsylvania, West Virginia, Ohio, Delaware, New York, Maryland, and New Jersey using indicators selected from the 2000 Census and the Federal Reserve Bank. We chose to measure economic insecurity at the level of the county because counties are policy-relevant units of research and analysis. Counties are self-governing entities that administer education, law enforcement and social and health services, maintain public roads and spaces, and enact zoning policies and economic development programs (18, 19). Additionally, characterizing county-level economic insecurity and county-level health outcomes allows us to capture the net effects of economic insecurity on the entire community.

Our measure of economic insecurity includes the following county-level indicators: percent not in labor force, percent unemployed, percent of income spent on rent, percent employed in service positions, and percent with a subprime credit rating (FICO credit score less than 660). We replicated this measurement model here using county-level data from every state in the US for the years 2000 and 2010. Replication was considered successful if fit statistics fell close to or within the accepted range: Comparative Fit Index (CFI) of 0.95 or higher and standardized root mean square residual less than 0.08 (20). Factor

scores were calculated as a standardized estimate of the magnitude of economic insecurity in each county.

Data Sources

Data for the measure of economic insecurity were from the 2000 Census, the Federal Reserve Bank/Equifax Consumer Credit Panel, and the American Community Survey (using pooled five-year estimates centered around 2010) (21-23).

We used mortality data from the Centers for Disease Control and Prevention (CDC) WONDER Compressed Mortality Files, 1999-2016 (24). First, consistent with the work done by Case and Deaton, we used age-adjusted mortality rates due to suicide (ICD-10 codes X60-84, Y87.0), alcohol and drug poisonings (X40-45, Y10-15, Y45, Y47, Y49), and chronic liver disease and cirrhosis (K70 and K73-4) (2). To maximize the number of counties that would be included in our analyses, we pooled three five-year time periods: 2001-2005, 2006-2010, and 2011-2015. For this outcome, we include deaths from all ages and races 1) to minimize missing data at the county level, 2) because deaths among Native Americans were also increasing during this time period (25), 3) the absolute mortality rates of blacks are much higher than those of whites, and we did not want to exclude populations at high risk for these events, and 4) deaths due to these causes are largely preventable, regardless of age at death (25). For the main analyses, deaths from these three causes were combined.

Second, we downloaded all-cause mortality rates for persons ages 45-54, the age group Case and Deaton observed to have increasing mortality rates (2). Using all causes of deaths allows us to evaluate the broader trends in premature death in this age group with data missing from fewer counties than if using deaths of despair in this specific age group. We used the same three time periods: 2001-2005, 2006-2010, and 2011-2015.

Analysis

The CDC suppresses death counts and rates when there are fewer than 10 deaths per county for each time period and cause of death, leading to substantial missingness in death rates for deaths of despair in smaller, rural counties (n= 511, 412, and 336 counties with no reportable data on the combined three causes of deaths of despair in 2001-05, 2006-10, and 2011-15, respectively). To account for this, we calculated state-specific average death rates for the rural counties of each state for each time period and imputed these averages when rural counties had missing death rates. Results tables containing analyses only on the counties with non-missing (non-imputed) data are included in the Appendix. To estimate changes in mortality by county, we subtracted the mortality rate in the earliest period (2001-2005) from the mortality rate in the latest period (2011-2015).

Counties were classified as metropolitan (further divided into large central metro, large fringe metro, medium metro, or small metro) or nonmetropolitan (divided into micropolitan or noncore areas) according to the NCHS urban-rural

classification scheme (26). Because outcomes were similar in large central metro and large fringe metro areas, we combined these categories into a single “metro” category. Small and medium metro areas were likewise combined into a single category (“small/medium metro”), as were micropolitan and noncore areas (“non-metro”).

County economic insecurity was divided into tertiles of high, medium, and low insecurity in each period. Using these tertiles, we created categories of change in economic insecurity. “Stable high” counties were in the highest tertile in both 2000 and 2010, “stable medium” were in the middle category in both periods, and “stable low” counties were in the lowest tertile in both periods. Counties were included in the “increasing” category if they moved into a higher category in 2010 (e.g., low to medium or medium to high), and “decreasing” if they moved into a lower category in 2010.

To evaluate the association of change in county economic insecurity between 2000 to 2010 with change in county-level mortality rates between 2001-2005 and 2011-2015 we used linear regression models with a robust standard error clustered on state. In addition to unadjusted models, we also used models that included the covariates percent black and Hispanic residents and urban/rural classification. Two sensitivity analyses were planned *a priori*. First, we limited our deaths of despair outcome to non-Hispanic white persons ages 45-54, the population previously observed to be driving increases in mortality in the US (2). Second, we replicated our analyses using a complete case analysis, including

only counties without suppressed death counts. Analyses were conducted in STATA 15.0 SE.

Results

County economic insecurity

Replication of the county economic insecurity measurement model produced scales of county economic insecurity in both 2000 and 2010 with good fit. In the model for the year 2000, root mean square error was 0.133 (0.117, 0.151), CFI was 0.931, and SRMR was 0.038. In the model for the year 2010, root mean square error was 0.110 (0.094, 0.128), CFI was 0.962, and SRMR was 0.031 (Appendix Table 3.1). Correlation between economic insecurity in 2000 and 2010 was 0.69. The mean change in county economic insecurity was 0.00 (SD 0.74), with a range of -3.57 to 2.467. Of 3147 counties, 671 (21%) were in the highest tertile of insecurity in both years (“stable high”), 485 (15%) were stable medium, 736 (23%) were stable low, 634 (20%) increased categories of economic insecurity, and 621 (20%) decreased. Figure 3.1 maps these categories for each US county. Clusters of increasing economic insecurity are seen in the South and Midwest. The South and California also had large clusters of counties with stable high insecurity in both 2000 and 2010.

Table 3.1 presents characteristics of US counties by tertile of economic insecurity in 2000. Compared to counties with medium or low economic insecurity, counties with high economic insecurity in 2000 were more likely to

have higher proportions of Hispanic and Black residents were less likely to be large suburban areas and much more likely to be non-metro (rural) counties.

The average county-level change in all-cause mortality from 2001-05 to 2011-15 among all ages was -69.7 (SD=82.0) per 100,000 for all residents and +34.9 (SD=107.4) per 100,000 among 45-54 year olds. Change in all-cause mortality was similar across tertiles of economic insecurity for all ages, but among 45-54 year olds, all-cause mortality increased more in high insecurity counties. Overall, the average change in rate of “deaths of despair” in counties from 2001-2005 to 2011-15 was +12.1 (SD=10.2) per 100,000, and was higher in high insecurity counties.

Deaths of despair (all ages)

Figure 3.2 shows trends in deaths of despair and the breakdown of each specific component cause of death by category of change in economic insecurity, for all ages. While rates of change in suicide are similar across categories of economic insecurity, increases in deaths due to drug and alcohol poisoning and chronic liver disease were higher in categories with elevated economic insecurity in either or both time periods.

Results of regression models testing the association in change in economic insecurity between 2000 to 2010 and change in mortality due to diseases of despair between 2001-05 to 2011-2015 are shown in the top portion of Table 3.2. After adjustment for urban/rural place type and racial composition (model 4), all categories of change in economic insecurity were associated with

an increase in deaths compared to counties with stable low economic insecurity. Counties with stable high economic insecurity had the largest increase in deaths of despair mortality, with an average of 8.3 more deaths per 100,000 (95% CI 4.2, 12.5) in 2011-15 compared with 2001-05 than counties with stable low economic insecurity. Counties with decreasing economic insecurity had the smallest increase compared to those with stable low insecurity: overall deaths of despair had an increase of 4.5 more deaths (95% CI 1.5, 7.5) per 100,000 than counties with stable low economic insecurity.

All-cause mortality (ages 45-54)

Among 45-54 year olds, the increase in all-cause mortality was also highest among counties with increasing economic insecurity, with an average of 59.0 more deaths per 100,000 in 2011-15 than in 2001-05 (95% CI 36.0, 82.1), compared to counties with stable low insecurity (bottom half of Table 3.2). The increase in all-cause mortality in this time period was smaller among counties with increasing economic insecurity than in counties with decreasing economic insecurity, with increases of 22.6 (95% CI 6.8, 38.5) and 31.3 (95% CI 17.1, 45.5) per 100,000 in such counties, respectively.

Sensitivity analyses: deaths of despair among middle-aged, non-Hispanic whites and complete case analysis

In sensitivity analyses, we assessed the robustness of our findings to our analytical assumptions. First, Supplement Table 3.2 shows the association between change in economic insecurity and change in death rates due to deaths

of despair among middle-aged, non-Hispanic white persons. Similar patterns were observed, but the magnitude of the associations was about twice as large as those for the total population (all races and ages, top half of Table 3.2). However, only 35% of counties had data on deaths in this age and race category and could be included in this model. Second, in Supplement Table 3.3 we present models for the deaths of despair outcome in which no imputation for missing data was used, and only counties with more than 10 deaths of despair in each time period were included (n=2614 counties). Similar estimates and patterns were seen, with all categories of change in economic insecurity associated with increases in the death rate compared to the stable low counties.

Discussion

We found that county-level rates of mortality due to suicide, drug and alcohol poisoning, and chronic liver disease increased more between 2001 to 2015 in counties with consistently high or increasing levels of economic insecurity. Among 45-54 year olds, the increase in all-cause mortality was also higher among counties with consistently high or increasing economic insecurity. This is, to our knowledge, one of the first analyses empirically testing the hypothesis that county-level economic insecurity is associated with increased levels of deaths of despair or midlife mortality. While all counties of all categories of economic insecurity had increases in deaths of despair and midlife mortality, these increases were more marked in areas that had ever had high economic

insecurity. In short, elevated economic insecurity in either 2000 or 2010 was associated with increases in deaths of despair at the county level. Additionally, we found that change in economic insecurity between 2000 and 2010 was associated with increase in all-cause mortality only among 45-54 year olds.

We found that county-level rates of mortality due to suicide, drug and alcohol poisoning, and chronic liver disease were higher in 2011-2015 than in 2001-2005. This finding is consistent with previous work (2, 3, 25), but extends analyses to the level of the US county and directly explores associations with a direct measure of economic insecurity. Using a previously developed measure of county economic insecurity, we show that 20% of counties experienced an increase in economic insecurity between 2000 and 2010, with clusters of increasing economic insecurity primarily observed in the Midwest and South.

Despite other work suggesting that increases in mortality in this time period were concentrated in non-urban areas (3, 10), place type was not a statistically significant predictor in our main analysis. However, unadjusted comparisons show higher prevalence of high insecurity in non-metro areas, and rates of mortality due to these causes of death were suppressed (missing) in a third of rural counties in either or both 2000 and 2010, limiting our ability to make inferences about this important group. Sensitivity analyses restricted to non-Hispanic white persons ages 45-54 demonstrate that associations between mortality and change in economic insecurity are twice as high among middle-aged, non-Hispanic whites compared to the total US population.

There are plausible mechanisms by which economic insecurity may increase mortality. Counties facing smaller tax revenue may reduce social services such as unemployment benefits, welfare spending, and drug and alcohol treatment programs. Prior to the 2014 rollout of the Affordable Care Act, large businesses leaving a county or shifting many of their workers to part-time would have left more people without health insurance, increasing insecurity through increased medical costs to both individuals and county hospitals, and potentially reducing access to healthcare (27, 28). Alternatively, economic insecurity may alter the composition of counties, with more skilled workers leaving the county in search of employment opportunities.

This study has some limitations. First, we are limited by the suppressed death counts in smaller counties. We implemented a simple imputation approach that netted similar results to a complete case analysis, so we are confident in the robustness of the economic insecurity – deaths of despair association among counties with reported deaths. However, given the importance of economic insecurity and deaths of despair in rural areas and smaller cities (3), future analysis should consider methods that allow for a more detailed exploration of this phenomenon in rural areas. Second, our measure of economic insecurity summarizes county economic insecurity, which may mask inter-county variation, and is lacking indicators from important domains such as debt and foreclosure due to data availability. Third, we cannot rule out that some of these changes seen may be due to changes in the coding of causes of death. Previous research

has shown that cause of death coding is imperfect, and may actually have differential measurement error by social factors such as race (29). This may be especially relevant for the attribution of alcohol-related liver disease (30, 31). However, our analysis of all-cause mortality in the 45-54 age group showed similar patterns to the analysis of deaths of despair. This study also has several strengths. First, we developed a theory-based measurement for economic insecurity that captures several dimensions of economic insecurity at the county-level. Second, this is the first application, to our knowledge, of a measure of economic security to county-level mortality outcomes. Third, we use vital statistics data from all US counties during a time span of more than 15 years.

Conclusion

Trends in economic insecurity are co-occurring with increases in mortality by deaths of despair among all ages and all-cause mortality among middle-aged adults in US counties, providing evidence for the health effects of economic conditions and their sequelae. Our work points to the importance of economic conditions in shaping mortality trends, especially in non-metropolitan areas. Future work should continue to validate this and other measures of economic insecurity, and explore the mechanisms by which such factors influence mortality.

Tables

Table 3.1 Characteristics of US Counties by Tertile of Economic Insecurity in 2000

	All Counties (n=3147)	Low Insecurity (n=1050)	Medium Insecurity (n=1048)	High Insecurity (n=1049)
County Economic Insecurity Change, 2000 to 2010				
Remained in same tertile, %	60.1	70.1	46.3	64.0
Increased economic insecurity, %	20.1	29.9	30.5	N/A
Decreased economic insecurity, %	19.7	N/A	23.2	36.0
Demographic Characteristics, 2000				
Hispanic, % (SD)	6.2 (12.0)	4.3 (6.5)	6.0 (10.0)	8.3 (16.8)
Black, % (SD)	8.7 (14.4)	3.0 (5.7)	7.3 (10.4)	15.8 (20.1)
Population, median (SD)	24,663 (292,717)	21,460 (182,961)	30,663 (264,500)	23,388 (392,776)
Population density per sq. mile, mean (SD)	243 (1668)	211 (759)	189 (500)	330 (275)
Large metro & suburban counties, %	13.3	21.1	12.9	5.7
Medium & small metro counties, %	21.4	20.9	25.5	17.8
Non-metro/rural counties, %	65.4	58.0	61.6	76.5
Change in Mortality Outcomes, 2001-05 to 2011-15, Age Adjusted per 100,000¹				
All-cause mortality, all ages (n=3136)	-69.7 (82.0)	-68.4 (84.6)	-69.5 (73.5)	-71.2 (87.3)
All-cause mortality, 45-54 years (n= 2906)	34.9 (107.4)	18.2 (87.3)	33.8 (98.8)	50.8 (127.5)
Deaths of despair, all ages (n=2148)	12.1 (10.2)	10.7 (7.6)	12.2 (9.0)	13.1 (12.9)
Drug and alcohol poisoning, all ages (n=836)	8.0 (7.6)	7.3 (5.3)	7.8 (6.0)	9.0 (10.8)
Liver disease, all ages (n=1104)	1.6 (3.3)	0.9 (2.0)	1.4 (2.6)	2.4 (4.6)
Suicide, all ages (n=1385)	2.4 (3.6)	2.3 (2.9)	2.4 (3.4)	2.4 (4.3)

¹ Due to privacy concerns, the CDC suppresses death counts when there are fewer than 10 deaths per county. Therefore, the number of counties varies by time period and mortality outcome.

Table 3.2 Association between change in county economic insecurity from 2000 to 2010 and change in mortality between 2001-05 to 2011-2015

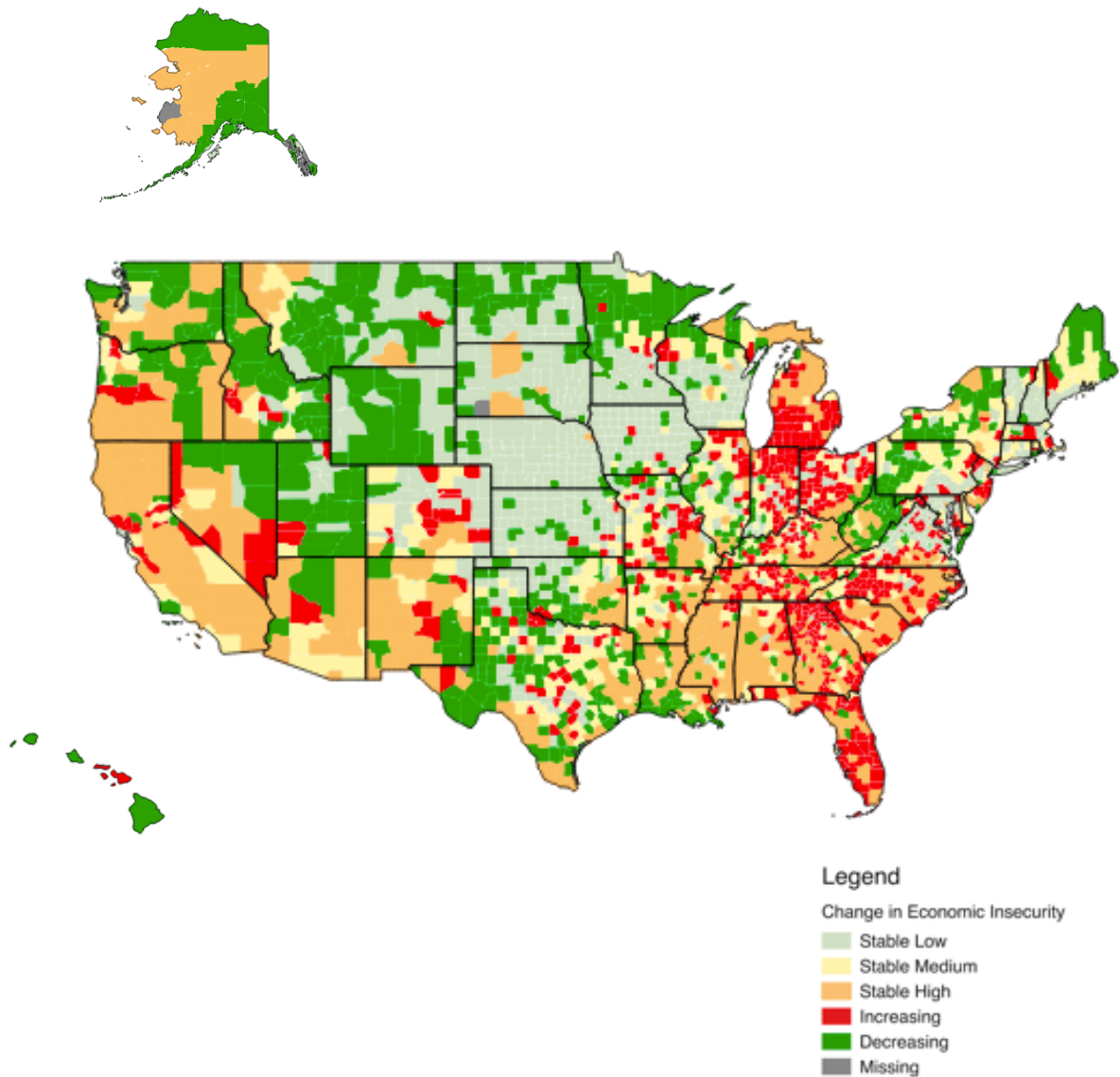
	Model 1	Model 2	Model 3	Model 4
Deaths of Despair per 100,000, all ages (n=3057 counties)				
Economic Insecurity				
Stable high	3.5 (-0.6, 7.5)	3.2 (1.0, 7.4)	8.5 (4.6, 12.4)	8.3 (4.2, 12.5)
Stable medium	3.7 (0.7, 6.6)	3.8 (0.8, 6.7)	5.1 (2.1, 8.2)	5.2 (2.2, 8.2)
Stable low	REF	REF	REF	REF
Increasing	3.8 (0.2, 7.3)	4.0 (0.6, 7.4)	5.5 (2.3, 8.8)	5.6 (2.4, 8.7)
Decreasing	3.4 (0.6, 6.3)	3.2 (0.2, 6.2)	4.6 (1.7, 7.4)	4.5 (1.5, 7.5)
Place type				
Large metro	-	-1.0 (-3.0, 0.9)	-	-0.2 (-2.1, 1.7)
Medium/small metro	-	REF	-	REF
Rural	-	1.2 (-0.1, 2.5)	-	0.5 (-0.9, 1.9)
Racial composition				
Hispanic, %	-	-	-0.06 (-0.1, 0.01)	-0.06 (-0.1, 0.01)
Black, %	-	-	-0.3 (-0.3, -0.2)	-0.3 (-0.3, -0.2)
All-Cause Mortality per 100,000, ages 45-54 (n=2903)				
Economic Insecurity				
Stable high	29.7 (4.6, 54.9)	17.9 (-4.0, 39.8)	74.2 (50.1, 98.3)	59.0 (36.0, 82.1)
Stable medium	12.6 (-5.2, 30.4)	10.8 (-4.4, 26.1)	25.8 (8.0, 43.6)	22.5 (6.2, 38.9)
Stable low	REF	REF	REF	REF
Increasing	6.7 (-16.0, 29.4)	10.4 (-8.4, 29.1)	21.5 (2.5, 40.5)	22.6 (6.8, 38.5)
Decreasing	30.3 (13.2, 47.3)	19.4 (5.8, 33.0)	41.8 (25.1, 58.4)	31.3 (17.1, 45.5)
Place type				
Large metro	-	-45.4 (-60.7, 30.1)	-	-38.8 (-49.9, -28.1)
Medium/small metro	-	REF	-	REF
Rural	-	26.4 (17.6, 35.3)	-	20.1 (11.9, 28.4)
Racial Composition				
Hispanic, %	-	-	-1.1 (-2.2, 0.01)	-0.9 (-1.8, 0.04)
Black, %	-	-	-2.1 (-2.8, -1.4)	-1.9 (-2.5, -1.2)

Bold values indicate p<0.05

All models contain a robust standard error clustered on state

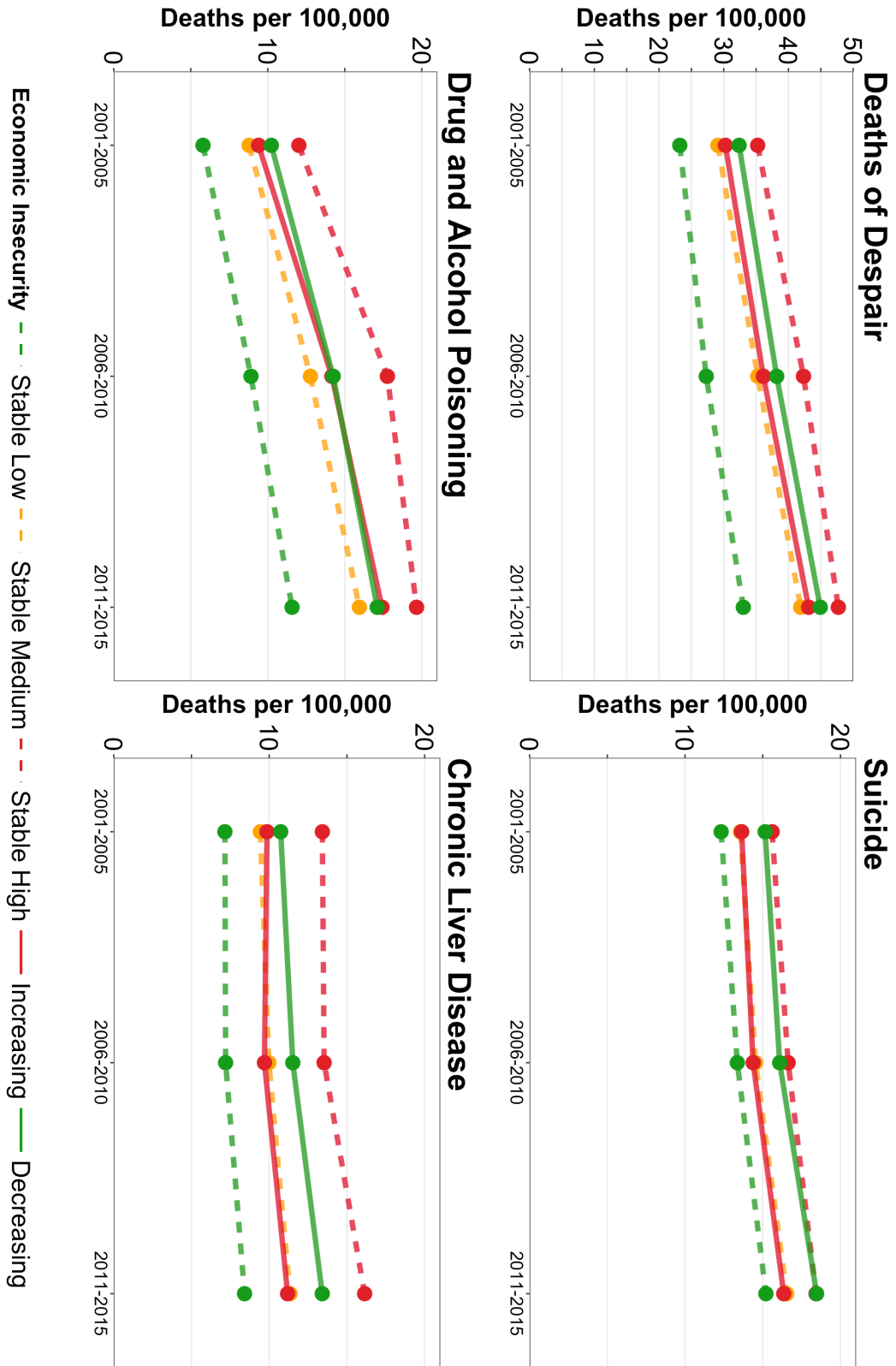
Figures

Figure 3.1 Categories of Change in Economic Insecurity between 2000 to 2010 in US Counties



Caption Figure 1. Each county in the US was classified according to the change in economic insecurity between 2000 and 2010.

Figure 3.2 Change in Mortality Rate from 2001-05 to 2011-15 by Change in Economic Insecurity 2000-2010



Caption Figure 3.2. Age-adjusted mortality rates in 2001-2005, 2006-2010, and 2011-15 are shown by category of change in economic insecurity for all “deaths of despair” and each of its individual component causes of death.

References

1. Tejada VB, Bastian B, Arias E, et al. Mortality trends in the United States, 1900–2015. In: Statistics. NCfH, editor.; 2017.
2. Case A, Deaton A. Rising morbidity and mortality in midlife among white non-Hispanic Americans in the 21st century. *Proc Natl Acad Sci U S A* 2015.
3. Stein EM, Gennuso KP, Ugboaja DC, Remington PL. The Epidemic of Despair Among White Americans: Trends in the Leading Causes of Premature Death, 1999-2015. *Am J Public Health* 2017;107(10):1541-1547.
4. Hacker JS. Understanding Economic Insecurity: The Downward Spiral of the Middle Class. *Communities & Banking* 2011:25-28.
5. Western B, Bloome D, Sosnaud B, Tach L. Economic Insecurity and Social Stratification. *Annual Review of Sociology* 2012;38(1):341-359.
6. Hacker JS. *The Great Risk Shift: The New Economic Insecurity and the Decline of the American Dream*. Revised and Expanded ed. New York: Oxford University Press; 2006.
7. Benach J, Vives A, Amable M, Vanroelen C, Tarafa G, Muntaner C. Precarious employment: understanding an emerging social determinant of health. *Annu Rev Public Health* 2014;35:229-53.
8. Chetty R, Grusky D, Hell M, Hendren N, Manduca R, Narang J. The fading American dream: Trends in absolute income mobility since 1940. *Science* 2017;24.
9. Austin B, Glaeser E, Summers LH. Saving the heartland: Place-based policies in 21st century America. In: BPEA Conference Drafts; 2018.
10. Monnat SM. Deaths of Despair and Support for Trump in the 2016 Presidential Election: Pennsylvania State University; 2016 12/04/2016.
11. Jones-Webb R, Karriker-Jaffe KJ, Zemore SE, Mulia N. Effects of Economic Disruptions on Alcohol Use and Problems: Why Do African Americans Fare Worse? *Journal of Studies on Alcohol and Drugs* 2016;77(2):261-271.
12. Seeman T, Thomas D, Merkin SS, Moore K, Watson K, Karlamangla A. The Great Recession worsened blood pressure and blood glucose levels in American adults. *Proceedings of the National Academy of Sciences* 2018:201710502.
13. Dwyer-Lindgren L, Flaxman AD, Ng M, Hansen GM, Murray CJ, Mokdad AH. Drinking Patterns in US Counties From 2002 to 2012. *Am J Public Health* 2015;105(6):1120-7.
14. Mack K, Jones C, Ballesteros M. Illicit Drug Use, Illicit Drug Use Disorders, and Drug Overdose Deaths in Metropolitan and Nonmetropolitan Areas — United States. *MMWR Surveill* 2017;66(No. SS-19).
15. Grant BF, Chou SP, Saha TD, Pickering RP, Kerridge BT, Ruan WJ, et al. Prevalence of 12-Month Alcohol Use, High-Risk Drinking, and DSM-IV Alcohol Use Disorder in the United States, 2001-2002 to 2012-2013: Results From the National Epidemiologic Survey on Alcohol and Related Conditions. *JAMA Psychiatry* 2017;74(9):911-923.

16. Cylus J, Glymour MM, Avendano M. Health effects of unemployment benefit program generosity. *Am J Public Health* 2015;105(2):317-23.
17. Cylus J, Glymour MM, Avendano M. Do generous unemployment benefit programs reduce suicide rates? A state fixed-effect analysis covering 1968-2008. *Am J Epidemiol* 2014;180(1):45-52.
18. National Association of Counties. *Counties Matter*. In; 2016.
19. Osypuk T, Galea S. What level macro? Choosing appropriate levels to assess the relation between space and population health. In: S G, editor. *Macrosocial determinants of population health*. New York, NY: Springer; 2007. p. 399-436.
20. Hu Lt, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal* 1999;6(1):1-55.
21. Federal Reserve Bank of New York and Equifax Consumer Credit Panel. 2000 Equifax Subprime Credit Population by County (percent). In: FRED.
22. Social Explorer and US Census Bureau. *Census 2000*. In. New York, NY: Social Explorer.
23. Social Explorer and U.S. Census Bureau. *Social Explorer Tables: ACS 2012 (5-Year Estimates)*. In: Social Explorer, editor. New York City, NY: Social Explorer 2017; 2017.
24. Centers for Disease Control and Prevention. *Underlying Cause of Death 1999-2015*. In: Statistics NCfH, editor.; 2016.
25. Shiels MS, Chernyavskiy P, Anderson WF, Best AF, Haozous EA, Hartge P, et al. Trends in premature mortality in the USA by sex, race, and ethnicity from 1999 to 2014: an analysis of death certificate data. *The Lancet* 2017.
26. Ingram D, Franco S. *NCHS Urban–Rural Classification Scheme for Counties*: National Center for Health Statistics.; 2012.
27. Schaller J, Stevens AH. Short-run effects of job loss on health conditions, health insurance, and health care utilization. *J Health Econ* 2015;43:190-203.
28. Wishner J, Solleveld P, Rudowitz R, Paradise J, Antonisse L. *A Look at Rural Hospital Closures and Implications for Access to Care: Three Case Studies*: The Henry J. Kaiser Family Foundation; 2016.
29. Noymer A, Penner AM, Saperstein A. Cause of death affects racial classification on death certificates. *PLoS One* 2011;6(1):e15812.
30. Lazo M, Mitchell M. Epidemiology and risk factors for alcoholic liver disease. In: *Alcoholic and Non-Alcoholic Fatty Liver Disease: Bench to Bedside*. [Internet]; 2015. p. 1-20.
31. Eric Single, Robson L, Rehm J, Xi X. Morbidity and Mortality Attributable to Alcohol, Tobacco, and Illicit Drug Use in Canada. *American Journal of Public Health* 1999;89(3):385-90.

**CHAPTER 4: IS ECONOMIC INSECURITY ASSOCIATED WITH
TRENDS IN SMOKING AND DRINKING IN US COUNTIES?**

Abstract

Counties with elevated economic insecurity have previously been shown to have larger increases in midlife mortality, and larger increases in mortality due to suicide, drug and alcohol poisoning, and chronic liver disease between 2001-05 and 2011-15. Here, we evaluate three health behaviors that may also be associated with economic insecurity: cigarette smoking, heavy drinking, and binge drinking. We used ecological, longitudinal mixed effects models stratified by gender to evaluate the association between change in county economic insecurity between 2000 and 2010 and county-level smoking and heavy and binge drinking prevalence between 2002 and 2012. Over the decade 2002-2012, smoking prevalence decreased overall, however, the rate of decrease was lowest among counties with stable high economic insecurity. Heavy drinking, and to a lesser extent, binge drinking, increased over this decade. Among women, there is an overall increase in heavy and binge drinking during this time, but the smallest increase is seen in the counties with stable high economic insecurity (1.8 per 10 years for heavy drinking, 95% CI 1.3, 2.2; 1.2 per 10 years for binge drinking, 95% CI: 0.7, 1.7). Patterns for drinking outcomes among men were less clear. Overall, this work provides evidence in support of the hypothesis that smoking, but not heavy or binge drinking, is associated with economic insecurity.

Introduction

In chapter 3, we demonstrated that counties with elevated economic insecurity had larger increases in mortality rates due to suicide, drug and alcohol

poisoning, and chronic liver disease; and among middle-aged Americans, all-cause mortality. In this chapter, we evaluate three health behaviors that may also be associated with economic insecurity: cigarette smoking, heavy drinking, and binge drinking.

Overall, rates of cigarette smoking have been declining in the US since the 1960s, and currently about 17% of adults are smokers (1). However, there is large variation in county-level rates of smoking, even within the same state, and similar variation in the rate of decline in recent decades (2). Rates of smoking are highest in the Midwest and South, and in counties with lower median income (2). Since secondhand smoke is harmful to health, reducing rates of smoking can improve health for both smokers and those around them. Tobacco use was the second leading attributable cause of death, leading to nearly 1 in 5 deaths in the US, and the largest contributor to disability-adjusted life years (years of life lost and years lived with disability) in the US in 2016 (3, 4). Cigarette smoking leads to heart disease, stroke, chronic obstructive pulmonary disease, and lung and other cancers. Smoking is one pathway through which economic insecurity may be associated with higher all-cause mortality rates.

Most American adults (70.1%) report consumption of alcohol in the past year, and almost 27% report binge drinking (consuming more than 4 drinks for women or five for men on a single occasion) in the past year in a 2015 survey (5). Similar to smoking prevalence, binge and heavy drinking (drinking, on average, more than 1 drink per day for women or 2 drinks per day for men) vary

substantially by county and demographic characteristics; binge and heavy drinking is highest in the northern states in the West and Midwest, and among younger adults and men (6, 7). Drinking is also sensitive to changes in drinking behaviors within social networks, area levels of social capital, and to policies targeting the price and availability of alcohol (8-10). Alcohol and drug abuse represented the fourth highest risk factor by disability adjusted life years, and the eighth leading cause of death (11). Alcohol consumption is a risk factor for mortality due to injuries such as motor-vehicle accidents and violence, and for chronic conditions such as liver disease, some cancers, and cardiovascular disease (12). Kaplan and colleagues found that about 20% of suicide deaths involve alcohol and that this number increased following the Great Recession (13). Therefore, smoking and alcohol use are modifiable risk factors with the potential to have large impacts on population health and mortality.

Economic insecurity: potential pathways to affect health

Economic insecurity can be defined as the likelihood of a downward trajectory of income, social capital, material resources, and socioeconomic status (14, 15). Economic insecurity may influence population health through several pathways: 1) changes in the material resources available for local governments to provide healthcare and other social and medically-related services; 2) declining opportunities in the local labor market or a downward shift in wages and benefits; and 3) selective migration in and out of the area, altering social

networks and the demographic makeup of counties. These changes may lead to stress-related changes in health behaviors such as smoking and drinking.

Previous work on economic insecurity and drinking and smoking

At the individual level, economic insecurity as measured by unemployment, income decline, and income below the poverty line has previously been associated with increased smoking among men (16). Evidence of the effect of economic conditions on alcohol consumption is mixed. Population-level alcohol consumption has been associated with higher income and negatively associated with unemployment (17), but some individual-level studies find higher levels of drinking among those who are unemployed (18). To our knowledge, no studies have explored the association of an area-level measure of economic insecurity on the health behaviors of smoking, heavy drinking, and binge drinking.

The objective of this manuscript was to estimate the association between change in economic insecurity between 2000 and 2010 and trends in smoking, heavy drinking, and binge drinking between 2002 to 2012 in US counties.

Methods

We evaluated the association between economic insecurity and trends in smoking, heavy drinking, and binge drinking in US counties using ecological, longitudinal mixed effects models.

Data

Exposure

A measure of economic insecurity for US counties was previously derived for the years 2000 and 2010 using confirmatory factor analysis (see Chapters 2 and 3 for an in-depth description of these methods). Counties are the primary geographic division of US states and have important governance, administrative, and health-service provision functions. Five variables from the Census and Federal Reserve bank were included in the final measurement model: percent unemployed, percent not in labor force, percent employed in service sector, percent with subprime credit rating (credit score below 660), and proportion of income spent on rent (among renters) (19, 20). Counties were then categorized according to the change in economic insecurity between 2000 and 2010. Counties were categorized as stable low if economic insecurity was in the lowest tertile in both 2000 and 2010, stable medium if in the middle tertile in both years, stable high if in the highest tertile (i.e., the highest level of economic insecurity), increasing if the county moved into a higher tertile of economic insecurity in 2010 than in 2000, or decreasing if the county had a lower tertile of economic insecurity in 2010.

Outcomes

The three primary outcomes are cigarette smoking, heavy drinking, and binge drinking prevalence measured at the county level. Annual county-level prevalence of each outcome was estimated from the Behavioral Risk Factor

Surveillance System (BRFSS) data. BRFSS is a collaboration between the Centers for Disease Control and Prevention and state health departments to collect standardized information on health conditions and health-related behaviors. Implemented annually, BRFSS is representative of the non-institutionalized US adults at the state level (21). For counties with no or very few BRFSS respondents, Dwyer-Linden and colleagues used mixed effects models to estimate sex-stratified, annual prevalence estimates for each outcome, taking into account demographic and county-level variables and spatial and temporal trends (2, 6). All outcomes were age-standardized to the 2000 population.

Cigarette smoking prevalence was defined as current daily or occasional smoking. Heavy drinking was defined consuming, on average, more than 1 drink a day for women or more than 2 drinks per day for men. Binge drinking was defined as consuming at least 4 drinks for women or 5 drinks for men on a single occasion at least once in the past 30 days (2, 6). Due to changes in BRFSS data collection, heavy drinking data is only available for the years 2005-2012. We use cigarette smoking and binge drinking data for the years 2002 to 2012.

Covariates

County-level demographic factors are from the Census: median age, educational attainment, median household income, racial composition, population density, census region (South, West, Midwest, and Northeast), and urban/rural designation (20).

Analysis

Descriptive statistics include mean and standard deviations by category of economic insecurity at baseline (2000).

We employed a progressive model building strategy. At each step, likelihood ratio tests and Akaike's Information Criteria (AIC) were used to evaluate model fit. First, we evaluated random intercepts for county and state, then random slopes for year. We then evaluated unstructured covariance structures (as the models we evaluated did not converge with an autoregressive covariance structure). Residual diagnostics included quantile plots, standardized residuals plotted over year, and standardized residuals compared to fitted values.

Final models included random intercepts for county and state, and random slopes for year. We estimated robust standard errors due to residual heteroscedasticity. Year was centered at 2002 (the first year for which we have outcome data) and scaled per ten years, and fixed effects for year and year by category of economic insecurity interaction terms were included. We adjusted for place type (large metropolitan area, medium/small metropolitan area, or non-metropolitan rural area) and percent black and Hispanic. Models were stratified by gender. Because we consider socioeconomic status to be a mediator between economic insecurity and health outcomes, we do not adjust for socioeconomic status. We present linear combinations of year and year by category of economic insecurity interactions: these coefficients can be interpreted as the rate of change over ten years within each of the five categories of economic insecurity.

Results

Table 4.1 shows descriptive statistics by category of county economic insecurity in 2000. Counties with high economic insecurity had a younger median age, lower percentage of high school and college completion, and lower median income compared to medium and low insecurity counties. Counties with high economic insecurity had higher proportions of Hispanic and Black residents, and were more likely to be rural and in the South. In 2002, the prevalence of smoking was 29.2% for men and 24.8% for women. Rates of smoking were higher in high insecurity counties. Overall, smoking decreased, and the decrease in rates of smoking across 2002-2012 was similar across all categories of economic insecurity for men and women. Prevalence of binge drinking was 23.9% for men and 9.8% for women in 2002. For both men and women, binge drinking was lower in counties with high economic insecurity. Heavy drinking prevalence was 8.9% in men and 4.1% in women in 2002, and was slightly lower in high insecurity places. Both heavy and binge drinking increased in men and women between 2002-2012, and this increase was higher in low insecurity counties.

Table 4.2 presents the results of mixed effects, longitudinal models of the association between the change in economic insecurity (2000 to 2010) and trends in smoking (2002-2012), heavy drinking (2005-2012), and binge drinking (2002-2012) in women, adjusting for urban/rural classification and racial composition. At baseline, the prevalence of smoking was 5.6 (95% CI 4.6, 6.5)

percentage points higher among women in stable high economic insecurity counties than in low economic insecurity counties. Over the decade 2002-2012, the rate of decrease in women's smoking prevalence was smallest in the stable high counties (-2.6 percentage points per 10 years, 95% CI -3.1, -2.0). Heavy drinking and binge drinking were both lowest at baseline among women in stable high counties in comparison to stable low counties (heavy drinking: -1.1, 95% CI -1.5, -0.7 and binge drinking: -0.6, 95% CI -1.0, -0.2). Over the decade, the rate of increase in heavy drinking was smallest among women in stable high counties (1.8 per 10 years, 95% CI 1.3, 2.2); this was almost two percentage points lower than the rate of increase in stable low counties (3.7 per 10 years, 95% CI 3.2, 4.1). For binge drinking, the rate of increase among women was smallest among the stable high counties (1.2 per 10 years, 95% CI 0.7, 1.7) and counties with decreasing economic insecurity (1.1 per 10 years, 95% CI 0.6, 1.5). Predicted prevalence rates from these models are presented graphically in Figure 4.1.

Table 4.3 and Figure 4.1 present the results of the same models for men. Smoking prevalence was 5.2 percentage points higher (95% CI 4.4, 6.0) for counties with stable high, compared to stable low economic insecurity counties, and the decrease in smoking was lowest in these counties (-3.2 over 10 years, 95% CI -3.7, -2.7). Rates of heavy drinking were similar in men at baseline across categories of economic insecurity, but the increase in heavy drinking was highest in the stable low counties (4.4 95% CI 3.4, 5.4). In 2002, rates of male binge drinking were lowest in stable high counties compared to stable low

countries (-1.3, 95% CI -1.9, -0.4), and rate of increase over 2002-2012 was also highest in this group (1.9 per 10 years, 95% CI 1.0, 2.9).

There were differences in the relationship between economic insecurity and smoking and drinking by gender. As seen in Table 4.1 and Figure 4.1, at baseline and across the study period, men have higher rates of smoking and drinking than women. However, the differences in smoking and heavy drinking in 2002 by category of economic insecurity are more pronounced among women than men, but changes across the decade are higher among men. For binge drinking, baseline differences are similar between men and women, but changes across the ten-year period are higher among women than men, with the exception of the stable high counties, in which the increase is higher in men.

Discussion

Our measure of economic insecurity was previously observed to be associated with increased all-cause mortality among middle-aged Americans and adult mortality due to suicide, drug and alcohol poisoning, and chronic liver disease. Here, we sought to explore potential mechanisms for these findings by evaluating the association between economic insecurity and trends in three modifiable risk factors: smoking, heavy drinking and binge drinking. We found that, among women, economic insecurity between 2000 and 2010 had a small impact on the changes in smoking between 2002 to 2012 and the decline in smoking was slowest among counties with stable high economic insecurity.

Stable high counties had slower increases in heavy and binge drinking rates among women. For men, the highest rate of increase in heavy drinking was in counties with stable low economic insecurity, and the lowest was seen in counties experiencing stable high economic insecurity. Binge drinking among men, however, did increase the fastest in counties experiencing stable high economic insecurity. Overall, higher levels of economic insecurity are associated with slower declines in smoking prevalence for men and women. Lower economic insecurity was associated with higher increases in heavy drinking for men and women, and binge drinking for women.

There are two competing hypotheses for the effects of economic conditions on drinking and smoking. One posits that in response to reduced financial resources, due to unemployment, reductions in household income, or perceived risk of job loss, smoking and drinking will be price elastic (i.e., they will be reduced to conserve funds). The second predicts an increase in smoking and drinking due to stress from perceived economic conditions (13, 22). For both men and women, rates of smoking fell during the study period, as has previously been observed (2). Counties experiencing stable high economic insecurity in this time period had the slowest decline in smoking prevalence among both men and women. This is counter to findings such as those from Ruhm, which show lower smoking in times of economic downturn (23), but consistent with findings that individual economic insecurity increases the probability that an individual will smoke (16). This is also consistent with the observed negative association

between income and smoking: economic insecurity is expected to lower income, which is associated with higher rates of smoking.

There were small increases in the prevalence of heavy drinking over time but these increases were faster in counties with stable low economic insecurity for women and men. Binge drinking was also highest at baseline in low insecurity counties in both men and women. In men, the largest increase across the ten-year period was observed in counties with stable high economic insecurity, but in women, the largest increase was seen in counties with stable low economic insecurity. Bor and colleagues demonstrated that while prevalence of abstinence from alcohol increased during the Great Recession (2008-2009), total alcohol consumption, the prevalence of moderate and heavy drinkers, and the frequency of binge drinking increased at the population level (24). The temporal trends we observe are consistent with these findings, but economic insecurity only had small effects on trends in heavy drinking in women, and these associations were in the opposite direction hypothesized to support drinking as a mechanism linking economic insecurity and mortality. However, small changes in risk factors can have large impacts at the population-level(25).

Our measure of economic insecurity is new, and this is the first application of this measure to the health-related behaviors of cigarette smoking and heavy and binge drinking. This analysis is limited by the temporal overlap between our exposure, category of change in economic insecurity (2000 to 2010) and our outcomes, which were measured between 2002 (and 2005) and 2012. Since this

is a new measure, we have not determined whether alternate parameterizations of our exposure may be more useful in relation to mortality rates, or what constitutes an appropriate lag between a measure of economic insecurity and subsequent health outcomes. Additionally, given the rise in opioid use, abuse and overdose during this time, it would have been preferable to include county-level measures of opioid use, but these are not yet available nationwide. While we had strong theoretical motivation for the selection of the smoking and drinking outcomes, it is possible that these outcomes are more strongly driven by secular trends or by alternate factors such as socioeconomic status. Smoking, especially, is known to exhibit a strong income gradient, with those with lower incomes smoking at much higher rates.

This study has several strengths. First, we used data on smoking and alcohol use prevalence data for every county in the United States. This allows us to make inferences about the entire country. Second, we explored a potential population-level determinant of health, economic insecurity. We previously found that economic insecurity predicts mortality due to suicide, drug and alcohol poisoning, and chronic liver disease. Here, we attempted to identify mechanisms through which this association may work.

Conclusion

Our measure of change in economic insecurity between 2000 and 2010 was associated with county-level smoking prevalence at baseline, and had a moderate impact on the rate of decline in smoking prevalence between 2002 and

2012, for both men and women. It was also associated with trends in heavy drinking, but with high insecurity counties experiencing the smallest rate of increase in heavy drinking. Overall, economic insecurity is associated with smoking, but its association with heavy and binge drinking is less clear.

Tables

Table 4.1 Characteristics of US Counties by Tertile of Economic Insecurity in 2000

	All Counties (n=3147)	Low Insecurity (n=1050)	Medium Insecurity (n=1048)	High Insecurity (n=1049)
County Economic Insecurity Change, 2000 to 2010				
Remained in same tertile, %	60.0	70.1	46.2	63.6
Increased economic insecurity, %	20.2	30.0	30.9	N/A
Decreased economic insecurity, %	19.8	N/A	23.2	36.0
Demographic Characteristics, 2000				
Median age, mean (SD)	37.3 (4.0)	37.9 (3.7)	37.6 (3.7)	36.5 (4.4)
Completed high school, % (SD)	77.4 (8.7)	82.8 (6.3)	77.4 (7.2)	71.9 (8.8)
College degree, % (SD)	16.5 (7.8)	19.7 (9.0)	16.1 (6.8)	13.8 (6.1)
Median household income, mean (SD)	35,372 (8,907)	40,858 (10,209)	35,238 (6,245)	29,953 (5,928)
Hispanic, % (SD)	6.2 (12.0)	4.3 (6.5)	6.0 (10.0)	8.3 (16.8)
Black, % (SD)	8.7 (14.4)	3.0 (5.7)	7.3 (10.4)	15.8 (20.1)
Population, median (SD)	24,663 (292,717)	21,460 (182,961)	30,663 (264,500)	23,388 (392,776)
Population density, per sq. mi (SD)	2.4 (16.7)	2.1 (7.8)	1.9 (5.0)	3.3 (27.5)
Large metro & suburban counties, %	13.3	21.1	12.9	5.7
Medium & small metro counties, %	21.4	20.9	25.5	17.8
Non-metro/rural counties, %	65.4	58.0	61.6	76.5
Northeast census region, %	6.6	6.3	8.5	5.2
Midwest census region, %	33.6	57.1	28.9	14.8
South census region, %	45.3	25.8	49.5	61.0
West census region, %	14.2	10.5	12.7	19.0
Health Behaviors, 2002				
Smoking, men ¹ , % (SD)	29.2 (4.0)	27.1 (3.5)	29.6 (3.5)	31.0 (3.8)
Smoking, women ¹ , % (SD)	24.8 (4.0)	23.2 (3.4)	25.4 (3.6)	25.9 (4.4)
Binge drinking, men ² , % (SD)	23.9 (6.4)	26.5 (5.9)	23.3 (6.3)	21.9 (6.1)
Binge drinking, women ² , % (SD)	9.8 (4.0)	11.2 (3.5)	9.5 (4.0)	8.5 (4.1)
Heavy drinking, men ² , % (SD)	8.9 (2.5)	9.3 (2.3)	8.8 (2.4)	8.7 (2.6)
Heavy drinking, women ² , % (SD)	4.1 (2.0)	4.5 (1.9)	4.0 (1.9)	3.6 (2.0)
Health Behaviors, Change 2002-2011				
Smoking, men ¹ , % (SD)	-3.7 (1.9)	-3.9 (1.7)	-3.9 (1.8)	-3.3 (2.0)
Smoking, women ¹ , % (SD)	-3.1 (2.1)	-3.1 (2.0)	-3.1 (2.1)	-3.0 (2.2)
Binge drinking, men ² , % (SD)	0.9 (2.6)	1.0 (2.8)	0.7 (2.6)	0.9 (2.5)
Binge drinking, women ² , % (SD)	1.6 (2.0)	2.1 (2.1)	1.5 (1.7)	1.0 (1.7)
Heavy drinking, men ²	1.7 (1.5)	2.2 (1.6)	1.4 (1.3)	1.5 (1.3)
Heavy drinking, women ²	1.5 (1.1)	2.0 (1.1)	1.4 (1.0)	1.2 (1.1)

¹ Prevalence of people who currently smoke (as a percentage of the population)

² Heavy drinking is defined as the consumption, on average, of more than one drink per day for women or two drinks per day for men in the past 30 days (data available starting in 2005). Binge drinking is defined as the consumption of more than four drinks for women or five drinks for men on a single occasion at least once in the past 30 days.

Table 4.2 Association between change in economic insecurity (2000-2010) and trends in health outcomes and behaviors, 2002-2012 among women

	Smoking	Heavy Drinking ¹	Binge Drinking
Baseline association between economic insecurity and health behaviors			
Stable low	REF	REF	REF
Stable medium	3.7 (3.1, 4.3)	-0.4 (-0.7, -0.2)	-0.1 (-0.4, 0.2)
Stable high	5.6 (4.6, 6.5)	-1.1 (-1.5, -0.7)	-0.6 (-1.0, -0.2)
Increasing	3.8 (3.2, 4.5)	-0.7 (-1.0, -0.4)	-0.5 (-0.9, -0.1)
Decreasing	3.1 (2.5, 3.6)	-0.3 (-0.5, -0.01)	0.1 (-0.2, 0.4)
10-year change in prevalence by category of economic insecurity			
Stable low	-3.1 (-3.7, -2.5)	3.7 (3.2, 4.1)	2.0 (1.6, 2.5)
Stable medium	-3.4 (-3.8, -3.0)	2.4 (2.1, 2.7)	1.5 (0.9, 2.)
Stable high	-2.6 (-3.1, -2.0)	1.8 (1.3, 2.2)	1.2 (0.7, 1.7)
Increasing	-3.2 (-3.4, -2.9)	2.1 (1.7, 2.5)	1.9 (1.4, 2.4)
Decreasing	-3.4 (-3.8, -3.0)	2.9 (2.4, 3.5)	1.1 (0.6, 1.5)
County characteristics			
Metro	-0.6 (-1.0, -0.2)	0.3 (0.1, 0.5)	0.6 (0.2, 1.0)
Medium Metro	REF	REF	REF
Non-metro	1.0 (0.7, 1.3)	-0.3 (-0.5, -0.1)	-0.5 (-0.8, -0.2)
% Black	-0.1 (-0.1, -0.1)	-0.001 (-0.01, 0.01)	-0.004 (-0.02, 0.01)
% Hispanic	-0.1 (-0.2, -0.1)	-0.01 (-0.03, 0.01)	-0.01 (-0.05, 0.02)

P <0.05

Robust standard errors

¹Heavy drinking data is only available for years 2005-2012

Table 4.3 Association between change in economic insecurity (2000-2010) and trends in health outcomes and behaviors, 2002-2012 among men

	Smoking	Heavy drinking ¹	Binge Drinking
Baseline association between economic insecurity and health behaviors			
Stable low	REF	REF	REF
Stable medium	3.2 (2.7, 3.7)	-0.3 (-0.7, 0.1)	-0.3 (-1.0, 0.3)
Stable high	5.2 (4.4, 6.0)	-0.3 (-0.8, 0.3)	-1.3 (-2.2, -0.4)
Increasing	3.7 (3.0, 4.4)	-0.5 (-0.9, -0.1)	-0.9 (-1.6, -0.2)
Decreasing	2.3 (1.8, 2.8)	-0.1 (-0.5, 0.3)	-0.1 (-0.7, 0.5)
10-year change in prevalence by category of economic insecurity			
Stable low	-3.7 (-4.3, -3.1)	4.4 (3.4, 5.4)	1.5 (0.3, 2.8)
Stable medium	-4.0 (-4.4, -3.5)	2.9 (2.3, 3.5)	0.8 (-0.2, 1.8)
Stable high	-3.2 (-3.7, -2.7)	3.2 (2.4, 4.0)	1.9 (1.0, 2.9)
Increasing	-4.1 (-4.5, -3.7)	2.8 (2.1, 3.4)	1.6 (0.6, 2.6)
Decreasing	-3.5 (-3.9, -3.0)	3.4 (2.7, 4.1)	0.6 (-0.1, 1.4)
County Characteristics			
Metro	-0.9 (-1.3, -0.6)	0.1 (-0.3, 0.4)	0.6 (0.02, 1.3)
Medium Metro	REF	REF	REF
Non-metro	1.1 (0.9, 1.4)	0.05 (-0.2, 0.3)	0.1 (-0.3, 0.5)
% Black	0.03 (0.01, 0.05)	-0.01 (-0.02, 0.003)	-0.01 (-0.03, 0.02)
% Hispanic	-0.03 (-0.04, -0.02)	-0.003 (-0.04, 0.03)	0.06 (-0.01, 0.1)

P <0.05

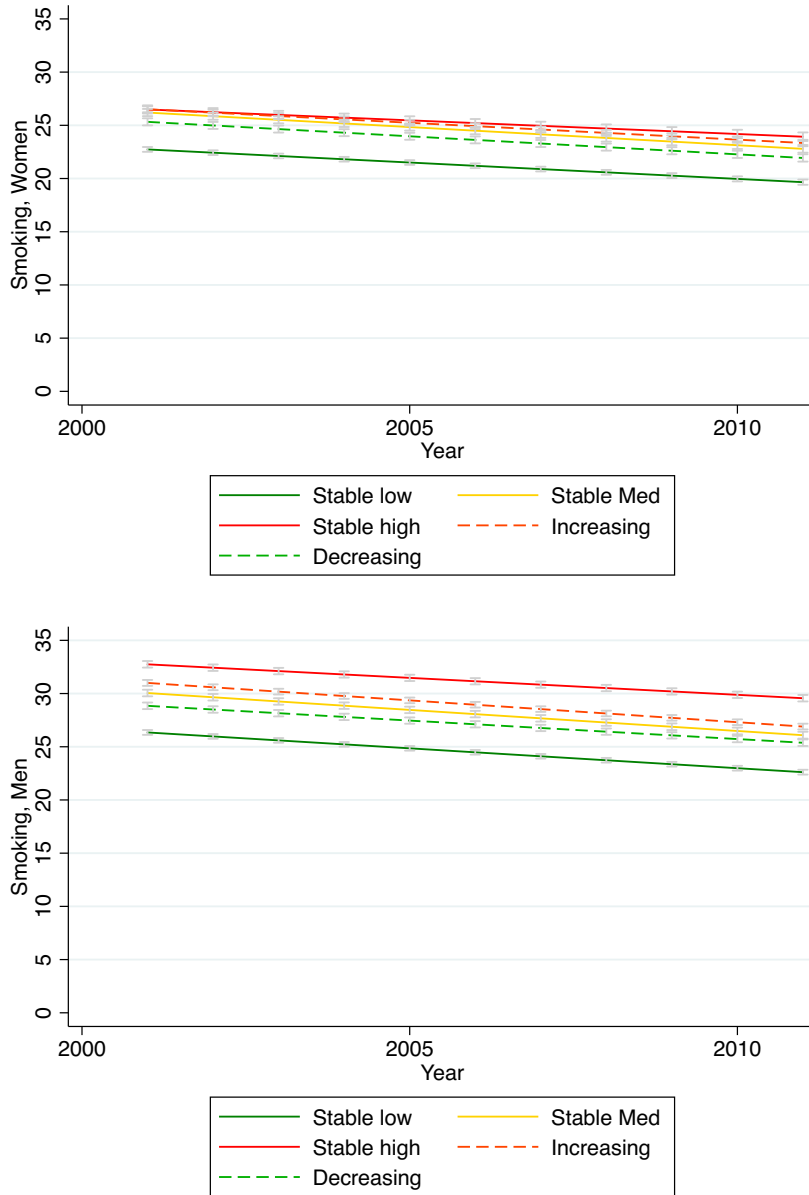
Robust standard errors

¹Heavy drinking data is only available for years 2005-2011

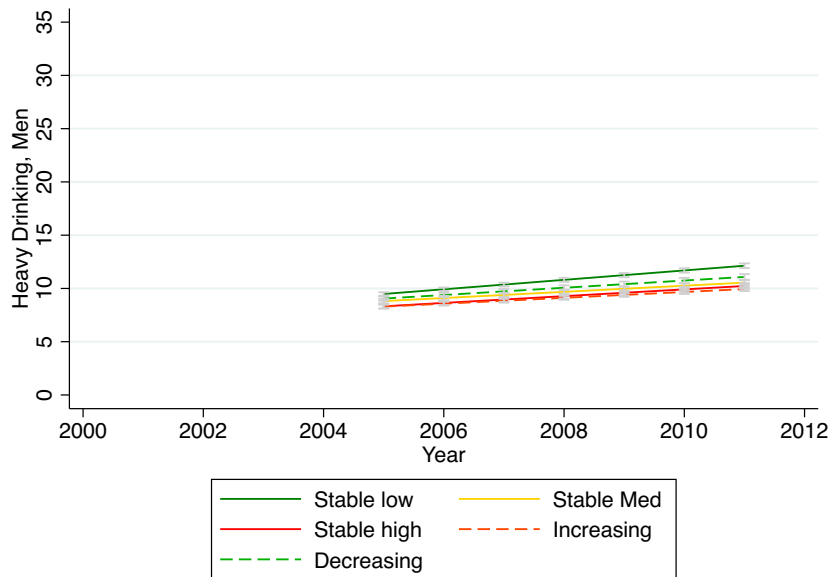
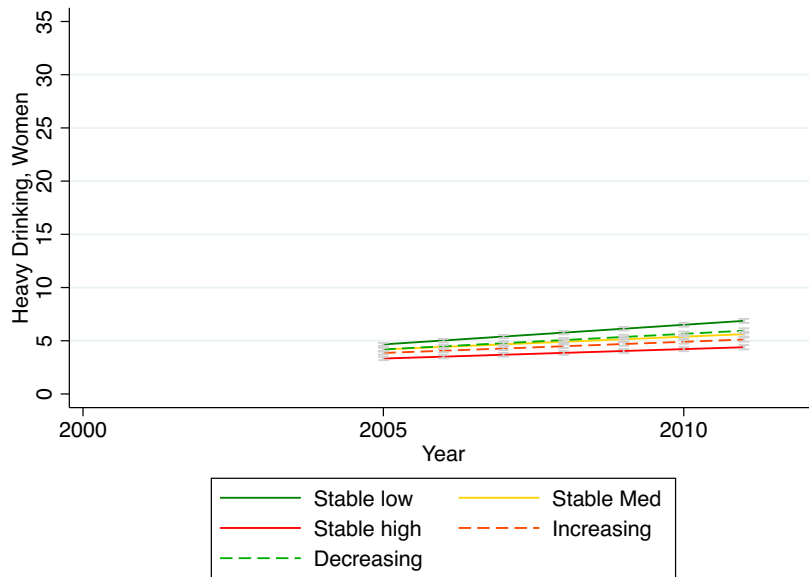
Figures

Figure 4.1 Predicted association between change in economic insecurity (2000-2010) and trends in smoking (A), heavy drinking (B), and binge drinking (C), 2002-2012 among women and men

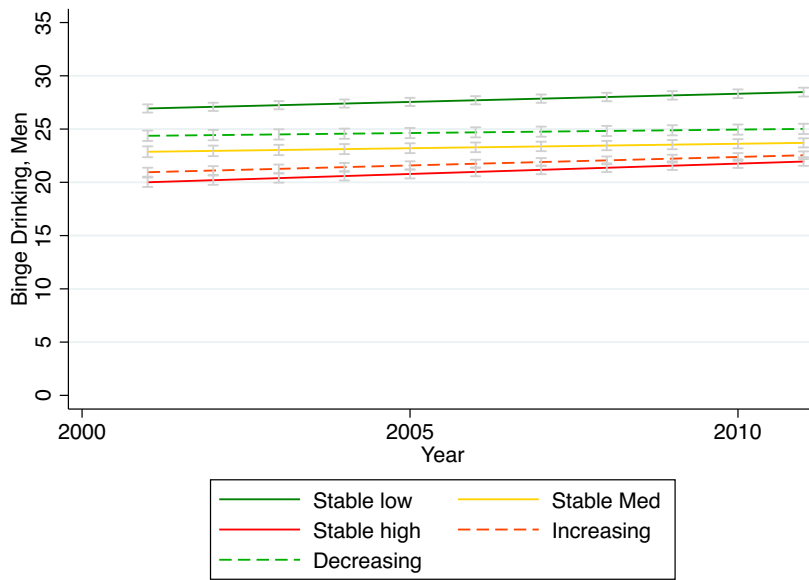
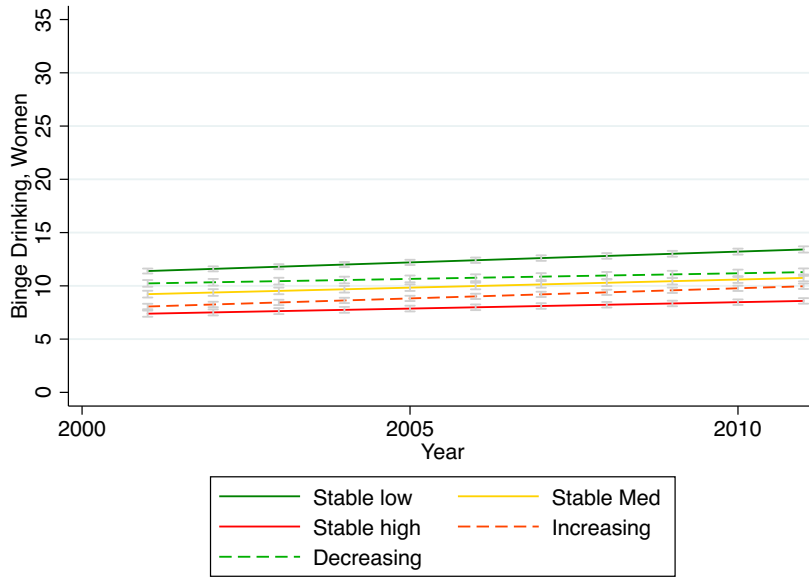
(A) Smoking Prevalence



(B) Heavy Drinking Prevalence



(C) Binge Drinking Prevalance



Caption Figure 4.1: Predicted prevalence of smoking (A), heavy drinking (B), and binge drinking (C), 2002-2012 among women (top) and men (bottom), by category of economic insecurity. Models are adjusted for place type and racial composition.

References

1. Centers for Disease Control and Prevention. Trends in Current Cigarette Smoking Among High School Students and Adults, United States, 1965–2014. In; 2016.
2. Dwyer-Lindgren L, Mokdad A, Srebotnjak T, Flaxman A, Hansen G, Murray C. Cigarette smoking prevalence in US counties: 1996-2012. *Population Health Metrics* 2014;12(5).
3. U. S. Burden of Disease Collaborators, Mokdad AH, Ballestros K, Echko M, Glenn S, Olsen HE, et al. The State of US Health, 1990-2016: Burden of Diseases, Injuries, and Risk Factors Among US States. *JAMA* 2018;319(14):1444-1472.
4. Centers for Disease Control and Prevention. Health Effects of Cigarette Smoking. In; 2017.
5. National Institute on Alcohol Abuse and Alcoholism. Alcohol Facts and Statistics. In; 2017.
6. Dwyer-Lindgren L, Flaxman AD, Ng M, Hansen GM, Murray CJ, Mokdad AH. Drinking Patterns in US Counties From 2002 to 2012. *Am J Public Health* 2015;105(6):1120-7.
7. Nelson DE, Naimi TS, Brewer RD, Bolen J, Wells HE. Metropolitan-Area Estimates of Binge Drinking in the United States. *American Journal of Public Health* 2004;94(4):663-671.
8. Skog O. The collectivity of drinking cultures: a theory of the distribution of alcohol consumption. *British Journal of Addiction* 1985;80(1):83-99.
9. Xuan Z, Blanchette J, Nelson T, Heeren T, Oussayef N, Naimi T. The alcohol policy environment and policy subgroups as predictors of binge drinking measures among US adults. *American Journal of Public Health* 2015;105(4):816-22.
10. Weitzman ER, Chen YY. Risk modifying effect of social capital on measures of heavy alcohol consumption, alcohol abuse, harms, and secondhand effects: national survey findings. *J Epidemiol Community Health* 2005;59(4):303-9.
11. Mokdad AH, Dwyer-Lindgren L, Fitzmaurice C, Stubbs RW, Bertozzi-Villa A, Morozoff C, et al. Trends and Patterns of Disparities in Cancer Mortality Among US Counties, 1980-2014. *JAMA* 2017;317(4):388-406.
12. Stahre M, Roeber J, Kanny D, Brewer RD, Zhang X. Contribution of excessive alcohol consumption to deaths and years of potential life lost in the United States. *Prev Chronic Dis* 2014;11:E109.
13. Kaplan MS, Huguet N, Caetano R, Giesbrecht N, Kerr WC, McFarland BH. Economic contraction, alcohol intoxication and suicide: analysis of the National Violent Death Reporting System. *Inj Prev* 2015;21(1):35-41.
14. Hacker JS. Understanding Economic Insecurity: The Downward Spiral of the Middle Class. *Communities & Banking* 2011:25-28.

15. Western B, Bloome D, Sosnaud B, Tach L. Economic Insecurity and Social Stratification. *Annual Review of Sociology* 2012;38(1):341-359.
16. Barnes MG, Smith TG. Tobacco Use as Response to Economic Insecurity Evidence from the National Longitudinal Survey of Youth. *The B.E. Journal of Economic Analysis Policy* 2009;9(1).
17. Ruhm CJ. Economic conditions and alcohol problems. *Journal of Health Economics* 1994;14:583-603.
18. Mossakowski KN. Is the duration of poverty and unemployment a risk factor for heavy drinking? *Soc Sci Med* 2008;67(6):947-55.
19. Social Explorer and U.S. Census Bureau. Social Explorer Tables: ACS 2012 (5-Year Estimates). In: Social Explorer, editor. New York City, NY: Social Explorer 2017; 2017.
20. Social Explorer and US Census Bureau. Census 2000. In. New York, NY: Social Explorer.
21. Mokdad AH. The Behavioral Risk Factors Surveillance System: past, present, and future. *Annu Rev Public Health* 2009;30:43-54.
22. Catalano R, Goldman-Mellor S, Saxton K, Margerison-Zilko C, Subbaraman M, LeWinn K, et al. The health effects of economic decline. *Annu Rev Public Health* 2011;32:431-50.
23. Ruhm CJ. Healthy living in hard times. *J Health Econ* 2005;24(2):341-63.
24. Bor J, Basu S, Coutts A, McKee M, Stuckler D. Alcohol use during the great recession of 2008-2009. *Alcohol Alcohol* 2013;48(3):343-8.
25. Rose G. Sick Individuals and Sick Populations. *International Journal of Epidemiology* 1985;14(1):32-38.

CHAPTER 5: CONCLUSION

Summary of Findings

The goal of this dissertation was to measure one upstream determinant of health, economic insecurity, and to estimate its association with mortality and three health behaviors: smoking, heavy drinking, and binge drinking. This dissertation had three main findings:

- (1) Economic insecurity can be conceptualized and measured as a county-level phenomenon. Our measure of economic insecurity consists of five indicators: percent not in the labor force, percent unemployed, percent employed in service jobs, percent of income spent on rent, and percent with a subprime credit rating, and had adequate fit with the observed data.
- (2) Economic insecurity is associated with increased “deaths of despair”: mortality due to suicide, drug and alcohol poisoning, and chronic liver disease. The increases in these deaths between 2001-05 and 2011-15 are higher in counties with high economic insecurity in both or either 2000 and 2010 compared to counties with low economic insecurity in both years. Among middle-aged Americans aged 45-54, all-cause mortality also increased more in counties with elevated economic insecurity in either 2000 and/or 2010, compared to counties with stable low economic insecurity.
- (3) The relationship between economic insecurity and smoking, heavy drinking, and binge drinking is less clear. Rates of decline in smoking

were slowest in counties with high economic insecurity, but binge and heavy drinking behaviors increased the fastest in low insecurity counties.

Challenges

Development, validation, and estimation of associations with health outcomes of a new measure presents some challenges. We confronted four main challenges while conducting this dissertation: (1) moving beyond single indicator measurement, (2) identifying the most appropriate scale, (3) differentiating economic insecurity from socioeconomic status, and (4) the challenging nature of reconciling social determinants of health research with the causal inference paradigm.

Moving beyond single indicator measurement

We developed a measure of county economic insecurity using confirmatory factor analysis. Confirmatory factor analysis is useful when the construct of interest is not directly observable, there is a strong theoretical justification for the construct, and when a numeric estimate representing the magnitude of the latent construct is needed for future work (1). Using multiple indicators is also preferable to single-indicator measures because it can lead to reduction in measurement error on the latent construct and allows multiple (related) domains of the construct to be represented. Confirmatory factor analysis also has the advantage of starting from a strong theoretical hypothesis about the

construct in question—this allows us to test a measurement hypothesis through the modeling process. However, there are several challenges in explaining the policy relevance of composite measures, and some epidemiologists find such measures to be problematic from a causal inference perspective.

Identifying the appropriate geographic scale

The choice of geographic scale is led by theoretical considerations of the exposure under study and the mechanisms through which it is posited to affect health (2). The *residential neighborhood* is a popular unit of analysis for social epidemiology research. However, neighborhoods rarely have any decision-making authority (i.e., they generally cannot set policies, legislation or enact laws). Relatedly, the residential neighborhood is a theoretical mismatch when the exposure of interest is macroeconomic or political in nature. Residents often commute outside their neighborhood of residence for work, so any influence of work conditions or labor markets encompasses a larger geographic scale. Additionally, the processes that create economic insecurity occur above the level of the neighborhood. There may not be sufficient variation in the economic insecurity of neighborhoods to warrant investigation at this level.

We chose to measure economic insecurity at the level of the US county because we hypothesized that counties are important mediators between national and state level policies and resulting individual health effects. Other important geographic groups might include states, metropolitan statistical areas, or other groupings of municipalities. Future work should evaluate the appropriate

potential geographic units at which to measure economic insecurity, both empirically and theoretically. For example, cities or metropolitan areas may be a better unit of analysis, both to parse out variation in economic insecurity within counties, and because cities also have self-governance and administration functions that may be amenable to policy solutions.

Differentiation from existing measures of socioeconomic status

The third major challenge of this dissertation was differentiating our measure of county economic insecurity from the related constructs of socioeconomic status and socioeconomic deprivation. We used our conceptual framework and the standard psychometric method of examining correlations between economic insecurity and related measures in our nomological network to validate our measure. However, validating a new measure is challenging, as there is no consensus on how to validate measures for which there is no gold standard. Future work should continue to validate economic insecurity and evaluate the distribution of economic insecurity across strata of county-level measures of socioeconomic status.

Availability of data at small geographic areas

We were also limited by the data available for geographic units smaller than the state. This limited our selection of geographic unit to the county level, which also placed a restriction on the data available for both constructing our measurement model and for obtaining data on health outcomes with which to assess the health effects of economic insecurity. We would have preferred to

include indicators such as foreclosure rates, bankruptcy, debt, and underemployment or involuntary part-time work in our measure of economic insecurity. Economic insecurity could be further subdivided into domains related to housing, work, and debt/finance. However, we could not obtain uniform data on these constructs at the county level. Based on the available data, the work domain is most fully covered in our measure.

Health outcome and health behavior data is also challenging to come by at smaller geographic units than the county, though this is improving. County-level prevalence of drug overdose hospitalizations, drug abuse, and opioid over prescription would have been useful for understanding the mechanisms through which county economic insecurity influences mortality. To our knowledge, these data are not routinely collected or available at the county level. Overall, this work underscores the importance of surveillance at local levels, for both indicators of economic conditions and for health outcomes.

Causal Inference for social determinants of health

Measuring the “upstream” determinants of health and evaluating their impact on health outcomes is a continuing struggle for the field of social epidemiology. The fundamental cause theory of health directs us to measure and seek understanding of factors that, through differential access to resources impact multiple disease outcomes through multiple risk factors, and continue to occur over time through ever changing mechanisms (3). Recently, the counterfactual or potential outcomes framework for causal inference has gained

prominence as a framework for conducting and evaluating epidemiologic research (4). This framework defines causal effects as the comparison of outcomes between groups that differ only by a “well-defined” intervention, which pushes epidemiologists to study only those factors that are able to be manipulated and isolated (5, 6). This framework pushes many social epidemiology research questions outside the bounds of what can be studied, which is highly problematic for the field.

This dissertation is aligned with the fundamental cause theory, and measures one such population determinant of health, county economic insecurity, and its association with mortality and other health outcomes. However, our ability to make causal claims about the effect of economic insecurity on county health outcomes is not strong. This is a new measure and will require continued validation. Additionally, more work is needed to rule out common causes of both economic insecurity and health outcomes. We do not believe that any such factor exists or has a strong enough association with economic insecurity that intervening on economic insecurity is not worthwhile. Further work could be done to illuminate the overlap and connections between economic insecurity and other related constructs. While acknowledging that we are on unsteady ground regarding causal inference according to standard definitions, we think this dissertation highlights the importance of developing alternative causal inference frameworks more amenable to social determinants of health. Constraining exposures of interest to those that fit within the causal

inference mold would limit the questions we allow ourselves to ask, to the detriment of population health (6).

Strengths

This dissertation contributes to the field of social epidemiology by expanding the literature of theoretically motivated measures and by bringing economic insecurity, which was previously mostly examined in the economics literature, into the public health literature. New measures of socioeconomic contexts with strong theoretical foundations help move the field forward by elucidating new facets and mechanisms of the socioeconomic gradient we observe for almost every health outcome and health behavior.

Economic insecurity has the potential to be more policy-relevant than existing measures of socioeconomic status. We have a stronger evidence base for the ways in which economic policy can be altered to affect health, and the ways in which economic policy shape individual behaviors. The minimum wage is an example of a financial policy that can be enacted at the federal, state, or city levels that could directly impact economic insecurity. Similarly, monetary, trade, and labor policies can be used to intervene on economic insecurity (although it is recognized that these generally operate at the state or federal level). Related constructs like socioeconomic status and deprivation have less obvious policy targets. Policies to address instability in service jobs or to increase the supply of affordable housing may be more politically amenable than interventions to raise income, for example (7). Additionally, we have a better understanding of the

ways in which social and welfare policies may be used to mitigate economic insecurity (for example, (8-11)).

Implications and Future Directions

This dissertation demonstrates the association between economic insecurity and mortality in US counties. This implies a relationship between economic conditions and public health that should not be ignored. Policy not directly related to public health can and does affect health outcomes, and should be evaluated within a “health in all policies” framework (12). While the relationship between socioeconomic status and health has been well-established, improvements to population health have been meager. It is our hope that economic insecurity offers a more politically feasible avenue for intervention.

This work also demonstrates the importance of small scale data collection. Social epidemiologists should collaborate with perhaps unlikely agencies (e.g., the law enforcement sector) or groups (e.g., the FDA or pharmacy benefits organizations) to make more robust surveillance data available, and should work to protect existing surveillance systems from budget cuts and other politically motivated changes. We are heartened by recent efforts to apply rigorous small-area estimation methods to existing surveillance data (for example, (13)), and the growth of local area monitoring for health outcomes and social determinants of health, such as the County Health Rankings developed by the Robert Wood Johnson Foundation (14). Publically available data on health determinants and health outcomes are important for development and eventual evaluation of

policies and programs to address poor health outcomes and to prevent them in the future.

Conclusion

In summary, this dissertation measures and describes the distribution of one policy-relevant determinant of health, economic insecurity, across US counties. We found that the counties with high economic insecurity in 2000 and 2010 had higher increases in mortality due to suicide, drug and alcohol poisoning, and chronic liver disease, as well as elevated all-cause mortality among 45-54 year olds. Counties with high economic insecurity also had slower declines in rates of cigarette smoking, but faster increases in binge and heavy drinking were found in stable low economic insecurity counties. Overall, this work points to the utility of new, theory-based measurement, and focuses on policy-relevant social determinants of health.

References

1. Bollen KA. Structural Equations with Latent Variables. New York: John Wiley & Sons; 1989.
2. Macintyre S, Ellaway A, Cummins S. Place effects on health: how can we conceptualise, operationalise and measure them? *Social Science & Medicine* 2002;55:125-139.
3. Link B, Phelan J. Social conditions as fundamental causes of disease. *J Health Soc Behav.* 1995;Spec No:80-94.
4. Hernán M, Robins J. Causal Inference. Boca Raton: Chapman & Hall/CRC; 2018.
5. Glass TA, Goodman SN, Hernan MA, Samet JM. Causal inference in public health. *Annu Rev Public Health* 2013;34:61-75.
6. Schwartz S, Prins SJ, Campbell UB, Gatto NM. Is the "well-defined intervention assumption" politically conservative? *Soc Sci Med* 2016;166:254-7.
7. Walls H, Baker P, Parkhurst J. Addressing trade policy as a macro-structural determinant of health: The role of institutions and ideas. *Global Social Policy* 2018;Article first published online: January 11, 2018 1-8.
8. Bilal U, Cooper R, Abreu F, Nau C, Franco M, Glass TA. Economic growth and mortality: do social protection policies matter? *Int J Epidemiol* 2017;46(4):1147-1156.
9. Cylus J, Avendano M. Receiving Unemployment Benefits May Have Positive Effects On The Health Of The Unemployed. *Health Aff (Millwood)* 2017;36(2):289-296.
10. Cylus J, Glymour MM, Avendano M. Health effects of unemployment benefit program generosity. *Am J Public Health* 2015;105(2):317-23.
11. Cylus J, Glymour MM, Avendano M. Do generous unemployment benefit programs reduce suicide rates? A state fixed-effect analysis covering 1968-2008. *Am J Epidemiol* 2014;180(1):45-52.
12. Rudolph L, Caplan J, Ben-Moshe K, Dilton L. Health in All Policies: A Guide for State and Local Governments. Washington, DC and Oakland, CA: American Public Health Association and Public Health Institute; 2013.
13. Dwyer-Lindgren L, Mokdad A, Srebotnjak T, Flaxman A, Hansen G, Murray C. Cigarette smoking prevalence in US counties: 1996-2012. *Population Health Metrics* 2014;12(5).
14. Remington PL, Catlin BB, Gennuso KP. The County Health Rankings: rationale and methods. *Popul Health Metr* 2015;13:11.

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Appendix A: Appendices for Chapter 2

Appendix 2.1: Potential Indicators of Economic Insecurity not included in Final Measurement Model

Indicator	Source
Owner occupied housing units, %	Census 2000
New residential construction, n	Census Residential Construction Branch
Vacant housing units for sale, %	Census 2000
Unemployment rate for women, %	Census 2000
Unemployment rate for men, %	Census 2000
Net migration, %	Census 2000
Employed in manufacturing, %	Census 2000
Employed in Construction, %	Census 2000
Median value of owner-occupied housing units, \$	Census 2000
Median rent for renter-occupied units, \$	Census 2000
Food stamp recipients, %	Census Small Area Income & Poverty Estimates (SAIPE)
Average commute time, minutes	Census 2000
County revenue per capita, \$	PA Dept. of Community and Economic Development
Refinance Loans, %	Federal Financial Institutions Examination Council: Home Mortgage Disclosure Act 2004

Appendix 2.2: Model Building Process for County Economic Insecurity

	Variables	DF	Chi-square test of model fit	Correlated measurement errors	RMSEA (90% CI)	CFI	TLI	SRMR
Model 1	8	21	487.565	0	0.263 (0.243, 0.284)	0.553	0.404	0.151
Model 2	7	15	340.813	0	0.261 (0.237, 0.285)	0.629	0.480	0.145
Model 3	7	9	96.608	0	0.174 (0.144, 0.207)	0.863	0.772	0.056
Model 4	7	10	255.120	0	0.277 (0.248, 0.307)	0.648	0.471	0.133
Model 5	5	4	21.903	1	0.118 (0.073, 0.169)	0.963	0.908	0.032
Final Model	5	5	24.042	0	0.109 (0.068, 0.155)	0.961	0.922	0.033

Notes. DF= Degrees of freedom, RMSEA= Root mean square error, CFI= Comparative fit index, TLI=Tucker Lewis Fit Index, SRMR= standardized root mean square residual.

Model 1: Labor force participation, unemployment, percent of income spent on rent, percent of income spent on housing, new residential construction, employed in service sector, owner-occupied housing, subprime credit.

Model 2: (drop owner occupied housing): Labor force participation, unemployment, percent of income spent on rent, percent of income spent on housing, new residential construction, employed in service sector, owner-occupied housing, subprime credit.

Model 3: (Drop percent of income spent on home): Labor force participation, unemployment, percent of income spent on rent, new residential construction, employed in service sector, subprime credit.

Model 4: (Drop new residential construction): Labor force participation, unemployment, percent of income spent on rent, percent of income spent on housing, employed in service sector, subprime credit.

Model 5: (Labor force participation is correlated with unemployment) Labor force participation, unemployment, percent of income spent on rent, employed in service sector, subprime credit.

Final Model: Labor force participation, unemployment, percent of income spent on rent, employed in service sector, subprime credit.

Appendix B: Appendices for Chapter 3

Appendix 3.1 County Economic Insecurity Models

All models are best-fitting models per year. The latent variable was constrained at 1. All models contain the same 5 indicators: percent not in labor force, percent unemployed, percent of income spent on rent, percent employed in service job, percent with subprime credit rating.

	2000	2010
Free parameters	17	17
RMSEA	0.133 (0.117, 0.151)	0.110 (0.094, 0.128)
CFI	0.931	0.962
TLI	0.770	0.872
SRMR	0.038	0.031
Correlated error terms ¹	2	2

¹ Correlated measurement errors include not in labor force with unemployment and not in labor force with service jobs.

Appendix 3.2 Association between change in county economic insecurity from 2000 to 2010 and change in deaths of despair 2001-2005 to 2011-2015 in non-Hispanic white persons aged 45-54, mortality rate per 100,000 (N=1098 counties)

	Model 1	Model 2	Model 3	Model 4
Economic Insecurity				
Stable high	18.2 (10.9, 25.4)	15.3 (8.8, 21.9)	20.7 (11.6, 29.8)	16.9 (8.1, 25.7)
Stable medium	7.5 (4.7, 10.3)	6.1 (3.1, 9.1)	8.5 (5.2, 11.8)	6.7 (3.3, 10.2)
Stable low	REF	REF	REF	REF
Increasing	10.4 (5.9, 14.9)	9.3 (4.9, 13.6)	11.1 (6.7, 15.5)	9.7 (5.3, 14.1)
Decreasing	12.1 (5.0, 19.2)	9.7 (3.4, 16.1)	13.2 (5.8, 20.7)	10.6 (3.7, 17.5)
Place type				
Large metro areas	-	-2.5 (-6.2, 1.2)	-	-2.2 (-6.0, 1.7)
Medium/small metro	-	REF	-	REF
Rural areas	-	5.6 (0.8, 10.3)	-	4.9 (0.8, 9.0)
Racial composition				
Percent Hispanic	-	-	-0.2 (-0.4, 0.04)	-0.1 (-0.3, 0.1)
Percent Black	-	-	-0.1 (-0.3, 0.07)	-0.2 (0.1)

Bold values indicate $p < 0.05$

All models have a robust standard error clustered on state. These models contain no imputation of missing outcomes data.

Appendix 3.3 Association between change in county economic insecurity from 2000 to 2010 and change in deaths of despair 2001-2005 to 2011-2015 among counties with non-missing mortality data (N=2614 counties)

	Model 1	Model 2	Model 3	Model 4
Economic Insecurity (REF is stable low)				
Stable high	3.7 (0.8, 6.5)	3.0 (0.1, 6.0)	8.3 (5.5, 11.2)	8.0 (5.0, 11.0)
Stable medium	3.4 (2.0, 4.8)	3.3 (1.7, 4.8)	4.8 (3.3, 6.4)	4.7 (3.1, 6.4)
Stable low	REF	REF	REF	REF
Increasing	3.5 (0.95, 6.1)	3.6 (1.0, 6.1)	5.2 (3.1, 7.2)	5.2 (3.1, 7.2)
Decreasing	3.5 (1.7, 5.4)	3.0 (1.1, 4.9)	4.7 (2.9, 6.5)	4.5 (2.6, 6.4)
Place type				
Large metro areas	-	-1.0 (-2.9, 0.9)	-	-0.2 (-2.1, 1.7)
Small/medium metro	-	REF	-	REF
Rural areas	-	1.6 (0.6, 2.7)	-	0.7 (-0.4, 1.8)
Racial composition				
Percent Hispanic	-	-	-0.08 (-0.2, -0.0002)	-0.1 (-0.1, 0.0)
Percent Black	-	-	-0.3 (-0.3, -0.2)	-0.3 (-0.3, -0.2)

Bold values indicate p<0.05

All models have a robust standard error clustered on state

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EDUCATION AND TRAINING

- | | |
|-----------------|--|
| PhD/August 2018 | Johns Hopkins Bloomberg School of Public Health,
Baltimore, MD
Thesis title: <i>Economic Insecurity and Mortality in the United States</i>
Advisor: Dr. David Celentano
Clinical Research and Epidemiology in Diabetes and
Endocrinology T32 pre-doctoral trainee |
| MHS/2016 | Johns Hopkins Bloomberg School of Public Health,
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Thesis title: <i>Cross-sectional and prospective associations between
neighborhood socioeconomic status and diabetes in the atherosclerosis risk
in communities (ARIC) study.</i>
Advisor: Dr. Jessica Yeh |
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PROFESSIONAL EXPERIENCE

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| 2016-2017 | Research Assistant, The Johns Hopkins Evidence-based
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Johns Hopkins Bloomberg School of Public Health,
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| 2015-2017 | Research Assistant, Global Obesity Prevention Center
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| 2014 | Research Assistant, Welch Center for Prevention,
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Johns Hopkins Bloomberg School of Public Health,
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2010-2015 Patient Registry Coordinator
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PROFESSIONAL ACTIVITIES

Society Memberships
2015-present Society for Epidemiologic Research
2017-2018 The Obesity Society

EDITORIAL ACTIVITIES

Journal Reviewer
2017 Social Science & Medicine Population Health

HONORS AND AWARDS

2018 Marilyn Menkes Book Award, Johns Hopkins Bloomberg School of Public Health

2018 Dorothy and Arthur Samet Student Support Fund, Johns Hopkins Bloomberg School of Public Health

2017 2nd Place, The Obesity Society Early Career Lightning Talks, The Obesity Society, Obesity Week 2017, Washington, DC

2017 Finalist, Epidemiology & Population Health Section Student and Trainee Poster Competition, The Obesity Society, Obesity Week 2017

2017 Invited Panelist, Careers in Public Health and Social Justice, Beloit College, Beloit, WI

2014 Nancy Fink Award for Scholarship and Service, Johns Hopkins Bloomberg School of Public Health

2010 Claudette Cummings Community Health Award, Beloit College, Beloit, WI

2009 Phi Beta Kappa, Beloit College Chapter

2009 Mortar Board National Senior Honor Society, Beloit College Chapter

PUBLICATIONS

Peer reviewed publications

1. Wendy L. Bennett, Renee F. Wilson, Allen Zhang, Eva Tseng, **Emily A. Knapp**, Hadi Kharrazi, Elizabeth Stuart, Oluwaseun Shogbesan, Eric B. Bass, Lawrence J. Cheskin. Methods for Evaluating Natural Experiments in Obesity: A Systematic Review. *Annals of Internal Medicine* [epub ahead of print 1 May 2018]. doi: 10.7326/M18-0309.
2. Bilal, U., **Knapp, E.A.**, Cooper, R.S., Swing voting in the 2016 presidential election in counties where midlife mortality has been rising in white non-Hispanic Americans, *Social Science & Medicine* 197: 33-38 (2017), doi: 10.1016/j.socscimed.2017.11.050.
3. Bennet W, Cheskin LJ, Wilson RF, Zhang A, Tseng E, Shogbesan O, **Knapp EA**, Stuart E, Bass EB, Kharazzi H. Methods for Evaluating Natural Experiments in Obesity: A Systematic Evidence Review. Comparative Effectiveness Review No. 204. (Prepared by the Johns Hopkins University Evidence-based Practice Center under Contract No. 290-2012-00007-1). AHRQ Publication No. 18-EHC006-EF. Rockville, MD: Agency for Healthcare Research and Quality; December 2017. www.effectivehealthcare.ahrq.gov/reports/final.cfm.
4. Melissa N. Poulsen, **Emily A. Knapp**, Annemarie G. Hirsch, Lisa Bailey-Davis, Jonathan Pollak, Brian S. Schwartz. Comparing objective measures of the built environment in their associations with youth physical activity and sedentary behavior across heterogeneous geographies. *Health & Place* 49 (2018): 30-38.
5. **Knapp EA**, Nau C, Brandau S, DeWalle J, Hirsch AG, Bailey-Davis L, Schwartz BS, Glass TA. Community Audit of Social, Civil, and Activity Domains in Diverse Environments. *Am J Prev Med.* 2017 Apr; 52(4): 530-540.
6. **Knapp EA**, Fink AK, Goss CH, Sewall A, Ostrenga J, Dowd C, Elbert A, Petren KM, Marshall BC. The Cystic Fibrosis Foundation Patient Registry: Design and Methods of a National Observational Disease Registry. *Ann Am Thorac Soc.* 2016; 13(7), 1173-1179.
7. Salsgiver EL, Fink AK, **Knapp EA**, LiPuma JJ, Olivier KN, Marshall BC, Saiman L. Changing Epidemiology of the Respiratory Bacteriology of Patients with Cystic Fibrosis. *Chest* 2015;149(2).
8. Goss CH, MacNeill SJ, Quinton H, Marshall BC, Elbert A, **Knapp E**, Petren K, Sewall A, Gunn E, Osmond J, Bilton D. Children and Young Adults in the US Have Improved Lung Function Compared to the UK. *Thorax* 2015 Mar; 70(3):229-36.
9. MacKenzie T, Gifford AH, Sabadosa KA, Quinton HB, **Knapp EA**, Goss CH, et al. Longevity of Patients With Cystic Fibrosis in 2000 to 2010 and Beyond: Survival Analysis of the Cystic Fibrosis Foundation Patient Registry. *Ann Intern Med.* 2014; 161:233-241.
10. Maisonneuve P, Marshall BC, **Knapp EA**, Lowenfels AB. Cancer risk in cystic fibrosis: A 20-year nationwide study from the United States. *Journal of the National Cancer Institute.* 2013 Jan 16; 105(2):122-9.

Peer reviewed publications in press or under review

11. **Knapp EA** and Dean LT. Consumer credit scores as a novel tool for identifying health in urban US neighborhoods. *Submitted to: Annals of Epidemiology.*

12. **Knapp EA**, Bilal U, Burke BT, Dougherty GB, Glass TA. A network approach to understanding obesogenic environments for children in Pennsylvania. *Connections* 2018. *In press*.
13. **Knapp EA**, Dean LT, Lazo M, Glass TA, Schwartz BS, Celentano D. A novel measure of economic insecurity in US counties as a risk factor for mortality. *Submitted to: Health and Place*.
14. Dean LT, **Knapp EA**, Sngunon S, Ransome Y, Qato DM, Visvanathan K. Consumer Credit, Chronic Disease, and Risk Behaviors. *Submitted to: JAMA*.

Other Publications

1. Case Example 29. Challenges in transitions and changes in data collection. In Gliklich R, Dreyer N, Leavy M, eds. *Registries for Evaluating Patient Outcomes: A User's Guide*. Third edition. Two volumes. AHRQ Publication No. 13(14)-EHC111. Rockville, MD: Agency for Healthcare Research and Quality. April 2014.
<http://www.effectivehealthcare.ahrq.gov/registries-guide-3.cfm>.

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TEACHING

<i>Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health</i>	
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2016-2017	Student Representative, Curriculum Committee
2015-2016	Student Representative, Admissions Committee
2015-2016	Coordinator, General Epidemiology & Methodology Research in Progress Meetings
2014-2015	Coordinator, General Epidemiology and Methodology Journal Club

SCIENTIFIC PRESENTATIONS

Oral Presentations

1. **Knapp EA.** Methods for Evaluating Natural Experiments in Obesity: A Systematic Evidence Review, Key Questions 4 and 5: Methods and Risks of Bias. Pathways to Prevention Workshop: Methods for Evaluating Natural Experiments in Obesity. December 5-6, 2017, National Institutes for Health, Bethesda, MD.

2. **Knapp EA** and Dean LT. Neighborhood credit score as a novel measure for individual obesity risk. Oral presentation and poster presentation at The Obesity Society Obesity Week 2017, October 30-November 2, 2017, Washington, DC.
3. **Knapp EA**, Bilal U, Palta P, Selvin E, Heiss G, Glass TA, Yeh H-C. Neighborhood Socioeconomic Status and Incident Diabetes in the Atherosclerosis Risk in Communities (ARIC) Study. Moderated Poster Presentation at the 76th Scientific Sessions of the American Diabetes Association, June 10-14, 2016, New Orleans, LA.
4. **Knapp EA**, Dougherty GB, Bilal U, Burke BT, Glass TA. Obesogenic environments in childhood in PA: a network approach. Oral Presentation at the 48th Annual Meeting of the Society for Epidemiologic Research, June 16-19, 2015, Denver, CO.
5. **Knapp E**, Salsgiver E, Fink A, Sewall A, Marshall B, Saiman L. Trends in Respiratory Microbiology of People with Cystic Fibrosis in the United States, 2006-2012. Oral Presentation at the 28th Annual North American Cystic Fibrosis Conference, October 9-11, 2014, Atlanta, GA.

Poster Presentations

1. **Knapp EA**, Dean LT, Lazo M, Schwartz BS, Celentano DC. A novel measure of economic insecurity is associated with mortality in US counties. Poster Presentation at Society for Epidemiologic Research Annual Meeting, June 19-22, 2018, Baltimore, MD.
2. **Knapp EA** and Dean LT. Neighborhood credit score as a novel measure for individual obesity risk. Oral presentation and poster presentation at The Obesity Society Obesity Week 2017, October 30-November 2, 2017, Washington, DC.
3. **Knapp EA** and Dean LT. Are credit scores associated with diabetes prevalence and risk factors? Poster Presentation at Society for Epidemiologic Research Annual Meeting, June 20-23, 2017, Seattle, WA.
4. **Knapp EA**, Nau C, Glass T. Community Audit of Social, Civil, and Activity Domains in Diverse Environments (CASCADDE): A new community audit methodology for direct observation of obesity-related environmental features. Poster Presentation at 2016 Epidemiology Congress of the Americas, June 21-24, 2016, Miami, FL.
5. **Knapp EA** and Fink AK. Estimating the Number of Individuals with Cystic Fibrosis in the United States. Poster Presentation at the 29th Annual North American Cystic Fibrosis Conference, October 8-10, 2015, Phoenix, AZ.
6. Dasenbrook E, Gemmen E, Chodnovskiy I, Sawicki GS, Hamblett NM, **Knapp EA**, Fink A, Goss CH. Association between the addition of inhaled hypertonic saline to RhDNase and clinical outcomes: propensity score matched analysis of the US CFF patient registry. Presented at the 28th Annual North American Cystic Fibrosis Conference, October 9-11, 2014, Atlanta, GA.
7. Fink AK, Marshall BC, **Knapp EA**, Engels EA. Risk of Cancer in Cystic Fibrosis Following Lung Transplantation. Presented at the 27th Annual North American Cystic Fibrosis Conference, October 17-19, 2013, Salt Lake, UT.

8. Goss CH, MacNeill SJ, Quinton H, Marshall BC, Elbert A, **Knapp E**, Petren K, Sewall A, Gunn E, Osmond J, Bilton D. Children and Young Adults in the US Have Improved Lung Function Compared to the UK. Presented at the 26th Annual North American Cystic Fibrosis Conference, October 11-13, 2012, Orlando, FL.