SOCIAL PATHOGENIC SOURCES OF POOR COMMUNITY HEALTH

by

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ABSTRACT

The United States currently provides a health care system that is neither efficient nor equitable. Despite outspending the world on health care, over three-fourths of developed countries produce better health outcomes (Auerbach *et al.,* 2000). Simultaneously, the "Ecological School of Thought" has documented the large impact that social, economic, and environmental circumstances play in health outcomes. Unfortunately, these 'ecological" studies are frequently conducted without theoretical justification, and rely solely on a cross-sectional research design and a myriad of unrelated variables.

This study represents an important step towards the development of a true theory of "ecology". More specifically, we argue that the adversity associated with socio-economic disadvantage, social disorganization, and a lack of health care resources, leads to adverse health outcomes, represented by sentinel health events. This research employs both a cross-sectional (2000) and longitudinal designs (1990 – 2000) to assess the antecedents of sentinel health events in 309 United States counties. Structural Equation Modeling was the statistical technique employed in the study.

Findings revealed that socioeconomic disadvantage remains a primary contributor to sentinel health. Indeed the economic growth between 1990 and 2000 was associated with increased rates of sentinel health events. Social disorganization was identified as a primary contributor to sentinel health events at a specific time point (2000), but was not significant over time (1990 -2000). Conversely, the inadequacy of health care resources was non-significant in the cross-sectional model (2000), but significant in the longitudinal model (1990 -2000). In both models, racial characteristics were fundamentally linked to ecological predictors of health

We found support for the notion that sentinel health events would be reduced through economic equity and the development of healthy environments where community ties are reinforced. Less support is found for saturating given geographical areas with health care resources in order to reduce sentinel health events. Future research should be directed by the theoretical advancements made by this study. More specifically, future studies should examine independent cross-level effects, that is, through the inclusion of behavior variables as mediating factors for ecological constructs.

I wish to express gratitude for the tremendous love and support extended by my parents, Neil and Patricia Smith. The enduring love of such great parents provides the key support to undertake such a project. Despite living in two separate continents, I know you are both with me everyday.

This body of work is dedicated to my incredible wife, Rachel Vandergeest. It was your continued support, love, and compassion that facilitated this achievement. I am truly blessed to have you by my side and look forward to many more good years. I could not have done this without you.

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LIST OF ACRONYMS/ABBREVIATIONS

AHRQ	Agency for Healthcare Research and Quality
ARF	Area Resource File
GIS	Geographic Information Systems
HCUP	Healthcare Cost and Utilization Project
ICD-9	International Classification of Disease
SEM	Structural Equation Modeling
SHE	Sentinel Health Event
UCR	Uniform Crime Report

CHAPTER ONE: INTRODUCTION

Disease has traditionally been described as the interaction of the human host, an infectious agent and the environment (2004). This triad of disease is also expressed in terms of the interaction of people, place and space. In recent years, academics (Berkman & Kawachi, 2000; Kaplan, 1996; Schwartz, 1994; Susser, 1994) have argued that epidemiology has overemphasized the elements of clinical experimentation at the expense of environmental or “place” type variables. Yadavendu (2003) states that this biological reductionism has occurred simultaneously with a medical philosophy that has moved from a population-based focus towards individualism. In other words, contemporary health research now favors risk factor, clinical and molecular epidemiology, while disregarding the social, political and environmental factors that precipitate the development of disease.

This biological reductionism has changed in recent years with the reemergence of social epidemiology, a field of study that examines the environmental, social and political positions of people in society (including variables of economic stratification, race, gender, and age) and its relationship to health. These group level or “ecological variables” reveal a dimension of public health that is not obtainable through individual-level data (Diez Roux *et al.,* 2002b).

It is hoped that the inclusion of these factors will transform the public health paradigm from solely individualistic concerns, towards a more holistic approach. This approach would include both macro and micro determinants of health. The ultimate aim of studying ecology and public health is to generate innovative health policies that reduce disease. This research represents a step forward in that direction.

Statement of the Problem

The United States currently provides a health care system that is neither efficient nor equitable. Despite outspending the world on health care, over three-fourths of developed countries produce better health outcomes (Auerbach *et al.,* 2000). In fact, the United States currently ranks 37th among all nations in health care performance (World Health Organization, 2000). Within the United States, disadvantaged segments of society, particularly the poor and black, experience a disproportionate amount of disease while living in environments where there is a paucity of health resources. These dismal outputs are indicative of a system that requires reexamination.

This study argues that the sub par performance of the United States health care system is the product of an over-investment in policies that target "lifestyle" or genetic issues; an over-investment that occurs at the expense of a broader set of causal variables often found in ecological studies. Yet, studies involving social and ecologic factors account for 56% of the variation in population health, compared to health behaviors with 21%, medical care with 19%, and genes and biology with only 4% (Tarlov & St. Peter, 2000).

While a plethora of studies are "ecological" in nature, no research to date has documented the relative influence of the key theoretical perspectives within the school of ecology. By collecting information on the ecological indicators of socio-economic disadvantage, social disorganization, and the inadequacy of health care resources, this research will examine what aspects of the school of ecology are most influential over time. This study will provide insight into the distal processes (social pathogenic sources) that lead to poor health.

The Ecological School of Thought

The ecological school of thought is based on ecology, a science dedicated to the study of evolving interactions between living organisms and inanimate matter and energy over time and space (Krieger, 2003). Central tenets of ecology are the quantification of spatial-temporal phenomenon, the identification of nested hierarchies within a system, the study of the inputs and outputs within this system, utilization of mathematical modeling, and the exploration of unique phenomena in relation to general processes. Guided by these principles, we argue that environmental conditions influence personal health at multiple levels, that is, ecological and social variables produce pathological conditions.

The ecological school of thought is also a derivative of general systems theory. Systems theory posits that social phenomena consist of mutually interacting components (Cantalano, 1979). Inherent within a systems approach is the need for social equilibrium through integration. However, a system must continually adapt to external and internal threats, such as psychological stress, family dysfunction, social disorganization, and war. Accordingly, a systems approach argues that community health is constantly adapting to fluctuations in the larger social system.

In terms of public health, the poor and certain racial groups in the United States currently experience a disproportionate amount of ill-health. At the environmental level, historical, political, and economic factors generate social milieus where disease and illness propagate. At the agent level, mechanisms such as a lack of adequate health care and preventive strategies render individuals more susceptible to disease or at risk for mortality. At the host level, specific individuals and groups become susceptible to these diseases. A schema of the ecological school of thought can be found in Figure 1.

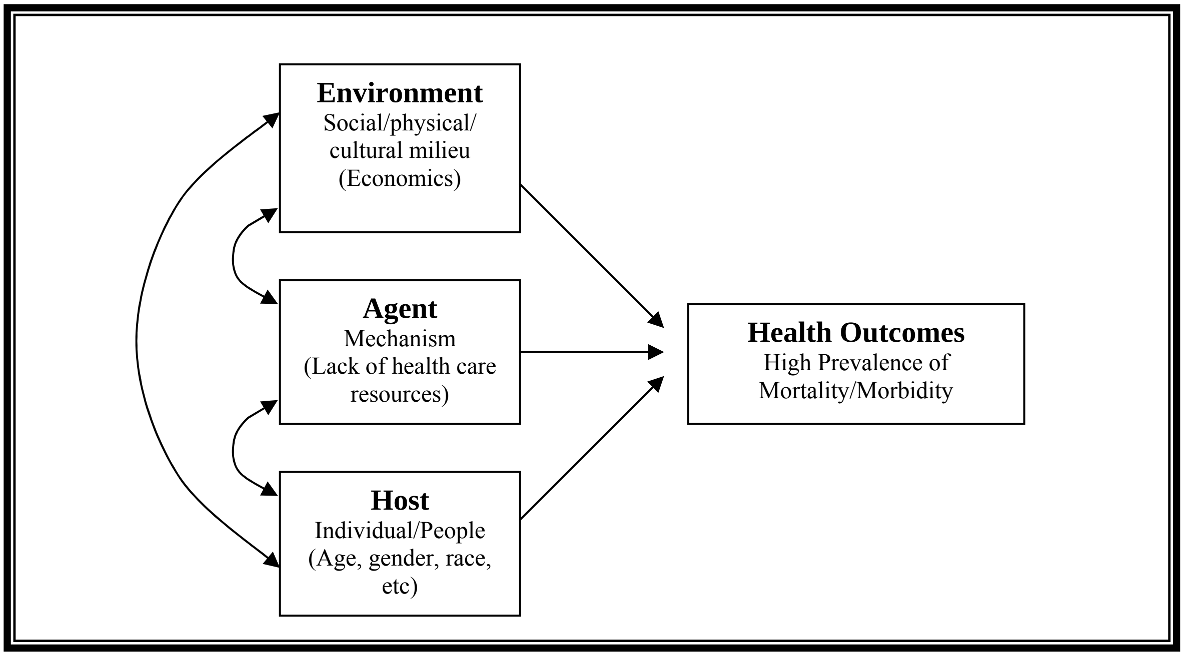

Figure 1: The Epidemiological Model

This schema is based on a materialist explanation of health. Here, variation in health is attributed to differential exposure and experiences, particularly the combination of negative exposures and a lack of resources held by individuals (Lynch *et al.,* 2000). The materialist explanation includes the analysis of health disparities caused by the differential accumulation of exposures and resources. These resources constitute a public infrastructure, one in which people receive varying standards of education, food quality, housing, work conditions, transportation, and welfare.

This explanation of health aims to document the material conditions that influence health, thus variables under study are restricted to the availability of social goods. The ecological school of thought argues that the scale and pattern of disease reflects the way that people live, as well as their social, economic, and environmental circumstances.

Social Causation Theory

The broad field of study known as the Ecological School of Thought can be neatly summarized using a single theory: the social causation theory. Social causation theory employs the philosophical tenets of social determinism. Here, materialistic mechanisms are viewed as causative agents that produce unhealthy behaviors. Stated differently, individual behaviors are "determined" by social interactions and constraints. Philosopher John Stuart Mill described social causation succinctly when he stated, "man is the creature of circumstances" (Heilbroner, 1999, p. 116).

It is worth noting that contemporary ecological researchers tend to adopt a view of "soft determinism", a view that acknowledges the role of free will while also stressing the significant influences that elements of the social environment bring to bear. To these ecological researchers, the non-innate factors of education, economics, culture, and the physical environment are the primary determinants of disease.

While the identification of the intervening mechanisms in disease has shifted its focus from historic concerns regarding immunization and sanitation towards the modern issues of diet, smoking, and exercise, inequalities within the social structure has remained a powerful predictor of disease. Hence, Link and Phelan (1995) describe social conditions, particularly the mal-distribution of social resources, as fundamental causes of disease.

In terms of this research, social causation theory is used to posit that adversity associated with socio-economic disadvantage, social disorganization, and a lack of health care resources, leads to adverse health outcomes, represented by sentinel health events. Sentinel health events are health conditions that are avoidable given current medical and public health knowledge and technology.

Research Questions

The ecological school of thought and the social causation theory generate a number of questions worthy of further investigation. This research aims to study the relative influence of socioeconomic disadvantage, social disorganization, and a lack of health care resources on sentinel health events. More specifically, this research is aimed at producing answers to the following questions:

1. Can socioeconomic disadvantage, social disorganization, and a lack of health care resources account for the variability in sentinel health events, at the county level (cross-sectional model)?

   1. a. What are the relative importance of socioeconomic disadvantage, social disorganization, and a lack of health care resources in explaining the variability?
2. Are socioeconomic disadvantage, social disorganization, and a lack of health care resources relatively constant over time?
3. Do any changing rates in socioeconomic disadvantage, social disorganization, and a lack of health care resources account for the change in sentinel health events (longitudinal model)?

New Contributions

This study considers community health as indicated by the prevalence of sentinel health events, to be a joint function of socioeconomic disadvantage (SED), social disorganization (DIS), and a lack of health care resources (HCR). Thus a generic model for investigating sentinel health events (SHE) may be expressed as follows: SHE = f (SED, DIS, HCR) + errors.

Currently, epidemiology over emphasizes behavioral and genetic approaches to health at the expense of ecological studies. As Krieger (2001) states, “ignoring social determinants of social disparities in health precludes adequate explanations for actual changing population burdens of disease and death, thereby hampering efforts for prevention” (p. 44). This research contributes to the existing literature by furthering knowledge in the areas of theory, methods, and policy application.

In terms of theory, academic researchers have not comprehensively investigated the correlates of sentinel health events. While ecological studies are increasingly common they frequently lack a theoretical justification. This research contributes to the existing literature by providing a clear theoretical basis for the three primary constructs used in ecological studies. Moreover, the interaction of these three constructs are investigated, an endeavor that was not found in the existing literature.

In terms of methodology, ecological research rarely examines the influence of ecological determinants with a longitudinal model. Yet, inequalities in health are not fixed or invariant; rather health varies in terms of time, place, and space. This research fills a void by including both a cross-sectional and a longitudinal design in order to examine the changes in population health at the county level. This allows one the opportunity to document and potentially remedy antecedents to poor health. This research design represents an important methodological advancement as it enables the researcher the opportunity to identify cause and effect relationships (Wan, 1995). Another area that differs from past research is the use of structural equation modeling. All previous research on sentinel health events relied solely on linear regression; this study is the first to use structural equation modeling. Finally, the use of standardized, comprehensive databases available at the national level represents a considerable advancement over past efforts to document sentinel health events. Prior to this research, the most rigorous study on sentinel health events was restricted to counties in the state of Virginia (see Ibrahim, 1997). While a commendable effort, this study has limited generalizability and is cross-sectional in design.

In terms of policy implications, this research utilizes geographic information systems to "map" aspects of the findings, thus providing a more efficient method of communicating with policy makers.

Structure of the Research

This document contains five chapters, each distinct in its function and content. What follows is a brief summery of the overall structure of this research endeavor.

Chapter one provides an outline of the dissertation. A summary of chapter one includes the notion that clinical epidemiology has moved from population-based research towards individualism. The Ecological School of Thought suggests that crucial determinants of disease have been ignored by this paradigm shift. The central tenets of ecology are summarized in social causation theory, which views historical, economic and political factors as causative agents that produce ill health. The ultimate aim of studying the ecology of public health is to generate innovative health policy and to reduce the prevalence of sentinel health events. The interplay of main and interaction effects, specifically of socio-economic disadvantage, social disorganization, and health care resources on sentinel health events, is an important phenomenon that should be thoroughly investigated.

Chapter two includes a review of pertinent literature. The chapter explores the dimensions and consequences of the ecological school of thought and the social causation hypothesis. It also discusses the utilization of the concept of sentinel health events and its validity for studying community health. There follows sections detailing the relevant literature and studies associated with the latent constructs of socioeconomic disadvantage, social disorganization, and a lack of health care resources.

Chapter three presents the methodology utilized in this study. The chapter contains sections on study design, the research population, data sources, measurement of variables, and the principal analytical model. This chapter also contains a section that underscores the importance of guarding against the ecological fallacy in the conduct of research.

Chapter four presents the results of the study. It starts with the exploratory analysis that includes descriptive statistics of the 309 counties under consideration, and correlation analysis between the study variables. A section follows on confirmatory analysis, which consists of a test of the measurement model and the evaluation of the covariance structural model.

Chapter five provide details on the implications and contributions of the study. The implications of the study span the theoretical, methodological, practical, and policy continuum. This chapter also contains a section that discusses the limitations of the study. Finally, conclusions and suggestions for future research are given.

Definition of Terms

- Epidemiology – Study of how disease is distributed in populations and the factors that influence or determine this distribution (Gordis, 2004)
- Social epidemiology – A subfield of epidemiology concerned with the social characteristics or psychosocial risk factors associated with patterns of disease within and across populations (Coreil *et al.,* 2001).
- Human ecology - Study of the relationships of humans to their physical environment and to one another. Environment includes physical, social, economical, political, historical, aesthetic and structural dimensions.
- Determinism – Philosophical doctrine that claims that materialistic mechanisms cause individual behaviors.
- Disease - The interaction of the human host, an infectious agent, and the environment (Gordis, 2004).
- Sentinel health events - Sentinel events refer to certain medical conditions, or the stage at which they are treated, that signal problems in the health care delivery system.

CHAPTER TWO: LITERATURE REVIEW

Historical Background

The examination of time and place on health has been the mainstay of epidemiology since its inception. In fact, the study of variations in the social conditions on public health and its relationship to public health is explicit in human history. The father of Western Medicine, Greek philosopher Hippocrates, proposed that in addition to the "humors" or functions of the body, the context of the surrounding society greatly influenced health. In the 5th century BC, Hippocrates wrote, "you will find, as a general rule, that the constitutions and the habits of a people follow the nature of the land where they live" (Hippocrates, 1978). Six centuries later the Roman philosopher and physician, Galen furthered medical science by conducting revolutionary dissections though he also addressed the influence of environmental conditions on disease susceptibility.

A more recent example is John Graunt's use of sanitation statistics to detail the relationship between plagues and the social distribution of death. Graunt (1939 [1662]) utilized life tables and survival data and was able to detect health disparities at the population level. Graunt attributed not only physical and topographical features to mortality, but also psychological and moral factors.

Simultaneously, Sir William Petty was utilizing mortality tables in his book *Political Arithmetick* (Petty, 1690). Written with the intention of quantifying the economic costs of mortality, Petty discovered that inept medical practice and unsanitary settings in hospitals were more significant contributors to mortality than the threat of the illness itself. Petty and Graunt both expressed considerable interest in the distribution and disparity of health across society, historically these efforts represent the first systematic study of the social regularities of mortality (MacIntyre & Ellaway, 2003).

In Germany, Peter Johann Frank (1941 [1790]) argued that health conditions would not improve until the issue of poverty was first addressed. Frank (1941 [1790]) wrote, "the extreme poverty of the people, just as it is the most fertile mother of crimes, in the same way corrupts the product of generation at the root. It causes a physical disposition for innumerable diseases and makes it very difficult or impossible to cure them, even with still better medical equipment" (p. 91). Other ecological pioneers include William Farr and John Snow. Farr (1852) and Snow (1855) prepared a variety of tables, charts and maps that analyzed the movement of cholera through time and space, a strategy that revolved around demographical, social, and topographical factors. The information gathered by Farr and Snow was eventually utilized to halt the course of the cholera epidemic, primarily through large scale engineering projects that improved sanitation in urban, industrialized areas.

The father of cellular pathology, Rudolf Virchow (1858) endorsed personal and political action to remedy social inequality. In fact, it was Virchow who wrote the famous dictum that, "physicians are the natural attorneys of the poor" (Bloch, 1974). Virchow became increasingly active in the Berlin City Council in order to remedy the problems associated with large-scale sepsis outbreaks. Despite political resistance, Virchow furthered methods of sewage disposal, hospital design, hygiene education, and meat inspection techniques

The history of ecological research also includes contributions from political philosophers, like Friedrich Engels. In *Conditions of the Working Class in England* (1968 [1845]), Engels detailed the exploitation of the proletariat that he witnessed during his residence in Manchester from 1850 to 1870. Not surprisingly this work condemns capitalism as an oppressive political system whereby workers are exploited, commodified and exposed to considerable harm. Engels (1968 [1845]) argues, "that English society has created for the workers an environment in which they cannot remain healthy or enjoy a normal expectation of life" (p. 109). Engels devotes a significant portion of the text to identifying the circumstances associated with proletariat status, particularly the dangers of unsafe working conditions, poverty and urban overcrowding. To Engels, (1968 [1845]) the effect of capitalism on public health represented nothing less then the "irrefutable charge of social murder" (p. 124).

Charles Darwin's theory of "Natural Selection" significantly expanded ecological theory. The theory of natural selection stated that environmental conditions determined the success of particular traits in species; success defined in terms of the organisms capacity to survive and reproduce. A disruption to this process occurred when environmental pressures such as overcrowding and scarce resources lead to the "survival of the fittest". Darwin (1975 [1859]) describes this survival process as such,

> "All that we can do, is to keep steadily in mind that each organic being is striving to increase at a geometrical ratio; that each at some period of its life, during some season of the year, during each generation or at intervals, has to struggle for life, and to suffer great destruction. When we reflect on this struggle, we may console ourselves with the full belief, that the war of nature is not incessant, that no fear is felt, that death is generally prompt, and that the vigorous, the healthy, and the happy survive and multiply" (p. 38).

In terms of social research, Darwinian thought has been extended beyond basic human needs (e.g. the need for basic health care) to include social needs. Examples of fundamental social needs include Fromm's (1955) social relations, creativity, fixed roots, personal identity and intellectual development, and Maslow's (1970) belonging, esteem, and self-actualization.

Unfortunately, Darwin's principles have historically been misapplied through social Darwinism, leading to racism, imperialism and laissez-faire economics. In spite of these misappropriations, the original principles of Darwin's work remain indispensable to social epidemiologists. The genius of Darwin was in recognizing the dynamic relationship between the macro conditions of life (the environment) with the micro result (traits, behaviors, etc.), an undertaking that remains prominent in modern ecological studies.

Sociologists in Chicago were the first ecological researchers to use Darwinian principles in social research. Robert Park and Ernest Burgess (1915) scientifically examined the relationship between social, economic, and historical forces that contribute to economic disadvantage and social alienation. Park and Burgess found that cities possessed a natural, ecological history that could be used to explain and predict social pathology. Later, Faris and Dunham (1960) identified a relationship between social disorganization and mental illness, and Wan (1991) identified demographic and community factors that determined psychiatric hospitalizations. Note that an outline of the history of ecological research is provided in Appendix A: A Brief History of Ecological Research.

The Endogenous Variable

This section includes an exploration of the theoretical underpinnings of both the endogenous and exogenous variables. Contemporary academic literature is examined with reference to emergent themes of interest.

Sentinel Health Events (SHE)

Sentinel health events (SHE) refer to certain medical conditions, or the stage at which they are treated, that signal problems in the health care delivery system (Dever, 1984; Rutstein *et al.,* 1976). The use of sentinel events was first developed by Rutstein *et al.,* (1976) as a measure of medical quality. Here, preventable and/or treatable diseases were tracked in order to examine if the health care system had functioned satisfactory in terms of avoiding the presence of unnecessary disease, disability, and death at the community level. To Rutstein *et al.,* the presence of certain preventable and/or treatable diseases functioned as a warning that the quality of health care needed to be improved. Similarly, the European Community Atlas of Health states that when one defines medical care in a broad sense that includes prevention, cure, and care strategies, it becomes clear that an excessive number of preventable or treatable events, "serves as a warning signal of possible shortcomings in the health care system and should be investigated further" (Holland, 1988, p. 1).

The initial list of conditions used by Rutstein and his colleagues were selected in conjunction with the National Center for Health Statistics, the Center for Disease Control, the Veterans Administration, as well as esteemed members of various medical fields. During the 1980's, this list of sentinel health events was redefined by established medical researchers, as part of the "European Community (EC) working group".

The European Community (EC) working group was instrumental in propagating ecological research, particularly the effect of socioeconomic and health care resources on sentinel health events (Charlton *et al.,* 1983; Charlton & Velez, 1986; Mackenbush *et al.,* 1988; Poikolainen & Eskola, 1986; Westerling, 1992). The findings demonstrated that disparities in economics, the lived environment, and the availability of health care resources were associated with sentinel health events (Niti & Ng, 2001).

This concurred with Rutstein *et al.,*'s (1976) early speculation that sentinel health events (SHE's) could, "be used to determine the level of health of the general population and the effects of economic, political, and other environment factors upon it" (p. 582). The important aspect of this statement is that the identified sentinel health events could evaluate the performance of the health care system, by examining the influence of ecological variables. This approach was markedly different from past research on health care systems.

Despite such potential, sentinel health research has yet to be adequately explored. To date, sentinel health event research has been narrowly restricted to clinical or occupational settings. In the clinical arena, sentinel health research has been used to assess adverse patient outcomes and medical errors (Diehr *et al.,* 2001). In occupational medicine, sentinel health research has assessed work-place health risks, like asbestos (and the resulting mesothelioma), carcinogen exposure, and work place accidents (Feldman & Gerber, 1990). While important research in its own right, such approaches fail to examine the broader social determinants of health within a given geographic area, and thus fail to utilize sentinel health events effectively. This gap can only be remedied through epidemiological (population-based) research with prime ecological variables.

Another criticism of past sentinel health research has been a reliance on mortality data. While mortality data are easily available and reliable, the concept of sentinel health events should be broadened to include morbidity measures ("unnecessary disease" or "unnecessary disability" in Rutstein *et al.,*'s terminology). This research includes both hospitalization data (discharge data) as well as mortality (death certificate data).

With regard to research design, past sentinel health event research has been exclusively cross-sectional in design. Such models provide an accurate evaluation of sentinel health events within a given geographic area; they fail to identify causal relationships. The need for longitudinal research becomes particularly salient in ecological research where social forces are assumed to influence health outcomes over time. This research aims to further sentinel health research by addressing these gaps. A longitudinal model is developed that contains measures of mortality and morbidity. Moreover, this study extends beyond clinical or occupational settings to include broad social and ecological antecedents.

A final issue concerns the large range of sentinel health event conditions. For example, the European Community group categorized sentinel health events into 17 disease categories[1], while Charlton *et al.,* (1983) further modified the conditions into 13 disease groups. These two lists are inconsistent, unwieldy and possibly outdated. Thus, we conducted a confirmatory factor analysis to assess the underlying structure for measures on eleven commonly-used sentinel health events. Determination of the appropriate number of variables to retain was based on eigenvalues, variance, scree plots, and residuals. The resulting five variables include: asthma, cancer of the colorectum/liver/lung, diabetes, hypertensive disease, and influenza/pneumonia. Refer to Appendix B: Confirmatory Factor Analysis of Sentinel Health Events, for a detailed explanation.

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[1] The European Community working group developed the following 17 categories of sentinel health events: Tuberculosis (ICD-8; 010-019), malignant neoplasm of cervix uteri (ICD-8; 180), malignant neoplasm of cervix and body of uterus (ICD-8; 180, 182), Hodgkin's disease (ICD-8; 201), chronic rheumatic heart disease (ICD-8; 393-398), respiratory diseases (ICD-8; 460-519), asthma (ICD-8; 493), appendicitis (ICD-8; 540-543), abdominal hernia (ICD-8; 550-553), cholelithiasis/cholecystitis (ICD-8; 574-575), hypertensive and cerebrovascular diseases (ICD-8; 400-404, 430-438), maternal deaths all causes (ICD-8; 630-678), perinatal mortality (ICD-8 not listed), infectious diseases e.g. measles, typhoid (ICD-8; 001, 033, 037, 055, 720), malignant neoplasm of trachea, bronchus, and lung (ICD-8; 162), cirrhosis of the liver (ICD-8; 571), and motor vehicle accidents (ICD-8; E810-819).

The Exogenous Variables

Multiple studies (Baron *et al.,* 2000; Carlson & Chamberlain, 2003; Chappell & Funk, 2004; Chung *et al.,* 2004; Cubbin *et al.,* 2000; Ellaway *et al.,* 2001; House *et al.,* 2000; Kawachi & Berkman, 2003; Subramanian *et al.,* 2002; Wan, 1972; Whitman *et al.,* 2004) indicate that demographic, socioeconomic and political factors tend to influence the health of individuals within a given spatial area.

This research has been supported by the theory of social causation, which suggests that it is the relationship to the social environment that is the pathogenic source of poor health. Social causation theory posits that ecological variables require in-depth and comprehensive analysis in order to develop effective public health programs and strategies. In terms of public health, these variables could include employment opportunities, educational provisions, transportation, housing, retail provisions, crime, policing, land use, availability and quality of health services, environmental hazards (air pollution, noise, hazardous waste), social networks, social cohesion, cultural norms and values, geology, and climate (MacIntyre & Ellaway, 2003). Simply, ecological research explores the relationship between human groups and their environment.

The rationale behind this research involves a close examination of the most prominent dimensions of the ecological school. An examination of ecological literature suggests that the key variables are socio-economic disadvantage, social disorganization, and a lack of health care resources.

Socio-Economic Disadvantage

Epidemiological studies that investigate socio-economic disadvantage are based on the notion of social stratification. Here, members of society are ranked according to their possession of some socially valued commodity, such as income, education or occupation. Social stratification is inherently tied to the concept of social class. Social class defined as "a segment of the population, distinguished from others by similarities in labor market positions and property relations" (Gabe *et al.,* 2004, p. 3). Encompassed within this definition are the central tenets of ownership of economic capital, and the correlated social relationships between groups. Each social class is thought to possess a "class history" that influences the individuals located within that social stratum. Here, the experiences and behaviors that are guided by social class are seen as more profound than the simple aggregation of individual experiences and behaviors.

Political philosopher, Karl Marx, explicated the notion of social class. In *The Grundrisse* (Marx, [1939] 1971), and *The Economic and Philosophical Manuscripts* (Marx, [1844] 1964), Marx detailed the alienating aspects of private property, the division of labor, and the quantification of the worker. Here, the proletariat worker is exploited to a point whereby their only valued commodity, personal labor, is reified into an alien product.

Within this alienating process, the proletariat experiences a disproportionate amount of poor health. Conversely, the upper class is thought to be conscious of its power and influence, and thus maintains a higher level of health. Class categorized by the group's relation to the means of production and ownership of private property. Prior to Marx, it was commonly accepted that individuals controlled and guided economics, following Marx; it was economics that governed human behaviors. As such, class can be identified as a social construct, one that is based on relationships within a society.

A founder of sociology, Max Weber, described social class as the degree of economic market opportunity, and the labor market position of a group of people (Weber, [1922] 1968). Weber maintained that economic ownership, social status, and political power connecting these social classes. Weber, like Marx, believed that class was explicit in the economic and social life chances which people experienced. Weber stated that homogeneity and stagnancy within the class structure was to be expected. However, when rare cases of social mobility did occur, it was accompanied by an integration of characteristics associated with the new social class. Thus, upward social mobility produced better health in the individual, while downward mobility ultimately produced poorer health.

This perspective was later conceptualized into the Erikson-Goldthorpe (1992) social class schema that identified 5 to 11 distinct social classes, ranked by occupation. Using this schema, Erikson and Goldthorpe conducted a statistical analysis of social class, which revealed significant constancy and commonality in underlying patterns of social fluidity. Central to this finding was the class differentiation and power structure found between employers, self-employed, and employees.

To Link and Phelan (1995) the hierarchical nature of social conditions first mentioned by Marx and Weber, can now be viewed as a *fundamental cause* of disease. Risk factors such as poor lifestyle choices continue to change over time (e.g. smoking, inactivity etc.), while economic inequality within the social structure continues to be enduring factors that influence health. Thus, social conditions are direct antecedents on a causal chain of disease, instead of a secondary or proxy factor. This explains why risk-factor epidemiology fails to diminish excess morbidity and mortality in less advantaged social groups. For example, risk factors like smoking and pollution have been associated with lung cancer for some time, yet lung cancer morbidity and mortality continues to occur disproportionately in lower socio-economic groups.

Link and Phelan (1995) posit that higher socio-economic groups are more favorably situated to know about the risks, and to possess the resources that allowed them to engage in protective behaviors to avoid them. Unfortunately, the majority of public health research and policy continues to be directed towards reducing risks at the individual level, while health behavior only accounts for 10-20% of the differences in mortality (Lantz *et al.,* 2001).

Conversely, social stratification remains so central to health, that some have attributed the dramatic improvements in health over the last two hundred to improved socioeconomic conditions, rather than advancements in medicine or vigilant individual-level interventions (McKeown, 1976). Link and Phelan cite a host of studies (Adler *et al.,* 1994; Buck, 1981; Pappas *et al.,* 1993) that reinforce the strong association between low socioeconomic disadvantage and lower life expectancy, higher overall mortality rates and higher rates of infant and perinatal mortality. Other studies also support the idea that socioeconomic status (Diez-Roux *et al.,* 1997; Kawachi, 1999; Subramanian *et al.,* 2001; Wilkinson, 1996), or its components of income (Lynch *et al.,* 2000), education (Christenson & Johnson, 1995), and occupation (Winkleby *et al.,* 1992) have tremendous impact on health.

Interest in the effects of socio-economic factors on health continues to grow. The number of publications that used social class as a keyword increased by 58 percent between the years 1987-1997, this represents the publication of 170 articles per month on social class (Kaplan & Lynch, 1997). Invariably, this research categorizes social class into the tripartite schema of income, education, and occupation. These components will now be examined in more detail with particular emphasis on classic ecological studies that relate to socio-economic disadvantage.

(a) Income and the Alameda Study – A considerable body of evidence supports the income deprivation hypothesis, which states that holding other factors constant, it is the median income of a geographic area in relation to an established poverty standard that is important to health (Wagstaff & Van Doorslaer, 2000). At the community level, it would be expected that counties that are economically disparate and possess large groups of people below a "poverty line", would have poorer health outcomes than more egalitarian counties. Additionally, counties with acute income deficiencies would possess a considerable amount of poor health.

In 1962, academics at the University of California, Berkeley undertook a large research project designed to assess deprivation at the county level. The Alameda Study was exceptional due to several, interrelated reasons. The first reason is that researchers adopted the World Health Organization's (WHO) definition of health as a complete state of, "physical, mental and social well-being and not merely the absence of disease or infirmity" (Breslow, 1972; World Organization of Health, 1946). This broad definition facilitated the inclusion of ecological variables such as occupation, housing status, and socioeconomic status. One variable in particular, "residence in a poverty area", represented an expansive approach when compared to the standard analyses of mortality risks during this time period (Berkman & Breslow, 1983; Hochstim, 1970; Kaplan, 1996). The second aspect of the study worth noting was the complexity of its methodology. The Alameda Study, a longitudinal, cohort design examined selected residents of the county during the years 1965, 1974, 1983, 1994, and 1995. By following a specific cohort over a thirty-year period the data enabled researchers the opportunity to examine the causative agents of morbidity and mortality.

Empirical research on the cohort data revealed that over time, those "residents in 'poverty areas' experienced higher age, race, and sex adjusted mortality" compared to residents in 'non-poverty' areas (MacIntyre *et al.,* 1993, p. 216). This finding was replicated by Haan *et al.,*'s (1987) comparison of a "designated poverty area" to a more economic viable area. Haan *et al.,* discovered that over a nine-year period (1965-1974) mortality rates were significantly higher in the poverty area. In fact, residing in a poverty area correlated with a 50% increased risk in all-cause mortality, even after controlling for individual level variables.

Other empirical research based on cohort data from the Alameda Study found correlations between location of residence and mortality (Beebe-Dimmer *et al.*, 2004; Berkman & Syme, 1979; Frank *et al.*, 2003; Kaplan *et al.*, 1987; Yen & Kaplan, 1999a, 1999b), loss of physical function (Balfour & Kaplan, 2002; Guralnik & Kaplan, 1989), declines in physical activity (Yen & Kaplan, 1998) , and increased depression and sleep complaints (Roberts *et al.,* 2000a; Roberts *et al.,* 1999; Roberts *et al.,* 2000b). In short, the Alameda Study found that ecological variations in income and location of residence were stronger predictors of health outcomes than personal lifestyle habits.

This work has coincided with research that documents the positive relationship between income and mortality at the county (McLaughlin & Stokes, 2002), state (Kennedy *et al.,* 1998), and international levels (Lynch *et al.,* 2004; Marmot & Bobak, 2000). Kawachi *et al.,* (1999) argue that United States can expect sub-standard health outcomes as it maintains the highest levels of income and wealth inequality of any industrialized country.

Absolute poverty remains a strong predictor of poor community health; in fact, it continues to produce some of the most robust findings in health research. Poverty produces deficits in social necessities like transportation, education, and housing. Poverty is also related to psychological conditions including chronic anxiety, depression, and helplessness. In fact, Wan (1971; also see Wan, 1972) explains that poverty is a form of psycho-social stress, which in turn leads to increased susceptibility to disease in individuals residing in an impoverished geographic region.

(b) Education - In addition to the variable of income, research (see Bundrys, 2003) indicates that there is a positive relationship between education and health status. Both income and education are thought to facilitate access to social goods, particularly access to health information and resources. Despite these similarities, the variables of income and education are distinct. Backlund *et al.,* (1999) discovered that income is strongly associated with poor health outcomes *below* a minimal level of $22,500 in yearly income, whereas variance in education was strongly associated with differences in health outcomes *above* $22,500 in yearly income. Here, the assumption is that a minimal level of income increases health outcomes, while higher education is a reflection of the ability to acquire knowledge and social status. Education is a strong predictor of health, independent of income status. In fact, Lantz *et al.,* (2001) found education to be a stronger predictor of health status than income, and reasoned that this was due to the network of advantages that educational achievement provides.

(c) Occupation and the Whitehall Studies – The categorization of one's occupation is an important aspect of social economic disadvantage. Members of different occupations possess distinct cultural characteristics and health attitudes that lead to variations in health. The impact of occupation was explored in two large-scale, longitudinal studies of civil servants in the 'Whitehall' area in England. Civil servants were selected as they possessed distinct work grades (Marmot *et al.,* 1987). This enabled researchers to collect data on social class, while holding medical insurance type constant.

The first Whitehall study discovered that individuals with high employment grades were much less likely to die prematurely than men in the lowest grades, in fact, after 10 years of follow-up, the high employment grade had one-third the mortality rate of the low grade workers (Ebi-Kryston, 1989; Marmot *et al.,* 1987; Marmot *et al.,* 1984; Marmot & Wilkinson, 1999). Occupation level also demonstrated an inverse relationship with the following sources of mortality: coronary heart disease, cancer, chronic bronchitis, gastrointestinal disease, accidents, homicides, and suicides (Marmot, 1986). To Marmot and Wilkinson (1999), "position in the hierarchy shows a strong correlation with mortality risk. Men second from the top have higher mortality than top-grade civil servants; clerical officers have higher mortality rates than the men above them in the hierarchy" (p. 11).

The Whitehall II study examined a new cohort of 10,314 civil servants (6900 men, 3414 women) aged between the ages of 35 and 55. Marmot discovered strong support reaffirming the presence of a social gradient of health (Marmot *et al.,* 1991). A lower ranking of one's occupational ranking being associated with a higher risk for coronary heart disease (CHD) and mortality. This finding has been replicated and confirmed in numerous academic studies (see

Bosma *et al.,* 1997; Brunner *et al.,* 1996; Ferrie *et al.,* 2002; Hemingway *et al.,* 1997; Marmot *et al.,* 2001; Marmot, 1998; Marmot *et al.,* 1997; Roberts *et al.,* 1993; Singh-Manoux *et al.,* 2003).

Further research identified a social gradient of health in the following conditions of morbidity; back pain, angina, ischaemia, chronic bronchitis, and general feelings of ill health (Council of Civil Service Unions, 2004; Marmot *et al.,* 1991). In fact, social gradients of health have been confirmed in almost the entire developed world with virtually every studied disease. Predating this research, Wan and Wright (1973) discovered that professional working groups not only possessed a lower rate of certain sentinel health disorders, but also experienced less chronic disability as a result of the disorder when compared to other groups.

What is most significant in the Whitehall studies was that behavioral risk factors failed to account for the variation found in the health gradients. Here, Marmot posited that occupational status reflected the degree of control one perceived to occupy within the workplace. Syme (1996) argued that low social status is associated with less control of one's destiny in general. Johnson and Johansson (1991) found that a lack of control in the workplace generated feelings of learned helplessness and increased job strain. In short, lower occupational status, with its high work demands, low discretion and low control, was positively associated with poorer health outcomes. This association remained even when individual risk factors were controlled.

(d) A synthesis of the literature: The Black Report - A synthesis of the literature pertaining to the influence of income, education, and occupation on health can be found in the Black Report. The Black Report is an important document that was created by medical sociologists during the 1980's. First, the Black Report reaffirmed that a marked difference existed between social

classes in terms of mortality and morbidity. Second, the Black Report described, analyzed and provided recommendations for reducing health inequalities.

The Black Report offered four models that attempted to explain health inequalities, these explanations included: artifact, selection, behavioral, and materialist/structural (MacIntyre, 1997). The artifact model suggests that the relationship between environment and health is basically spurious, a product of measurement error. The selection model argued that biologically determined natural abilities lead to the allocation of social position and health. The behaviorist model (or lifestyle model) argued that habits, customs and practices of low socioeconomic individuals produced poor health, with foremost importance placed on instances of maternal mismanagement (i.e. smoking while pregnant, no prenatal care, etc) that produce infant mortality or unhealthy offspring. The behaviorist model placed emphasis on the disease pathways of personal ignorance and irresponsible lifestyles. The materialist/structural viewpoint is identical to the ecological approach mentioned throughout this literature review. This perspective argues that ecological factors influence health, "independent of inherited constitution" (Szreter, 1984, p 528).

Of particular significance was the Black Report finding that the ecological model (materialist/structuralism) possessed the greatest explanatory power in terms of health disparity (Black *et al.,* 1993). This means that despite the contribution of genetic, behavioral and cultural factors, the governing explanation for health inequality was material deprivation and economic stratification. No other model could justify why mortality rates in higher social classes had steadily declined while those at lower levels had stagnated or even increased.

In light of recent advances in English socialized medicine, the Black Report Committee concluded that, "the availability of health care did not overcome social and economic differences"…which, "were central to the explanation for the existence of health disparities" (Bundrys, 2003, p. 171). The Black Report recommended the inclusion of a comprehensive anti-poverty strategy, educational development, and equity in the distribution of resources. It is important to note that historical-materialist theorists would support structural changes that eliminate inequality, over interventions that ameliorate the effects.

While the research found in the Alameda Study, the Whitehall Studies, and the Black Report provides valuable direction, it is also imperative to take account of contemporary studies that examine the relationship between socio-economic disadvantage and specific sentinel health events. Due to the vast amount of information that needs to be conveyed, we first discuss ecological studies that rely exclusively on single-indicators of socio-economic disadvantage. These studies are presented in Table 1: Single Indicator Socio-Economic Disadvantage Studies

Table 1: Single Indicator Socio-Economic Disadvantage Studies

Author	Study Type	SED	SHE	Finding
(Duran & Rona, 1999)	CS (n=15,562)	I	AST	Persistent wheeze highly prevalent in deprived areas. (+)
(Weitzman et al., 1990)	CS (n=15,416)	I	AST	Poverty status associated with childhood asthma. (+)
(Lang & Polansky, 1994)	L (n=365 tracts)	I	AST	Low-income = asthma mortality risk, by census tract. (+)
(Brenner *et al.,* 1991)	CS (n=2,627)	I	CAN	Low-income = lower colorectal cancer survival rate. (+)
(Franks *et al.,* 2003)	CS (n=437,743)	I	DIA	Low patient income = Lower glycohemoglobin compliance, by zip code. (+)
(Harrison *et al.,* 2000)	CS (n=1, 412)	I	FLU	Lower community median income is a risk factor for pneumonia in older adults.
(Solberg *et al.,* 1997)	CS (n=4,245)	I	FLU	Lower income, less likely to get flu/pneumonia shots. (+)
(Diez Roux *et al.,* 2000)	CS (n=41)	I	HYP	State level inequality = increased high blood pressure in women only. (+)
(Regidor *et al.,* 2003)	CS (n=1,110)	E	FLU	Lower education is associated with increased pneumonia and influenza mortality. (+)
(Vargas *et al.,* 2000)	CS (n=5,861)	E	HYP	Low education = higher incidence of hypertension for Non-Hispanic whites, not with non-Hispanic black. (?)
(Abramson *et al.,* 1982)	CS (n=19,427)	O	CAN	Occupation associated with lung cancer mortality. (+)

Socio-Economic Disadvantage abbreviations: I=Income, O=Occupation, E=Education. **Sentinel Health Event abbreviations**: APP=appendicitis, intestinal obstruction, and hernia, AST=bronchitis, emphysema, asthma, CAN=malignant neoplasm of colo rectum, liver, and lung, DIA=diabetes mellitus, FLU=Influenza and Pneumonia, HYP=hypertensive diseases. **Study Type abbreviations**: CS=Cross-sectional, L=Longitudinal. **Relationship abbreviations**: (+) = positive relationship, (-) = negative relationship, (?) = mixed or inconclusive relationship.

Income (INC) – A review of academic literature indicates that income is strongly associated with sentinel health events. For example, Brenner *et al.,* (1991) found an inverse relationship between low-income and risk of death from colorectal cancer when using German cancer registry. The relative hazard of death associated with low-income compared to high income was 1.22 for colon cancer and 1.32 for rectum cancer. Similarly, an analysis of Surveillance, Epidemiology, and End Results (SEER) data revealed a moderately strong, inverse association between median household income level and the incidence of carcinoma of the cervix at the census tract level (Mackillop *et al.,* 2000).

This trend is also discernible with regard to influenza and pneumonia mortality. Singh and Siahpush (2001) discovered a relative risk of 2.69 ($p<0.05$) for the lowest compared to the highest income group of the United States population over the age of 25. Analogous findings were also discovered in a study of Minneapolis-St. Paul clinics, that revealed that persons whose self-reported household income was below 150% of the federal poverty level were far less likely ($p<0.004$) to receive influenza and pneumococcus immunization than other income groups (Solberg *et al.,* 1997). At the community level, there is evidence of an inverse relationship between income levels and influenza and pneumonia incidence. More specifically, community median income has been identified as a risk factor for pneumonia in older adults (Harrison *et al.,* 2000).

At the zip code level, residence in lower socioeconomic zip codes in the New York area has been associated with fewer eye examinations and less glycohemoglobin compliance in diabetic patients (Franks *et al.,* 2003). Franks *et al.,* argued that most prevention and treatment therapies designed to manage diabetes were underutilized by lower socioeconomic populations. This a concern as low-income populations have exhibited higher prevalence of Type 2 diabetes in countries such as Britain (Barker *et al.,* 1982), Italy (La Vecchia *et al.,* 1987), New Zealand (Scragg *et al.,* 1991), and Egypt (Herman *et al.,* 1995).

At a broader geographical level, Lang and Polansky (1994) examined Philadelphia census tracts over a 20 year period and found that low-income status was significantly associated with risk of mortality from asthma. Furthermore, children with asthma from low-income families were more likely to have lower school attendance, frequent emergency room visits, and lack of compliance with treatment regimes (Milton *et al.,* 2004; Nassau & Drotar, 1995). This is significant because asthma is the most prevalent childhood chronic illness in the United States and is increasing in prevalence (Milton *et al.,* 2004; Mitchell & Murdock, 2005). At the state level, Diez Roux *et al.,* (2000) conducted a multilevel analysis on the influence of state-level inequality (n=44) on hypertension. State income inequality was associated with increased hypertension, particularly at low-income levels (household incomes <$25,000). These differences were statistically significant in women but not in men.

There exists a paucity of income studies that examine the role of "poverty status" on specific sentinel health events, though certain key exceptions do exist. Several studies (Bonett *et al.,* 1984; Mackillop *et al.,* 1997), have recognized higher incidence rates, late stage at diagnosis, and lower rates of survival of lung cancer patients in poverty areas. One study of British poverty areas identified a high prevalence of persistent wheeze and asthma (Duran & Rona, 1999). In the United States, Weitzman *et al.,* (1990) analyzed data from the 1981 National Health Interview Survey (n=15,416) and reported that poverty status was associated with increased risk for asthma. Rarely have these findings have been replicated in international settings (Groholt *et al.,* 2001).

***Education (EDU)* –** Few studies examine sentinel health events by using only education-level data. Studies that use education as a socioeconomic measure support the notion that low educational attainment is correlated with poorer health. For example, Regidor *et al.,* (2003) found an association between lower education and pneumonia and influenza mortality. In fact, a stepwise relationship was discovered, with every one less year of education associated with a 2.9% increase of pneumonia/influenza mortality in men and 4.1% increase of pneumonia/influenza mortality in women.

An analysis of the data in the First National Health and Nutrition Examination Survey (NHANES I) identified non-Hispanic White subjects with less than 12 years of education as significantly more at risk for hypertension than those with more than 12 years of education (Vargas *et al.,* 2000). For low-educated men, the relative risk was 2.14, while for low-educated women the relative risk was 2.06, though no significant differences in hypertension incidence was identified in the non-Hispanic Black subjects. Later, the third National Health and Nutrition Examination Survey (NHANES III) supported the notion that low education attainment was associated with higher rates of asthma and wheeze (Arif *et al.,* 2003). The NHANES III representing the continuation of a large scale (N=18,393) epidemiological survey that included an array of potential antecedents to asthma. Interestingly, income and education remained statistically significant predictors while other variables such as indoor pollution were not statistically significant.

Occupation (OCC) – Ecological theorists have long proposed an association between occupational status and health. In terms of methodology, only one study has relied solely on occupation as an indicator of socioeconomic status. This was Abramson et al.,'s (1982) study that found an inverse relationship between occupation status and lung cancer mortality.

Summary of single indicator studies – Taken as a whole, the aforementioned studies suggest that increases in income, education, and occupation lead to decreases in sentinel health events. In terms of methodology, these studies are unusual because they use a single-indicator as a measure of socio-economic disadvantage. A more common approach involves the combination of two or three indicators to fully illustrate the concept of socio-economic disadvantage. These composite measures are summarized in the following table; Table 2: Composite Indicator Socio-Economic Disadvantage Studies.

Table 2: Composite Indicator Socio-Economic Disadvantage Studies

Author	Location	Study Type	SED	SHE	Finding
(Lipton *et al.,* 2005)	California	CS (n=1707 zips)	I E	AST	Low SED = increased risk of bronchitis/emphysema. (+)
(Marmot *et al.,* 2001)	U.K.	L (n=10,308)	I E O	AST	Low SED = increased risk of chronic bronchitis. (+)
(Tavani *et al.,* 1999)	Italy	CS (n=3,533)	I E	CAN	Low SED associated with lower colorectal cancer. (-)
(Ferraroni *et al.,* 1989)	Italy	CS (n=151)	E O	CAN	Low SED inversely related to liver cancer. (+)
(Devesa & Diamond, 1983)	U.S.	CS (n=20,868)	I E	CAN	Low SED by census tract related to lung cancer. (+)
(van Loon *et al.,* 1995)	Netherlands	L (n=58,279)	E O	CAN	Low SED inversely associated with lung cancer. (+)
(Krieger *et al.,* 1999)	San Francisco	CS (n-=70,899)	I E O	CAN	SED and colorectal cancer confounded by race. (?)
(Mao *et al.,* 2001)	Canada	CS (n=8,353)	I E O	CAN	Low SED = higher lung cancer risk. (+)
(Ko *et al.,* 2001)	Hong Kong	CS (n=2,847)	E O	DIA	Lower SED is a risk factor for diabetes. (+)
(Tang *et al.,* 2003)	Canada	CS (n=39,021)	I E	DIA	Lower SED = increased prevalence of diabetes. (+)
(Bachman *et al.,* 2003)	England	CS (n=770)	I E	DIA	Less educated and poorer diabetics had less compliance. (+)
(Harris, 2001)	U.S.	CS (n=1,306)	I E	DIA	Race = high DIA, Low SED ≠ higher DIA. (-)
(Haffner *et al.,* 1989)	San Antonio	CS (n=422)	I E	DIA	Low SED ≠ higher DIA in Hispanics. (-)
(Morris & Munasinghe, 1994)	U.S.	L (n=3,097)	I E	FLU	Lower SED = higher incidence of pneumonia in seniors. (+)
(Ostbye *et al.,* 2003)	U.S.	L (n=20,776)	I E	FLU	In elderly, income not related to influenza vaccination, lower education is related to lower influenza vaccination. (?)
(Wood *et al.,* 1999)	British Columbia	L (n=928)	I E O	FLU	Lower SED = higher pneumonia mortality risk. (+)
(Galobardes & Morabia, 2003)	Switzerland	CS (n=588)	E O	HYP	Low SED = risk of high blood pressure, 35-78 year olds. (+)
(Ford & Cooper, 1991)	U.S.	CS (n=7,073)	I E	HYP	Low education = increased risk of hypertension in white females, income not significant. (+)
(Diez Roux *et al.,* 2002a)	U.S.	CS (n=15,792)	I E O	HYP	SED inversely associated with aging related increases in systolic blood pressure. (+)
(Winkleby *et al.,* 1990)	California	CS (n=3,349)	I E O	HYP	Education level inversely related to hypertension risk. (+)

Socio Economic Disadvantage abbreviations: I=Income, O=Occupation, E=Education. **Sentinel Health Event abbreviations**: APP=appendicitis, intestinal obstruction, and hernia, AST=bronchitis, emphysema, asthma, CAN=malignant neoplasm of colo rectum, liver, and lung, DIA=diabetes mellitus, FLU=Influenza and Pneumonia, HYP=hypertensive diseases. **Study Type abbreviations**: CS=Cross-sectional, L=Longitudinal. **Relationship abbreviations**: (+) = positive relationship, (-) = negative relationship, (?) = mixed or inconclusive relationship.

Composite Socio-Economic Disadvantage Measures - The vast number of studies of socioeconomic disadvantage and sentinel health events utilize a composite measure that contains either two or three variables. Two variable measures overwhelmingly focus on the variables of income and education, while ignoring the role of occupational status. Three variable composite measures include income, education, and occupation measures; however at the ecological level they tend to focus on measures related to income distribution rather than actual measures of poverty.

Two-Variable Measures – Generally, two-variable measures tend to focus on the role of income levels and educational attainment in sentinel health events.

At the individual level, several studies have used an income/education measure. An example being a recent analysis of Canadian National Population Health data (n=39,021), which indicated that increasing income and education attainment was associated with decreasing rates of self-reported diabetes (Tang *et al.,* 2003). Related to this research, Bachman *et al.,* (2003) discovered an association between low socioeconomic status, categorized by 5 income levels and 6 educational levels, and retinopathy (retinopathy being a primary complication from diabetes and the leading cause of blindness in the United States). Other studies on income/education levels and poor diabetic outcomes have been confounded by racial differences. While racial and ethnic differences in diabetes were statistically significant, Haffner *et al.,* (1989) could find no association between low-income and education levels and risk of hyperglycemia or retinopathy in Mexican Americans living in the United States. In fact, Harris (2001) argues that when examining national-level data on diabetes, race represented a better predictor of diabetic patient outcomes than either income or education status.

A recent study by Lipton *et al.,* (2005) employed geospatial techniques in determining the prevalence of bronchitis and emphysema within California zip codes. By utilizing hospital discharge data Lipton *et al.,* found that zip code tabulation areas with lower average incomes and percentage of college graduates were more likely to have significantly higher rates of bronchitis and emphysema.

Data from the Third National Cancer Study (n=18,514) identified a strong inverse relationship between socioeconomic and lung cancer incidence, at the census tract level (Devesa & Diamond, 1983).This relationship remained strong ($p<0.001$) even after racial differences were controlled for. It appears that inequality in lung cancer risk can partly be explained by the well known inverse relationship between socioeconomic disadvantage and the prevalence of smoking (Flint & Novotny, 1997).

In one of the few ecological studies of socioeconomic status and rates of pneumonia, Morris and Munasinghe (1994) discovered that at the county level, both income and median school years were associated with elevated rates of hospital admission for pneumonia among seniors. Though, caution should be used when analyzing income levels in the elderly population because socioeconomic status may be influenced by retirement status. Similarly, a community study of Americans over the age of eighty, found that education (dichotomized into "completed high school" and "not completed high school") was significantly related to influenza immunization, yet income levels by quartiles were not associated with influenza immunization (Ostbye *et al.,* 2003).

While there is ample evidence of an inverse relationship between income/education and sentinel health events, not all studies are definitive. Certain types of cancers and hypertension have produced inconsistent results when using the income/education composite measure. In the case of colorectal cancer, higher income and education was actually associated with higher risk of colon cancer, whereas no association was found with rectal cancer (Tavani *et al.,* 1999). Analysis of Surveillance, Epidemiology, and End Results (SEER) data found no statistically significant differences in socioeconomic incidence of colo-rectal cancer (Baquet *et al.,* 1991). While Ford and Cooper (1991) discovered that education was negatively associated with the risk of hypertension in white women, and was of borderline significance among white men and black women. However, income was not found to be a good predictor of hypertension.

In addition to the above studies, research has also documented a relationship between socio-economic disadvantage and sentinel health events, when using a composite education/occupation measure. In Italy, Ferraroni *et al.,*'s (1989) case-control study found that low education and occupation status, specifically low head of household occupation status, was correlated with a higher risk of liver cancer. In this study, alcohol consumption was found to have a positive, though unpredictably non-significant relationship with liver cancer. Although it has been speculated that socioeconomic inequalities are related to liver cancer this remains untested, due in large part to the confounding of the primary risk factors of alcoholic cirrhosis. Van Loon *et al.,* (1995) identified an inverse association between highest level of education and lung cancer, which was still apparent after adjustment for traditional risk factors. Moreover, males with a lower white-collar profession had a significantly lower relative rate of lung cancer compared with blue-collar workers (RR = 0.66), but after adjustment for smoking habits this difference was reduced (RR = 0.73).

In South Carolina, researchers found that the incidence rate of hypertension was three to four times greater when the study participants were of low social class (measured by education and occupation), than when they had higher social class scores at the beginning of the study (Keil *et al.,* 1977).

At the international level, Ko *et al.,* (2001), examined the role of low education/occupation status on a high risk Hong Kong Chinese population. The age-adjusted odds ratio of having diabetes was 4.5 in low socioeconomic females compared to high socioeconomic females. The corresponding odds ratio in male subject was 1.9 but was not statistically significant. In Switzerland, Galobardes & Morabia (2003) surveyed 588 people and discovered a higher prevalence of hypertension in the lowest compared to the highest groups, defined on the basis of education and occupation.

While the vast majority of two variable socioeconomic measures find statistical differences in prevention and treatment of sentinel health events, it becomes clear that they also fail in some aspects. While face validity would lead one to assume an inverse relationship, by using two variables, this relationship often is neutral or even positive. With this in mind we turn to three variable measures.

***Three Variable Measures* –** The influence of socioeconomic disadvantage on sentinel health events has been examined through three indicators of income, education and occupation.

At the individual level, the aforementioned Whitehall Study that identified an inverse relationship between income/education/occupation and chronic bronchitis in English civil servants(Marmot *et al.,* 2001). In fact, low socioeconomic status is also a strong predictor of poorer asthma control (De Vries *et al.,* 2005).

Diez Roux *et al.,* (2002a) utilized income, education and occupation levels in a nine year study. They discovered that changes in blood pressure and risk of hypertension varied by socioeconomic status, with disadvantaged segments of society two to three times more likely to experience hypertension (white hazard ratio = 2.75, black hazard ratio = 2.13). After controlling for baseline blood pressure, racial differences disappeared while socioeconomic disparities remained. While in a dated, though remarkable article, Winkleby *et al.,* (1990) initiated four cross-sectional surveys between 1979 and 1986. In all four surveys, education levels were inversely associated ($p<0.01$) with hypertension, even after controlling for the usual socioeconomic variables of income and occupation. Winkleby *et al.,* documented a social gradient in risk score for all four years of data; with each progressive education level showing a decrease in hypertension. Lastly, Mao *et al.,* (2001) discovered that smoking habits, alcohol use, and diet could only partially explain lung cancer risk. Rather, income and education levels followed by occupational status were associated with increased risk of developing lung cancer (income: OR=1.7, education: OR=0.6).

At the broader geographic level, a tripartite measurement of socioeconomic disadvantage has been associated with sentinel health events. While not associated with incidence rates of colorectal cancer, socioeconomic variables were significantly correlated with mortality rates and individual perceptions. Indeed, in South-West England, colorectal cancer five year survival rates have demonstrated a 3%-5% difference between the most affluent and deprived quartiles of the population (Wrigley *et al.,* 2003). Within the United States this figure is estimate to be between 5%-7% when comparing low-income areas (by zip code) to middle-income or high-income areas (Jessup *et al.,* 1996). A study of 2,627 German patients with colorectal cancer discovered the relative hazard of death associated with low socioeconomic status compared to high socioeconomic status to be 1.22 for colon cancer and 1.32 for rectal cancer. Studies also found that survival decreased with decreasing family income in both Ohio (Chirikos & Horner, 1985) and New Mexico (Goodwin *et al.,* 1996). While some researchers have speculated that this inequality is due to the general social and emotional well-being of individuals residing in low socioeconomic areas, others have identified a knowledge disparity. Price (1993) surveyed 500 low socioeconomic adults in Ohio and discovered great variability in their perceptions and practice surrounding colorectal cancer. Price discovered that low socioeconomic status was correlated with poor knowledge and the succeeding lower rates of preventative practices (e.g. low rates of proctoscopic exam and stool occult blood test).

At the county level, Krieger *et al.,* (1999) found that increases in socioeconomic deprivation in white working class women and men were associated with higher incidence of colon cancer (n=70,899). In another study, Wood *et al.,* (1999) grouped a sample of Canadians into 5 social classes on the basis of individual level income, occupation and education. Lower social class quintiles exhibited an increased relative risk (RR=2.3) for pneumonia mortality. Interestingly, this study found that while education was a slightly better indicator of avoidable pneumonia mortality than income, it was the composite socioeconomic measure of income, education, and occupation that provided the most significant results.

***Summary of Socio-Economic Disadvantage* -** After exhausting the review of relevant literature on measures of socioeconomic disadvantage and sentinel health events, several observed trends emerge.

First, an overwhelming number of studies support an inverse relationship between socioeconomic status and sentinel health events. Second, the choice to include one or more socioeconomic variables into the model varies considerably. While measures of socioeconomic disadvantage frequently rely solely on a single measure, this approach fails to adequately capture the complex relationship between socioeconomic disparity and health. When using two variables, the vast majority of studies under consideration place income and education into a composite measure. No justification is provided explaining why the variable of occupational status is usually ignored. The two-variable composite approach is insufficient, and it intermittently fails to find a significant correlation when face validity would expect such a relationship to exist. It appears that measures of socioeconomic disadvantage that use the tripartite income/education/occupation measure provides the best chance of identifying a meaningful relationship. This perspective has been supported elsewhere by Liberatos *et al.,* (1988), and O'Campo *et al.,* (1997).

Third, of note is that the majority of these studies assess the 'average' income levels of an individual or geographical area, while few include community-level poverty, which is adjusted for the standard of living. This research aims to fill this void by measuring income disadvantage, through poverty levels rather than median income levels.

Four, while supporting the presence of a relationship the operationalization of socioeconomic disadvantage varies dramatically in its unit of analysis. Unfortunately, due to a paucity in ecological research, the majority of the studies occurred at the individual level. While some studies dealt with neighborhoods, zip codes, census tracts, and state levels, very few studies occurred at the county level. This is unfortunate; as these geographic boundaries do not represent socio-political boundaries in which key health policy decisions are made. Rather, health policy is usually formed at the county level. Furthermore, a disproportionate amount of socioeconomic research on health outcomes hails from international settings. Ecological research is more common and well established in Europe, yet the generalizability of these studies to North American geographic areas is unknown.

Five, while every attempt was made to review studies that were longitudinal in design, the majority of these studies were cross–sectional. Cross-sectional designs lack the ability to identify causality in a precise manner. Six, the relationship between socioeconomic disadvantage and sentinel health events is rarely extended to issues such as prevention and treatment. For example, low socioeconomic status is associated with diabetes in terms of prevention (i.e. education campaigns that target the poor) and also treatment (delayed treatment, amputations, foot sores etc). This is analogous to the approach used in Rutstein *et al.,*'s (1976) seminal article.

In summary, regardless of differences in the selection of variable or unit of analysis, there is strong evidence of an inverse relationship between income, education, and occupation and specific sentinel health events. This relationship has been documented in a range of temporal and spatial settings. With this in mind, we will now examine the latent construct of social disorganization in the community.

Social Disorganization

Another key component of the school of ecology is the concept of social disorganization. Social disorganization includes the contextual aspects of social living that influence individual health, specifically the degree of social cohesion within a given area. It is important to note that social disorganization examines the elements of "place", while the previously discussed concept of socio-economic disadvantage was concerned with the stratification of "people". Ellen *et al.,* (2001) explains this as such, "there has been little systematic exploration of whether those living in poor communities are sicker because they tend to be of lower socioeconomic status, or because there is something unhealthy about living in such communities" (p. 392).

The concept of social disorganization is longstanding within sociology. In 1915, Robert Park argued that all urban areas contained a natural, ecological history that could be scientifically studied (see Park, 1915). Later, Robert Park and Ernest Burgess coauthored the classic book *The City*, in which they contended that the social environment was a reflection of competition between social groups' for scarce resources. Park and Burgess argued that social disorganization could be measured by fluctuations in rates of disease, crime and suicide.

Park and Burgess examined the geographical structure of Chicago and identified 5 distinct "zones" or "rings". Zone I, the central business district possessed few residents except for vulnerable populations like the homeless. Zone II, the zone of transition was dominated by unsafe housing and living conditions, this area was typified by deterioration and consisted of recent immigrants and the poor. Zone III, the working class zone possessed some transient populations though was described as fairly stable. Lastly, zone's IV and V were categorized as higher class areas. Park and Burgess acknowledged that these "concentric rings" were neither permanent nor overly precise; more significant was the discovery that at the aggregate level the function of "place" was essential to understanding social pathologies. To Park and Burgess (1984 [1925]), the ecological organization of the concentric zones served, "as a selective or magnetic force attracting to itself appropriate population elements and repelling incongruous units, thus making for biological and cultural subdivisions of a city's population" (p. 78).

The prediction being that social pathologies would continue to transpire disproportionately near the city center, an area segregated on the basis of class and function. Of particular interest was the finding that pathologies like crime continued to plague the "transitional" zones (Zone I, II and to some extent Zone III), regardless of the fact that individuals in those zones relocated to other zones. Burgess and his students collected large amounts of census tract and city agency data, and created dot maps that identified gradients in social characteristics (Bulmer, 1984).

To many sociologists, the city of Chicago was an important place for systematic, ecological research as it was saturated with an assortment of social pathologies including crime, population density, divorce, unemployment, and mental illness. For example, Wirth (1938) developed a theory of urbanism, which highlighted the heterogeneous and transitory nature of urban areas. Wirth (1938) argued that population density increased friction while paradoxically also increased anonymity; with escalating diversity and heterogeneity of groups continually eroding social structures and social control. These processes were particularly apparent in cities, which Wirth characterized as unstable, tangential and problematic.

But how does social disorganization lead to social pathology? The answer to this can be found in the work of sociologist, Emile Durkheim. In his classic book titled *Suicide* (1951 [1897]), Durkheim, explained that individuals are connected to society by two forms of integration: attachment and regulation. Attachment defined as the degree of communal relations an individual engages in, and regulation defined as the extent to which society governs one's norms, values and beliefs. Durkheim (1951 [1897]) utilized this concept of social integration to examine the phenomenon of suicide, an action typically depicted as intensely personally and psychological. Durkheim observed that geographic areas and social groups exhibited consistent rates of suicide over time. Higher suicide rates were observed in Protestants, unmarried people, city dwellers, and during periods of economic change. The degree of social attachment, bonding and connectivity are key components of Durkheim's work.

The act of suicide was attributed to the deregulation of social conditions rather than a personal decision. As Durkheim (1951 [1897]) explains,

> "Instead of seeing in them only separate occurrences, unrelated and to be separately studied, the suicides committed in a given society during a given period of time are taken as a whole, it appears that this total is not simply a sum of independent units, a collective total, but is itself a new fact *sui generis*, with its own unity, individuality and consequently its own nature - a nature, furthermore, dominantly social" (p. 46).

Durkheim's work produced a paradigm shift. The study of the 'reality' of the social environment was now separate from the sum of individual ideas, beliefs and customs (Yen & Syme, 1999). For social scientists, Durkheim presented a theory that linked external conditions to individual experiences. If social determinants were responsible for suicide rates, then it was entirely possible they were also responsible for other health outcomes like health disease, cancer, and depression. To date, a host of academic studies (Blazer, 1982; Bruhn, 1987; Cohen & Syme, 1985; Colantonio *et al.*, 1992; Mookadam & Arthur, 2004; Uchino, 2004; Uchino *et al.*, 1999) support the notion that high rates of social disorganization correlate strongly with morbidity and mortality.

Sociologist, Robert Faris echoed a Durkheimian approach in his book *Social Disorganization* (1948). First, Faris presupposed that individual-level behaviors are fundamentally motivated by group approval. Second, Faris stated that a society becomes disorganized when, "the parts of it lose their integration and fail to function according to their implicit purposes" (Faris, 1948, p. 49). Social disorganization being a condition where the usual controls over unhealthy behavior are lacking, where friends and family may support unhealthy behaviors, where many opportunities are available to engage in unhealthy behaviors, and where little encouragement, training, or opportunity exists for healthy behaviors. Third, when the conditions of social disorganization are met, there is no longer a standard for group approval, thus unhealthy behaviors ensue.

These behaviors are particularly chronic in areas that are least integrated, mainly because disorganized communities are unable to realize the common values of their residents and are incapable of solving social problems.

While Faris argued that a disorganized society facilitated individual pathologies like criminal activity, alcoholism, drug addiction, gambling, prostitution, and suicide, he did not explore the possibility that social disorganization could lead to poor physical health. Nevertheless, insight can be gained from Faris's subsequent work on mental health. Here, Faris and Dunham (1960) found that social disorganization was strongly associated with increased hospitalization rates for mental illness. Specifically, exposure to a socially disorganized area represented a risk factor for developing schizophrenia. This finding has since been supported by Wan's (1991) analysis of demographic and community factors that were associated with psychiatric hospitalizations. Here, Wan extended the ecological perspective beyond rudimentary economic factors, such as poverty levels, in order to further understand the contextual effects of the environment that lead to ill health.

Social disorganization now supported multidimensional ecologic factors, that is, the research now provided insight into the range of factors that influenced social milieu. This approach has also been called the socio-ecological view of health, whereby social milieu is the major contributor of health (Tarlov, 1996). Socio-ecological research studies immediate surroundings such as family, home, and neighborhood, and area influences such as schools, church and work sites.

Social disorganization theory is not without criticism, particularly in the defining of the concept. On one hand, some research includes socioeconomic variables within the operationalization of social disorganization (Sampson & Groves, 1989), while other research excludes socioeconomic variables, and focuses exclusively on formal and informal social controls, family disruption, and residential mobility (Bursik & Webb, 1982; Shihadeh & Steffensmeier, 1994; Skogan & Maxfield, 1981). To these researchers, social disorganization is an issue of social control and as such socioeconomic variables are seen as being more germane to the concept of social stratification. We concur with these researchers and exclude socioeconomic variables from our examination of social disorganization.

Recent research suggests that social disorganized areas increase social stress (Steptoe & Feldman, 2001) and restrict health related activities (Saelens *et al.,* 2003). Yet, we know little about the influence of social disorganization on behaviors such as smoking tobacco, alcohol and drug abuse, poor diet, and sedentary lifestyle. Indeed, under a Durkheimian approach, one in which the individual is integrated into the social whole, society is able to restrain these individual appetites to a manageable level (Useem, 1985). The lack of social disorganization research in health is unfortunate; particularly as health studies continue to utilize comparable measures without theoretically justification.

Despite a lack of research, direction for future research is provided in Richard Wilkinson's (1996), *Unhealthy Societies: the Afflictions of Inequality*. Wilkinson asserts that contextual aspects of the environment contribute to early mortality. Wilkinson takes the reader to wartime Britain where massive improvement in life expectancy occurred during a period of deteriorating living standards, limited medical services, and food rationing. In fact, the increase in life expectancy during the world wars for civilian populations was "twice as fast as the average rate of improvement during the rest of the century" (Wilkinson, 1996, p. 113; also see Winter, 1985). Wilkinson credits this development on a greater sense of social cohesion; with the psychological and social fortitude needed to fight a common enemy leading to an environment of solidarity. In this setting, economic stratification becomes secondary to issues of social cohesion.

Wilkinson also discusses Roseto, Pennsylvania, a town that historically was characterized by low death rates, particular from heart attacks. Roseto displayed heart disease rates over 40 per cent lower than neighboring towns, a difference that could not be explained by risk factors like diet, smoking and exercise (Wolf & Bruhn, 1993). Roseto also exhibited a high sense of social cohesion among various ethnic groups. When Roseto's sense of social cohesion deteriorated, possibly due to the turbulent 1960's and children moving away from home, the rates of heart disease increased to that of the neighboring towns. The researchers concluded:

> The data obtained over a span of twenty years in the Italian-American community of Roseto, when compared with those of neighboring communities, strongly suggests that the cultural characteristics – the qualities of a social organization – affect in some way individual susceptibility to myocardial infarction and sudden death. The implication is that an emotionally supportive social environment is protective and that, by contrast, the absence of family and community support and the lack of a well-defined role in society are risk factors (Bruhn & Wolf, 1979, p. 134)

It becomes clear that a lack of social cohesion within a given area is associated with poor health, and that this relationship is distinct from economic considerations. Indeed, while the United States remains the wealthiest country in the world, a recent study found that death rates in Harlem, New York are at most ages higher than in rural Bangladesh (McCord & Freeman, 1990). This suggests that disorganization within the social fabric influences health, not simply economic factors.

Social cohesion has been studied in a number of different ways. Robert Putnam's social capital focused on the normative levels of trust and reciprocity needed to drive a civic society (Putnam, 1995; Putnam *et al.,* 1993). Biologists like Robert Sapolsky studied male baboons, and found that long term exposure to social stress elevated basal glucocorticoids, a risk factor for cardiovascular disease (Sapolsky, 1998; Sapolsky *et al.,* 2000). This research differs in that it follows a materialist perspective of ecology. Here, the components of an area necessary for social disorganization are of primary importance. This includes the components of residential mobility, urbanization, female head of household, foreign-born residents and crime.

Table 3: Social Disorganization Studies

Author	Study Type	SED	SHE	Finding
(Hughes & Baumer, 1995)	CS (n=44)	M	AST	House moving associated with childhood asthma. (+)
(Lebowitz et al., 1990)	CS (n=48)	M	AST	Residential mobility related to risk of asthma. (+)
(Leaderer et al., 2002)	L (n=1,002)	U	AST	Density related with increased cockroach allergens. (+)
(Wieringa et al., 2001)	CS (n=14,299)	U	AST	Urbanization associated with higher occurrence of asthma-related symptoms in adults, not children. (+)
(Yang & Hsieh, 1998)	L (n=355)	U	CAN	Urbanization correlated with incidence of lung cancer. (+)
(Howe et al., 1993)	L (n=102)	U	CAN	High population density related to higher rates of liver, lung, female breast and cervix cancer, by county. (+)
(Mahoney et al., 1990)	L (n=106,569)	U	CAN	Urbanization related to cancer mortality. (+)
(Stains et al., 1997)	L (n=536)	U	DIA	Urbanization not associated with incidence of diabetes. (-)
(Bruno et al., 1993)	L (n=1,445)	U	DIA	Urbanization associated with incidence of diabetes. (+)
(Harik-Khan *et al.*, 1998)	L (n=4.093)	FH	AST	FH associated with higher rates of asthma. (+)
(Wickrama et al., 2001)	L (n=707)	FH	HYP	Divorce associated with middle-age hypertension. (+)
(Wood *et al.*, 2002)	CS (n=386)	FB	AST	FB parents associated with asthma in children. (+)
(Goel *et al.*, 2003)	CS (n=32,440)	FB	CAN	FB status = less screening for cancer. (+)
(Wright et al., 2004)	CS (n=937)	C	AST	Exposure to violence related to asthma morbidity. (+)
(Greenhalgh *et al.*, 1998)	CS (n=50)	C	DIA	Crime limits adherence to diabetes management. (+)
(Wilson et al., 2002)	CS (n=56)	C	HYP	Exposure to violence associated with hypertension. (+)

Social Disorganization abbreviations: M=Residential Mobility, U=Urbanization, FH=Female Head of Household, FB=Foreign Born, C=Crime. **Sentinel Health Event abbreviations**: AST=bronchitis, emphysema, asthma, CAN=malignant neoplasm of colo rectum, liver, and lung, DIA=diabetes mellitus, FLU=Influenza and Pneumonia, HYP=hypertensive diseases. **Study Type abbreviations**: CS=Cross-sectional, L=Longitudinal. **Relationship abbreviations**: (+) = positive relationship, (-) = negative relationship, (?) = mixed or inconclusive relationship.

Residential Mobility (MOBILITY) **-** The negative influence of residential mobility is observable in classic studies of social disorganization (Bursik & Grasmick, 1993a; Crutchfield *et al.*, 1982; Hagan *et al.*, 1996; Shaw & McKay, 1942). In terms of criminal justice research, mobility is one of the principal neighborhood indicators of violent crime (Sampson, 1985; Sampson *et al.,* 2002).

Clear *et al.,* (2003) argue that residential mobility contributes to social disorganization in three distinct ways. First, mobility tends to isolate individuals and reduce the self-regulating processes of a community. Second, social cohesion is impossible to develop when a community continually experiences a high influx of new residents, mainly because this process stifles the development of extensive friendship networks, kinship bonds, and local associational ties (Kasarda & Janowitz, 1974; Veysey & Messner, 1999). Third, an atmosphere of anonymity reduces the sense of commitment to a neighborhood, creating a cycle of social disorganization (see Warner & Pierce, 1993). Thus, residential mobility leads to a lack of social integration and greatly reduces the community's capacity for collective efficacy. Additionally, this process decreases the likelihood of establishing shared values and norms.

While the concept of residential mobility is indispensable to the theory of social disorganization, it has received little empirical testing in public health. Only a handful of applicable studies could be located. Of the few existing examples, Metzner *et al.,* (1982) found that greater residential mobility, particularly in childhood but also in later life, was significantly associated with greater prevalence of hypertension and higher mean diastolic blood pressure in older persons. Other evidence shows that residential mobility represents a barrier to adequate treatment in hypertensive patients (Cowan *et al.,* 1980), and can increase risk factor of stroke like blood pressure and hostility (Harburg *et al.,* 1973). In an interesting study that utilized an urban-rural dichotomy, Wan (1972) discovered that mobility was associated with increased risk of asthma, and surprisingly decreasing risk of diabetes and cancer. When individuals moved from rural to urban settings, they were particularly prone to higher rates of diabetes, compared to other non-mobile groups. In another study, Hughes and Baumer (1995) identified a strong correlation between residential mobility in asthmatic children and the age of asthma onset ($p<0.0001$). Hughes and Baumer were puzzled since the confounding factors of socioeconomic status, local air pollution levels, and house conditions could not explain these differences. Similarly, Lebowitz *et al.,* (1990) examined a small sample of 48 children and found that residential mobility was moderately associated with increased risk of asthma incidence and remission.

***Urbanization (URB)* -** As stated earlier, the concept of social disorganization was originally founded on concern for excessive population density in urban areas. The premise being, that an exorbitant number of people residing in a given area eventually weaken the influence of social institutions. The outcome of urbanization was also thought to include a weakening of family bonds, and a declining significance of the local community (Kasarda & Janowitz, 1974).

Urban areas can influence rates of sentinel health events, through direct exposure and indirectly through the stress associated with lived environment. For example, Leaderer *et al.,* (2002) categorized geographic areas, and discovered that asthmatic children in urbanized areas were exposed to higher cockroach allergens, a key risk factor. An even more compelling finding comes from a large study of neighboring communities in Belgium (n=14,299). Here, Wieringa *et al.,* (2001) conducted a random sample of individuals between the ages of 5 and 75, asking for self-reported instances of asthma-related symptoms. Higher urbanization was related to all symptoms at a statistically significant level in adults ($p<0.05$), but not in children. The authors concluded that the high prevalence of asthma in populated, urban areas in adults was caused by, “a progressive effect of long-term exposure to the urban environment” (p. 422).

Investigators have examined urbanization gradients in relation to cancer rates. An ecological study of cancer rates in Illinois counties over a five-year period revealed consistent trends, with urbanization found to be associated with increased rates of colo-rectal, liver, lung, female breast, and cervix cancers (Howe *et al.*, 1993). Using a chi-square test, increasing levels of urbanization were significantly ($p<0.001$) related to all of these site-specific incidence rates. A similar analysis of New York State found a significant linear relationship between increasingly urbanization and cancers of the colon and lung in men, and cancers of the colon, liver and breast in women (Mahoney *et al.,* 1990). In fact, areas with the urbanization demonstrated a 12% excess of cancer deaths among males and a 6% excess among females. This study has been replicated with similar results. Here, Nasca and colleagues (1992) found that urbanization was related to incidence of colo-rectal and liver cancer in males, and lung and breast cancer in females.

Another study documented a significantly increasing linear relationship ($p<0.02$) between urbanization and the standardized incidence rates of lung cancer mortality in Taiwan (Yang & Hsieh, 1998). In fact, the ecological study of 355 Taiwan municipalities discovered that the standardized relative risk for lung cancer ranged from 1.06 in the least populated areas to 1.31 in the most populated.

Several studies provide positive though weaker support for the relationship between urbanization and sentinel health events. In Turin, Italy discovered that urbanization was associated with increased incidence of diabetes, with high rates of diabetes widespread in populated urban areas (Bruno *et al.,* 1993). Similar trends have also been identified in Ireland, at the post code level (Patterson *et al.,* 1996). However, this finding was immediately challenged by an ecological analysis of incidence data from a register of children with diabetes in the north of England (Stains *et al.,* 1997). Here, urbanization was not significantly related to incidence of diabetes.

Female Head of Household (FHE) - In our society, the family unit is viewed as an institution defined by a marriage. Family disruption, through single-parenthood, represents the decline of this mainstay of society, and is integral to the theory of social disorganization (Raudenbush & Sampson, 1999; Sampson & Groves, 1989). Sampson (1987) has argued that family disruption decreases informal social control at the community level. In fact, Sampson's research found that family disorganization has stronger effects on crime than economic status (Sampson, 1983). The assumption being that two-parent households provide increased instruction, supervision and protection. Here, the family unit is viewed as increasingly defunct, unable to maintain its traditional role in the education and socialization of the youth. Furthermore, a substantial body of research has demonstrated that married persons have better physical and mental health than their unmarried counterparts (Eng et al., 2005).

In terms of empirical research, Wickrama et al., (2001) used log-logistic survival models to identify an association between female head of household and hypertension in later life. This longitudinal model controlled for effects of behaviors, work status, and education level. Additionally, a large (n=4,093) study of U.S. children aged 6-17 years, found a significant positive relationship between the presence of female head of household and rates of asthma (p<0.001). The effect of household type was independent of biological predispositions, nutritional factors, and poverty/race indicators (Harik-Khan *et al.*, 1998).

Foreign Born Resident (FBO) - To early theorists, like Shaw and McKay (1942), the rapid influx of newly arrived immigrants into Chicago neighborhoods represented a destabilizing force that limited social control. While a great deal of research has linked racial/ethnic heterogeneity to delinquency and crime, recent research has explored the relationship between the foreign-born resident status and associated rates of sentinel health events. Goel *et al.*, (2003) argues that foreign birthplace may contribute to some disparities previously attributed to race or ethnicity. Here, the researchers examined National Health Interview Survey data and found that Hispanic and Asian-American respondents were significantly less likely to report screening, particularly for fecal occult blood testing (odds ratio = 0.72).

A similar study of six urban clinics discovered that children with foreign-born mothers were at more risk of exposure to environmental triggers for asthma, with subsequent higher school absences and emergency room visits due to complications (Wood *et al.*, 2002). These children with foreign-born parents exhibited more asthma symptoms and higher utilization of health care.

Crime (CRIME) - Crime represents a serious threat to neighborhood stability and viability (Bursik & Grasmick, 1993b). Areas that exhibit high levels of crime and disorder provide recognizable cues that social cohesion is weak. Within this context, even low level property crimes such as littering, vandalism and graffiti are signs of a potential to be harmed (Ross & Mirowsky, 2001; Skogan, 1990). The implication being that social cohesion has been replaced by individualism and alienation. High levels of perceived or actual crime can affect the health of residents directly through violent acts, substance abuse, and financial loss.

Crime also influences health indirectly, with fear of crime leading to stress, social isolation, and a loss of self-efficacy. Fear of crime has been associated with prolonged stimulation of the flight/fright response, which in turn, is linked to accelerated blood glucose levels, reduced resistance to infections and cancers (Glaser *et al.,* 1999; Herbert & Cohen, 1993), and the exacerbation of chronic health conditions (Fremont & Bird, 2000). Fear of crime also leads to decreased outdoor activity as residents avoid exposure to unsafe conditions (Ross, 1993).

To some, crime may not appear to be an issue related to sentinel health events; yet, crime reflects the quality of the social environment and can influence the health of residents. For example, older adults living in a crime-ridden area of San Francisco have stated that fear of crime was the most important *health* problem in their lives (Robert, 1999). Half way around the world, a fascinating study of diabetic Bangladeshis living in London discovered that a lack of walking due to crime and harassment, seriously hindered management of the disease (Greenhalgh *et al.,* 1998).

Recently, Wright *et al.,* (2004) administered a community violence survey to caretakers of children with asthma. After controlling for socioeconomic status, housing condition and negative life events, a gradient was established between exposure to violence and the morbidity conditions of symptomatic days ($p=0.0008$) and more nights that caretakers lost sleep ($p=0.02$). Wilson *et al.,* (2002), found that experiencing, witnessing, or hearing about violence in early adulthood was positively associated with elevated blood pressure ($r = 0.42$, $p < 0.0001$). There is also preliminary evidence that exposure to violence among adolescents places them at greater risk of developing hypertension in early adulthood.

Summary of Social Disorganization - In summary, the evaluation of empirical research relating to social disorganization and its influence on sentinel health events bring forth several points. First, and foremost, the vast majority of the studies focus exclusively on the notion of "place". Suitably, in the United States it is the condition of the neighborhood, census tract, and county that remains central to the research.

Second, to some extent, there appears to be a divide between the theory of social disorganization and its treatment in empirical research. The variables of urbanization, female head of household, and foreign born residents are essential to the theory of social disorganization, and there is some evidence that they influence specific health events. However, the variable of residential mobility is also essential to the theory, yet little empirical research has been conducted. The variable of crime also produced a nominal amount of studies but this was to be expected. Social disorganization has traditionally been applied to issues of crime, and as such, crime was the dependent variable. Advancement in knowledge can be gained through this research, which uses crime as an independent variable. In any case, the justification of residential mobility within the theory of social disorganization stands in stark contrast to its empirical applications.

Third, despite a lack of composite measure approaches to studying sentinel health events, we proposed that social disorganization, a latent exogenous variable measured by multiple indicators, is most suitable to measuring the influence of neighborhood or community, as these are multifaceted concepts.

Inadequacy of Health Care Resources

Another concept contained within the school of ecology is the degree to which health care resources are distributed within a society (Wan, 1995). Here, the premise being that differential access to basic health services produces different health outcomes. To a large extent, an equitable health care system, one that administers resources to all with fairness is the primary goal of public health. This can be seen in the Healthy People 2010 goals that are centered on the elimination of health disparities among dissimilar segments of the population (United States Department of Health and Human Services, 2006). It can also be seen in the perspectives of respected health service researchers like Lu Ann Aday, who argue that equity in the distribution of health care resources is an essential component of a functional medical system (see Aday *et al.,* 1984). In fact, the reliance on adequate health care resources to solve health disparities is so entrenched in public health, that it is best described as an assumption rather than a theoretical concept. In short, disparities in health events are viewed as a consequence of inequalities in access to health resources.

Avedis Donabedian, a pioneer of health service research, included the adequacy of health services into his renowned structure-process-outcome model. Donabedian's S-P-O model is still heralded as an effective model for evaluating the adequacy of a health care system. To Donabedian, structure refers to the setting in which health services are issued and is largely based on the issue of quantity. Quantity refers to "the number of physicians, nurses, and other providers as well as the quantity of monetary resources" (Aday *et al.,* 1998, p. 50). Here, an increase in the quantity of county resources logically makes the point of care more easily accessible and available. This approach suggests that the structure of a health care system that is most feasible and efficacious maximizes the potential for increasing accessibility to health care resources.

Process refers to the “set of activities that go on within and between practitioners and patients” (Donabedian, 1980, p. 79). Process variables are difficult to measure in ecological studies, and are not included in this research. Outcomes are defined as the “consequences to the health and welfare of individuals and society” (Donabedian, 1980, p. 80), and in this research outcomes are sentinel health events. To Donabedian, the structure-process-outcome model represented a simple way to document the adequacy of the health system, with an acceptable system confirming to the desires and expectations of the patient.

In similar fashion, the classic definition of adequate health care is centered on, “the degree of fit between the clients and the system” (Penchansky & Thomas, 1981, p. 128). When clients cannot receive medical care due to a lack of access, the system is described as inadequate. While the concept of accessible health care is complex and open to interpretation (Rohrer, 1999), basic measures of the *presence* of health care resources within a given area represent a mainstay within the school of ecology. Here, researchers have assessed the degree of access those in need have to available resources. Health service research indicates that different geographical areas exhibit great variation in resources availability.

The first documented study on variations in the distribution of health resources occurred in 1938, when Glover reported variation in tonsillectomy rates in England (Glover, 1938). Since then, a host of studies have reported variations in health resources within the United States (Lewis, 1969; Wennberg & Gittelsohn, 1973). Wennberg, in particular, conducted several important studies that found striking variations in the distribution of health care. Specifically, certain areas of Vermont displayed tonsillectomy rates up to 6 times higher than other areas. In

Boston, discharge rates for chronic obstructive pulmonary disease were 2.2 times higher than New Haven despite similar demographic constitutions (Wennberg, 1987). These results were replicated in the states of Maine, Iowa, and Massachusetts with very high variability found in surgical admissions for discretionary procedures such as knee operations and deep-vein thrombophlebitis (Wennberg, 1984). To Wennberg and his colleagues it became apparent that the distribution of health services was determined by physician practice style and the supply of personnel and hospital beds, not by actual patient need. It was argued that Wennberg's studies exposed inherent inadequacies at the system level, with the supply of health resources being issued in a capricious manner. These inequalities in turn produce variations in the utilizations of health resources. Note that this perspective argues that socioeconomic status is relatively unimportant in explaining inequalities in health events, that is, it is the health care system not the social structure or community effects that requires examination and amelioration.

To date, support for Wennberg's confidence in the health care system remains mixed. Some studies (Parchman & Culler, 1994; Shi *et al.,* 1999) state that a lack of health care resources undeniably leads to poor community health, while other studies (Barros, 1998) state that the level of health resources in the community is only marginally associated with health outcomes.

Researchers in the school of ecology who support the causal linkage between the distribution of health resources and consequential health outcomes refer to the positive changes that were produced by the introduction of Medicare and Medicaid programs of the 1960's. Increasing the quantity of health resources, particularly in impoverished areas, was associated with improvements in a variety of health indicators (Mechanic & Aiken, 1989). Equally, the Veterans Administration Hospital system decision to reduce health resources during the 1980's produced negative health consequences. Here, the elimination of a primary source of medical care was associated with reported poorer health, an effect that lasted one year longer in individuals who lost access to medical care compare to those who found other medical care (Fihn & Wicher, 1988). At the ecological level, Turnock (1997) provides evidence that the distribution of health resources has contributed to an increase in life expectancy in the United States from 47 to 75 years over the period from 1900 to the 1990s. Turnock argues that 67 percent of the reduction in stroke mortality, 49 percent of the reduction for cardiovascular mortality, and 28 percent of the reduction in motor vehicle crash mortality from 1960 to 1993 can be attributed to the accessibility of community and public health resources. This finding has since been supported by a number of contemporary researchers (Farmer *et al.,* 1991; Robst, 2001; Starfield, 1991).

Opposing research, finds that structural social changes and neighborhood effects determine health outcomes, and that the level of health resources contributes only in minor ways. For example, an examination of data from the nineteenth century found that the major declines in population mortality preceded the introduction of medical advancements, and were in fact more directly attributable to economics, nutrition, and sanitation (McKeown, 1976). The perspective that the medical system had little influence on changes in health has since been coined the "McKeown thesis" after its author. McKeown's thesis has been supported by continued failures of national health systems, in which improved access to medical care produced only negligible results. In Britain, for example, commentators assumed that free medical care offered by the National Health Service (NHS) would lead to large reductions in health inequalities, yet after five decades the NHS has largely failed to achieve this goal (see Bambas & Casas, 2003; also Blane *et al.,* 1996).

While it remains unclear the degree to which the inadequacy of health resources leads to poor health outcomes, the underlying assumption remains a key facet of the school of ecology and well worth investigating. Of particular interest is the concept of sentinel health events which was first developed to scrutinize geographic differences in health care resources (Wood *et al.,* 1999).

As stated above, a large body of health research takes place under the assumption that increasing the level of health care resources into a given area produces better health outcomes. Wan and Broida (1983, 1986) produced one of the earliest attempts at teasing out these determinants of community health. Wan and Broida used multiple indicators, including socio-economic status, demographic information, environmental data, and availability of health care resources to assess the health of communities in Quebec, Canada. Quebec was selected as the place of study because the province had introduced universal medical care insurance that aimed to, "reorient the health care system and make it more accessible more responsive, and more comprehensive to the public" (Wan & Broida, 1986, p. 43). Wan and Broida's results supported the notion that increased access to health resources was strongly correlated with community health outcomes. It was also discovered that universal health care appeared to increase resident's use of preventive medicine, and that increased availability of health care was financially viable with regard to distal outcomes. In fact, accessibility to medical services was essential to increasing first-contact care, physician-patient continuity, and disease management.

A synthesis of the literature indicates four components that are central indicators of the adequacy of health care resources. Here, the number of primary care physicians per capita, the number of registered nurses per capita, and the number of pharmacist per capita were selected because these groups constitute the largest categories of health care workers in the United States and exert a direct influence on health outcomes. Also, the number of hospital beds per capita was selected because it is represents a clear material good that is posited to influence health outcomes. These indicators will now be examined in more detail and with reference to empirical studies.

Lack of Primary Care Physicians (PHS) - Researchers in the school of ecology have attributed the inadequacy of the United States health care system as largely the result of a move away from primary health care. Primary care being viewed as the most appropriate method to influence health because it, "provides entry into the system for all new needs and problems, provides person-focused (not disease-orientated) care over time, provides care for all but very uncommon or unusual conditions, and coordinates or integrates care provided elsewhere or by others" (Starfield, 1998, p. 8). Primary care physicians are a valuable resource as they can identify conditions at an early stage, in some cases when the condition is merely a vague or ill-defined complaint. A primary care physician working in a community setting usually knows the patient, and the patient initiates the contact. This consistency and the development of patient trust that is implicit in primary care tend to favor the poor, minorities, and those living in urban or rural areas. Primary care physicians are typically exposed to greater variety of diagnoses, with subspecialists expected to treat patients with more rare conditions that require a more narrow focus. This means that an efficient health system reserves specialized care for a smaller group of patients, whom often exhibit a more differentiated stage of illness. Thus, a vast majority of patients in an efficient system are better served via primary care. In short, an emphasis on primary care is likely to lead to more appropriate care, better health outcomes, and lower total costs (Aday *et al.,* 1998).

To date, non-primary care specialists occupy less than 30% of the proportion of total physicians (United States Department of Health and Human Services, 2003), and simultaneously the U.S. health care system as a whole continues orientate itself towards increasing uses of technology, specialization, and a reliance on the primacy of the hospital. Yet, a health care system orientated towards specialization threatens the goals of equity. The expense of specialized care restricts the access of certain groups within society, and often absorbs the resources from basic services towards highly technical services. Empirical evidence continues to document that a higher proportion of general physicians in a community produces lower frequency in hospitalizations, mainly because primary care reduces the flow of patients into expensive, specialized environments (Moore, 1992).

Furthermore, there is substantial evidence that the rate of primary care doctors within a given area in inversely related with rates of mortality. At the state level, Shi (1992) documented that the level of primary care is significantly correlated with life expectancy and mortality rates. A finding that has been replicated at the city, zip code, census tract, and county levels (Farmer *et al.,* 1991; Kitagawa & Hauser, 1973; Laveist, 1990; Marston, 1968). International comparisons reveal that countries with health systems that possess a strong base of primary care are more likely to produce better health levels at lower costs (Starfield, 1994).

It is surprising that it was not until ten to fifteen years ago that epidemiologists at Johns Hopkins School of Public Health advanced research into the impact of primary care physicians on actual sentinel health events. These ecological studies documented that geographic areas with more family and general physicians per population had lower hospitalization rates for conditions that should be preventable with adequate primary care (Parchman & Culler, 1994). The researchers examined all 67 Pennsylvania counties and discovered a significant inverse relationship between the number of family and general practice physicians per population and the conditions of hypertension, pneumonia, asthma/bronchitis, and diabetes ($r=-0.53$, $p=0.005$).

More recently, Gaskin and Hoffman (2000) conducted a multi-level analysis that linked individual patient characteristics with county-level variables such as primary care physicians per capita. They found that an increased primary care physicians-population ratio was significantly related to decreased risk of hospitalization due to diabetes and hypertension ($p<0.05$). Similarly, Starfield *et al.,* (2005) examined all U.S. counties (n=3,075) over a four year period, and identified an inverse relationship between the primary care physician to population ratio and mortality due to cancer ($p<0.001$). Unfortunately, the researchers did not clarify the specific site of the neoplasms that were included in the analysis, though the findings did establish a clear link between an emphasis in primary care and reduced mortality. In effect, this study was a replication of state-level research (Shi, 1994), that identified primary care-population ratios as being significantly related to lower deaths due to hypertension ($t=-5.05$, $p<0.01$), and cancer ($t=-2.90$, $p<0.01$). Here, a higher density of primary care physicians and lower density of specialists being strongly associated with better health across numerous indicators, a relationship that remained after controlling for other factors like socioeconomic disadvantage.

Shi *et al.,* (1999) analyzed U.S. state data and found that primary care exhibited a direct influence on hypertensive disease ($p<0.1$). Specifically, the number of primary care providers per population exerted a significant inverse effect on stroke, after controlling for variables such as economic inequality and rates of tobacco smoking. In addition, one study of large metropolitan hospitals found that in men with complications from hypertension were far less likely to have a source of primary care compared to men whose hypertension was an incidental finding (Shea *et al.,* 1992). The presence or absence of primary care was significant even after adjusting for socioeconomic and insurance status. At the international level, Macinko and colleagues (2003) discovered that per capita primary care physicians levels were negatively associated with mortality from asthma, bronchitis, emphysema and pneumonia ($p<0.05$). This finding was consistent over an extended time period (1970-1998) in eighteen countries.

Ecological researchers will likely continue to emphasize a primary care approach to health. One recent study discovered that an increase of 1 primary care physician per 10,000 population was associated with a 2% increase in self reported health, even after controlling for other covariates (Shi & Starfield, 2000). Unfortunately, by grouping health events it is impossible to identify the role of primary care physicians in targeted sentinel health events. One criticism of this body of research on primary care and sentinel health events is that it has been restricted to a small group of Johns Hopkins academics. This examination of primary care to population ratios is clearly in need of further research from different perspectives, in order to further validate the findings.

Lacks of Registered Nurses (NRS) - In addition to primary care physicians, registered nurses are also considered a valuable health care resource, one which is invaluable to a functioning health care system. In fact, the impacts of nurse shortages in recent years highlight the essential role that registered nurses play in the delivery of public health. Rohrer states that a, "shortage of any particular type of essential personnel might be interpreted as indicating substandard quality, because it suggests that some kinds of care are being delivered by unqualified staff or are not being delivered at all" (Rohrer, 1999, p. 91).

The link between low nurse staffing levels and mortality has been well documented and is clearly a reflection of the adequacy of the health system. In one recent study, researchers documented a positive significant relationship between per capita nurse staffing and quality of health care (Buerhaus *et al.,* 2000). Specifically, after analyzing over 5 million discharges, a constant relationship remained between nurse staffing variables and five adverse patient outcomes. These outcomes being urinary tract infections, pneumonia, shock, upper gastrointestinal bleeding, and increased length of hospital stay in medical and major surgery patient. In fact, higher registered nurse staffing was associated with a 2 percent to 25 percent reduction in adverse outcomes (Buerhaus *et al.,* 2000).

As nursing shortages continue, researchers warn that low nurse-to-patient ratios will increase medical errors and poor patient outcomes. One study found that for every patient over four in a registered nurse workload, the risk of death increases by 7% for hospital patients (Aiken *et al.,* 2002). The factors associated with nurse shortages (i.e. job dissatisfaction, the increased age of the workforce and retiring baby boomers) are predicted to become even more problematic in years to come.

The relationship between the absence of registered nurses and the presence of sentinel health events is implicit in ecological research. Yet, a review of empirical studies that examine the influence of registered nurses on specific sentinel health events produced only two relevant studies. One study of a large hospital in Thailand, retrospectively examined patient data (n=2,531) and found that increasing nurse staffing levels is associated with decreasing patient mortality rates due to malignant neoplasms of all forms, hypertension, and pneumonia (Sasichay-Akkadechanunt *et al.,* 2003). This study controlled for a range for patient-level characteristics. The other study, examined 422 hospitals over a period of time and found that increased nurse staffing had a diminishing effect on reducing mortality from pneumonia (Mark *et al.,* 2004). This finding provided limited support ($p<0.1$) for the prevailing notion that improved registered nurse staffing leads to better health outcomes.

In contrast, a number of studies have found that after reaching an adequate level, the impact of nurse staffing on sentinel health events is negligible. For example, Wan and Shukla (1987) examined forty-five acute care community hospitals and discovered that nursing staff mix, nursing model, and nursing resources consumption were not significantly related to a number of outcomes. Furthermore, a seminal study by Al-Haider and Wan (1991) examined the organizational determinants of mortality in 239 hospitals. Here, the relationship between the number of nurses working in a hospital and rates of mortality was not statistically significant. Interestingly, the ratio of registered nurses to total nurse staffing was statistically significant, suggesting that factors like nursing education and training were far more important than basic staffing levels.

These few, important studies reflect a lack of empirical research on the relationship between registered nurse-population ratios and sentinel health events. This lack of research is troubling when one considers the wide variation in registered nurse-to-population ratios that currently exists within the United States, for example, in the year 2000 California had 554 registered nurses per 100,000 compared to Massachusetts with 1,194 registered nurses per 100,000 (Kovner & Jonas, 2002).

Lack of Pharmacists (PHM) - Pharmacists can also be considered a crucial health care "good" because they are in a unique position of documenting emerging health trends and problems. Pharmacists have increasingly become "primary care" providers as their traditional role of dispensing medications has been extended to include patient education and disease prevention. This occurs through patient counseling for risk management and the promotion of interventions that improve compliance (O'Loughlin *et al.,* 1999). The presence of pharmacists in a community can also produce positive effects like decreased medication errors (Bond *et al.,* 2001).

With regard to sentinel health events, one recent community-based endeavor revealed how pharmacists clustered by geography could improve asthma outcomes (McLean *et al.,* 2003). Here, six hundred thirty-one patients were randomized to two levels of care within a specific area of British Columbia. After one year, asthma patients receiving more access to pharmacist care displayed a decrease of 50% in symptom score, a decrease of 0.6 days per month in work and/or school absenteeism, and a 19% improvement in self-rated quality of life. Furthermore, emergency room visits and medical visits both decreased by 75% for this group, while little change was displayed in the control group. In the United States, one recent study (Knoell *et al.,* 1998) utilized a quasi-experimental design on adults with asthma. The researchers discovered that the experimental group with greater access to pharmacists reported receiving more information about asthma self-management (p=0.001), were more likely to monitor peak flow readings (p=0.004), and had increased satisfaction with care, and perceived higher quality of care. In short, improved access to pharmacists improved economic and clinical outcomes in these patients.

Access to pharmacists is also important in terms of patient-education and patient outcomes for neoplasms. In 1989, researchers in California received surveys from almost 1,200 active pharmacists (Lum *et al.,* 1989). Seventy percent of the pharmacists reported that several patients every month wanted advice about possible cancer signs and symptoms, particularly for colorectal sites. One quarter of these patients intended to purchase an over-the-counter medication to treat the symptoms, yet pharmacists felt that educational interventions pertaining to patient-referral patterns and cancer-related diagnoses were needed. In this study alone, the rate of interaction by pharmacists translates to more than 60,000 patients counseled about cancer symptoms per 1,000 pharmacists per year. This finding parallels qualitative reports that identify the increased pharmacist's role in smoking cessation programs among smokers with smoking-related lung cancer (Tadros *et al.,* 2000), and the effective pharmacotherapies of Bupropion and nicotine replacement therapy (Westmaas & Brandon, 2004).

Pharmacists have demonstrated significant impact on the management of hypertension, with evidence dating back to McKenney *et al.,*'s (1973) examination of pharmacist services. In this study, 25 study patients with essential hypertension were compared to the course followed by 25 control hypertensive patients not receiving these services. Those receiving pharmacist services exhibited significant improvement in knowledge of hypertension and its treatment ($p < 0.001$), in patient compliance with prescribed therapy ($p < 0.001$), and in outcomes related to reduction of blood pressure ($p < 0.001$).

Clinical pharmacists are also instrumental in providing diabetes education, medication counseling, monitoring, and insulin initiation. This was demonstrated in several primary care clinics in which patients with Type II diabetes were provided direct pharmacist interventions (Coast-Senior *et al.,* 1998). Patients displayed significant improvements in a range of glycemic control measures (all indicators under $p<0.05$). The pharmacist intervention also reduced the number of emergency room visits or hospitalizations related to diabetes. These findings have been replicated in high-risk indigent (Rothman *et al.,* 2003) and minority populations (Davidson *et al.,* 2000).

Another reason for the importance of pharmacists in primary care is their role in immunization campaigns. Recently, rural primary care clinics within the United States used pharmacists to provide vaccinations for influenza, which increased from 28% at baseline to 54% after program initiation (Van Amburgh *et al.,* 2001). In particular, the pharmacist-managed program increased the influenza immunization rate in high-risk patients. There is evidence that influenza immunization can be extended to include pharmacist-managed pneumonia vaccination, and that this approach can be initiated through mailing strategies (Mehta, 2002).

In summarizing the aforementioned studies, it is important to point out that most are qualitative in nature. As such, no ecological studies were located on the direct effect of the rate of pharmacists in an area and the distribution of sentinel health events. Clearly, more research is required to validate the important role of the pharmacist in treating and/or managing sentinel health events.

Hospital Beds (BED) - The number of hospital beds per capita is significantly and positively correlated with all major mortality measures (Shi, 1992). This finding dates back to the Wennberg studies in which physicians practicing in areas with fewer beds per capita were less apt to admit patients with minor acute illnesses such as bronchitis, simple pneumonia, or gastroenteritis, and with chronic disease such as diabetes (see Wennberg *et al.,* 1987).

Fundamentally, the availability of hospital beds is thought to determine physician practices, with fewer beds per capita more likely to lead to inadequate medical care. This becomes important when one considers that the number of hospital beds per capita is generally lower in the United States than many other countries. For example, in 1994 the United States had 4.7 beds per 1,000 people, which was exceeded by the United Kingdom (5.9), Canada (6.3), Germany (10.3), Netherlands (11.4), and Sweden (11.9) (Schieber *et al.,* 1994). Furthermore, in the United States it has been argued that the continued decline in hospital beds per capita has contributed to poor system performance.

Few studies examined the relationship between the presence of hospital beds in a county and rates of sentinel health events. One large-scale study of Medicare beneficiaries over the age of 65 found no relationship between hospital beds per capita and preventable hospitalizations due to Type 2 diabetes (Niefeld *et al.,* 2003). However, this finding was countered by a national sample that identified fewer hospital beds per capita in areas that were predominately Black or Hispanic (Hargraves & Hadley, 2003). These areas also featured much higher rates of diabetes. On the other hand, Morris and Munasinghe (1994) examined Medicare data over a 6-year period for the sentinel health events of pneumonia, influenza, and asthma.. They found that the number of hospital beds per capita was positively associated with hospital admissions ($r=0.142$, $p<0.0001$). An opposing perspective suggests that a high bed to population ratio is a reflection of the need for care within a geographic area. As shown, although theoretically the number of hospital beds is thought to correlate with sentinel health events, the empirical evidence remains unclear and often contradictory.

Testable Hypotheses

For this research four hypotheses were developed. They include:

1. The variability of sentinel health events is positively associated with socioeconomic disadvantage, social disorganization, and a lack of health care resources, irrespective of time period.
   1. a. Relatively speaking socioeconomic disadvantage will have a greater impact on sentinel health events than social disorganization and a lack of health care resources.
2. The exogenous variables of socioeconomic disadvantage, social disorganization, and a lack of health care resources are expected to remain relatively constant over time, at the county level.
3. Any change in one of the exogenous constructs (socioeconomic disadvantage, social disorganization, or a lack of health care resources) is positively associated with change in the rates of sentinel health events, holding the non-change variables constant.

Summary

Socio-economic disadvantage, social disorganization, and the inadequacy of health care resources are ecological variables that have been associated with sentinel health events. The main and interactive effects of these variables require further study.

Equity and Public Health

The policy implication of this research centers on the allocation of health care resources. If the most significant features of the model relate to deficits in the socioeconomic environment, social organization, or the availability of resources, then the logical implication is to financially support preventative programs relevant to the area of deficiency. Furthermore, the identification of specific indicators within the ecological constructs will enable researchers to guide policies that are efficient and promote equity. We propose that while health interventions should continue to operate at the individual level, they should also attempt to remedy macro-level issues like access to resources, the constitution of the community, and the promotion of change. A broader rationale for this study is that the policy implications inherent to social egalitarianism are akin to core public health values.

Equity is defined as, "justice according to natural law or right; specifically, freedom from bias or favoritism" (Bambas & Casas, 2003, p. 323). We concur with Woodward and Kawachi's (2000) proposition that health inequalities are unethical, avoidable, and affect all members of the society. Woodward and Kawachi argue that interventions designed to reduce inequalities can be cost-effective and successful. This argument gained academic support through Wan and Broida's (1983, 1986) early work in the assessment of community health in Quebec, Canada. Wan and Broida discovered that the introduction of a universal health care system lead to increased utilization of preventive medicine. Over an extended period of time, it was argued the presence of a health policy directed at reducing inequality and providing universal health care, was financially viable. In fact, countries governed by social democratic parties (Sweden, Norway, Denmark, and Austria), have continued to foster environments whereby equity did not negatively influence efficiency.

Political philosopher, John Rawls, provides a remarkable justification for the necessity of equity in public health. Under a Rawlsian framework, a society can only be considered ‘just’ when social and economic inequalities are reduced, and basic liberties are fortified (Rawls, 1971). To Rawls, social goods should be distributed equally, unless an unequal distribution of these goods is to the advantage of the least favored. In other words, inequality is only acceptable when it benefits the most disadvantaged individuals in society (Smith, 2006). This represents an interesting variation of the social contract, as free and equal citizens of ‘most need’ now have improved dealings with institutions, and those with “greater bargaining advantages” are restricted to some extent (Rawls, 1993, p. 23). The economist, Amartya Sen (1992), states that a just society ensures the development and the capacities of all its members. In concurrence with Rawls and Sen, the overlying argument set forth in this research is that health policy must include ecological variables, constituting the foundations of the social structure.

CHAPTER THREE: RESEARCH DESIGN

Study Design

This study consists of two study designs, a cross-sectional model (2000) and a longitudinal model (1990 – 2000). Both research models utilize archival, secondary data. While cross-sectional studies are commonplace in ecological research, the addition of a longitudinal design is atypical and is intended to examine the change in social conditions and health outcomes over time.

The study is retrospective, and utilizes data from the time points of 1990 and 2000. These two time points were selected primarily because the United States Census Bureau collects extensive data every decade. These ten-year data collection points contain a richer description of ecological factors when compare to the change in social conditions and sentinel health events over the source of a decade. These counties will be identified through a Federal Information Processing Standards (FIPS) five digit-code. Here, the first two-digits identify the state and the following three-digits identify the county (Ibrahim, 1997).

Research Population

This study utilizes data collected at the county level. Counties remain the predominant source of policy development and local decision making by public health and social services agencies (Rohrer, 1999); that is, it is within the county that social policies are formulated and implemented. Ecological studies of larger spatial units, such as states, frequently contain errors associated with unmeasured variation (i.e., differences within the state are ignored). On the other hand, studies with small units of aggregation such as zip code, tend to increase the problem of "border crossing" (i.e., individuals seeking medical services in areas adjacent to their geographical residence). Therefore, when considering different levels of spatial aggregation one is faced with a tradeoff of within variation and between variation (Fortney *et al.*, 2000). Furthermore, this research minimizes the issue of "border crossing" by excluding all counties with a population equal to or less than 10,000.

The initial acquisition of Healthcare Cost and Utilization Project (HCUP) datasets included a concerted and systematic attempt to obtain data from a potential thirty-eight state agencies. All thirty-eight state agencies were contacted for information on the availability and pricing of county level inpatient data. Twenty nine states were excluded from the study for the following reasons; fifteen of these states did not have data dating back to the year 1990, five lacked the requisite variables (i.e. zip code rather than county codes), and nine states were excluded from the study due to their unfeasible pricing structure, which ranged from $520 to $840 per year of data.

Therefore, we obtained county-level data from the remaining nine states: California (58), Florida (67), Maine (16), Maryland (24), Nevada (17), New Jersey (21), South Carolina (46), Washington (39), and West Virginia (55). This represented a total of 343 counties. Thirty four counties were removed due to their small population size, that is, county population was less than 10,000. The resulting sample includes 309 counties in the same nine states: California (54), Florida (63), Maine (16), Maryland (24), Nevada (9), New Jersey (21), South Carolina (45), Washington (32), and West Virginia (45). Economic, racial and ethnic characteristics are summarized in the following table: Table 4: Comparison of sample counties to United States counties.

Table 4: Comparison of Sample Counties to United States Counties

Characteristic	Study Counties (n=309)	Total Counties (n=3,141)	Statistical Results
Economic Characteristics **			
Median Household Income	$43,189	$41,347	p = .519 (not statistically significant)
Racial Characteristics **			
White	76.7 %	78.5 %	p = .620 (not statistically significant)
Black	11.8 %	10.8 %	p = .767 (not statistically significant)
Asian	3.8 %	2.9 %	p = .363 (not statistically significant)
Ethnic Characteristics **			
Hispanic	10.9 %	7.8 %	p = .325 (not statistically significant)

*Note: Median Household Income is in 1999 dollars.
**Economic, racial and ethnic characteristics were tested via a one-sample t-test.

The economic variable, household income was tested using a one-sample t-test. The median household income (in 1999 dollars) for the study counties was $43,189, while the median household income (in 1999 dollars) for all counties was slightly lower at $41,347. The difference was not statistically significant at the .05 level (t = .674, df = 308).

Racial and ethic values were also examined using a one-sample t-test. For the counties in the sample, the values of the mean for White, Black, and Asian percentages are 76.7%, 11.8%, and 3.8%, respectively. The national mean for White, Black, and Asian percentages are 78.5%, 10.8%, and 2.9%, respectively. The difference between the sample mean and the national mean was not statistically significant at the .05 level for any value (White (t = -.525, df = 308), Black (t = .306, df = 308), Asian (t = .964, df = 308)). With regard to Hispanic ethnic status, the value of the mean for counties in the sample is 10.9%, whereas the national mean is 7.8%. Yet, this difference the sample mean and the national mean was not statistically significant at the .05 level (t = 1.05, df = 308).

With regard to the selected economic, racial, and ethnic characteristics there are no statistically significance differences between the counties in the sample and the total U.S. counties. Thus, the study counties are comparable to the broader counties within the United States.

Data Sources

The data sources in this research include: inpatient data from various State Health Departments and Agencies (HCUP datasets), census data from the United States Census Bureau, the Area Resource File (ARF), and the Uniform Crime Report (UCR). All of these sources provide data that is secondary and deidentified in nature. While the limitations of secondary data are acknowledged, it has been argued that "the uses of secondary data sources are an efficient and economic means by which to analyze data on outcome measures" (Best, 1999, p. 175).

State Health Department and Agency Data: Health indicators collected from various State Health Departments or their associated agencies measure the endogenous variable, sentinel health events. This data include all 309 counties in the following nine states; California (CA), Florida (FL), Maine (ME), Maryland (MD), Nevada (NV), New Jersey (NJ), South Carolina (SC), Washington (WA), and West Virginia (WV). A list of the participating state agencies are provided in detail in Appendix D: Participating State Health Departments and Agencies.

Each study state provided sentinel health data to the Agency for Healthcare Research and Quality (AHRQ), a component of the U.S. Department of Health and Human Services (HHS). The dataset is titled the Healthcare Cost and Utilization Project (HCUP) and is designed to identify, track, and evaluate national trends in health care utilization, access, and outcomes.

HCUP data is processed in two forms, the Nationwide Inpatient Sample (NIS) and the State Inpatient Database (SID). The State Inpatient Database (SID) is more appropriate for this study as it contains information on the patient “county of residence”. All data obtained from state health departments and agencies were in the detailed format of the State Inpatient Database. Although this data set provides individual patients specific information, all data elements that could in any way identify patients are excluded from the data set prior to analysis. All individual-level information is aggregated to the patients’ county of residence. The use of this data is the most efficient approach to estimating the prevalence of health conditions in the United States as well as to examine a variety of health policy issues (see Best, 1999).

The data were collected in a standardized manner using the International Classification of Disease (ICD-9) coding procedures. The source of the data and the actual databases obtained from the state health departments and agencies were reviewed by an expert in health care and medical coding. This expert, Mr. Tom Falen, a faculty member of the Department of Health Professions at the University of Central Florida has over 30 years of medical coding experience. Mr. Falen confirmed that the data and coding system obtained from the different state departments and agencies are standardized and reliable.

Census Data: Data for several endogenous variables were obtained from the decennial census, years 1990 and 2000. During each decennial census, the Census Bureau collects data from every household in the U.S. and its territories. During this massive undertaking the Census Bureau collects a wide range of data on population characteristics, for example, age, sex, migration status, race, ethnicity, household type, tenure of house being owned or rented, vacancies of houses, and living arrangements. Census data are available for many levels of geography, including states, counties, cities and towns, ZIP codes, census tracts and blocks.

Area Resource File (ARF): Other data collected for the exogenous variables are from the Area Resource File (ARF). The ARF is a large, county-level database that combines information from over 75 primary data sources, including the decennial census, the American Medical Association's Physician Master File, American Nurse's Association Inventory, American Hospital Association's County-Level Hospital File, and the National Center for Health Statistics' mortality and natality data files. The Area Resource File is extensive and includes almost 7,000 variables compiled by the Health Resources Service Administration's Bureau of Health Professions. All data within the Area Resource File are collected at the county level or aggregated up to the county level. As Best (1999) states, "the Area Resource File provides one of the greatest national sources of variables to be analyzed on a county level" (p. 179). Best adds that all variables included in the ARF database are checked for reliability and validity.

Uniform Crime Report (UCR): The remaining data for the exogenous variables consist of crime statistics from the Uniform Crime Report (UCR). The Uniform Crime Report data are collected and compiled by the Federal Bureau of Investigations on a yearly basis and it remains the oldest and best-known source of crime statistics. The crime database consists of 8 crimes deemed serious in terms of nature and/or volume (Federal Bureau of Investigations, 2005). These crimes include both violent crime and property crime. Violent crimes include murder, rape, robbery, and aggravated assault. Property crime includes burglaries, larcenies, motor vehicle theft and arson. All 8 crimes are deemed 'index crime" because their accumulation provides a standardized crime rate within a given geographic area. A complete list of these index crimes, with accompanying definitions is provided in Appendix E: Definitions of Crime Used by the Uniform Crime Reports (UCR).

Measurement of Variables

This research employs a quantitative strategy in its analysis. The large amount of data require complex statistical methods at the county level, therefore techniques aimed at identifying variations in small areas is most appropriate. As stated above, this research contains existent and generally accepted data sources that increase the validity and reliability of the data. Also stated above, the research strategy consists of both a cross-sectional and longitudinal design. As such, variables in the cross-sectional design consist of data collected for the single year, 2000. Variables in the longitudinal design include a measurement of the change (delta) that occurred between the years 1990 and 2000. The strategy for measuring these variables will now be reviewed:

Sentinel Health Events: All sentinel health events within this research are classified by ICD-9 primary diagnosis codes. ICD-9 codes are a commonly accepted measure in health care, as they provide a comprehensive picture of risk factors and patients' clinical status (Daley *et al.*, 2003). The International Classification of Disease (ICD-9) codes are published by the United States National Center for Health Statistics. Every disease, or every group of related diseases, is described with its diagnosis and given a unique code, up to five letters long. Diagnostic detail is facilitated by codes with three, four, and five digits, as each ICD-9 code represents increasing levels of specificity. Only ICD-9 codes that are highly preventable or treatable were selected from the data. This narrows sentinel health events to conditions that are theoretically preventable or treatable through adequate service delivery, that is, conditions that are avoidable given our present knowledge, professional skills, and technology. A detailed account of each sentinel health event with estimates of social costs to the community is provided in Appendix B: Prevalence and Significance of Sentinel Health Events.

To be included, sentinel health events must justify two basic requirements, “first, a consensus must exist about what, in a given place and time, are considered to be preventable diseases, disabilities, and deaths; second, reliable and detailed data on deaths and diseases must be available” (Carr *et al.,* 1989, p. 705). This research is based on the consensus initially developed by Rutstein *et al.,* (1976), and later modified by the European Community working group (Niti & Ng, 2001).

We replicate the socio-medical indicators used in these seminal articles, with some amendments. First, since Rutstein et al.’s classic study in 1976, health data coding has moved from an ICD-8 format to an ICD-9 format. Fortunately, the conditions under study contain the same ICD numbering system for both the years 1990 and 2000, which enhances validity to the original measure. Second, discrepancies surrounding the operationalization of sentinel health events were reduced via confirmatory factor analysis (mentioned in the previous chapter). Third, we combine measures of morbidity (discharge data) as well as measures of mortality (death certification data) into each variable. The ensuing variables that displayed communality are now presented in the following table: Table 5: Operationalization of Sentinel Health Events.

Table 5: Operationalization of Sentinel Health Events

Label	Condition	ICD-9 Codes	Formula
AST	Asthma, Bronchitis, and Emphysema	490-493	Cases / total county population
CAN	Malignant Neoplasms of the (a + b + c)		
	a. Colo, rectum, and recto-sigmoid junction	153-154	Cases / total county population
	b. Liver and intra-hepatic billary duct	155	Cases / total county population
	c. Trachea, bronchus, lung	162	Cases / total county population
DIA	Diabetes Mellitus	250	Cases / total county population
FLU	Influenza and Pneumonia	480-487	Cases / total county population
HYP	Hypertensive Diseases	401-405	Cases / total county population

Socio Economic Disadvantage: In this research, the latent concept of socio-economic disadvantage is explored in a given geographic region, U.S. counties. As such, a composite measure is formed that includes the indicators of income (poverty), education, and occupation. Stockwell (1963) first validated this tripartite approach by studying socioeconomic disadvantage at the census tract level to examine mortality rates in Connecticut and Rhode Island. Further validation has been provided by Abramson *et al.,* (1982) who tested nine measures of social class on a variety of health outcomes. Abramson and his colleagues concluded that income, education, and occupation, represented the most efficacious measure of social class.

In conducting ecological research, the use of a single variable to measure socioeconomic disadvantage is inadequate, often due to confounding control variables. For example, Kessler (1982) discovered that income was the strongest predictor of psychological distress for men, while education was most important to women. Green (1970) found that education was the most important predictor of nine crucial health behaviors in whites, while income was of primary significance in non-whites. No research to date has examined the relative influence of income, education and occupation on sentinel health events; therefore this study represents a potential increase in knowledge.

To date, a substantial body of research has demonstrated a strong positive relationship between socio-economic disadvantage and excess morbidity and mortality, at the census block group (Krieger *et al.,* 1997), census track (Mackillop *et al.,* 2000; O'Campo *et al.,* 1997), zip code (Franks *et al.,* 2003) , county (Morris & Munasinghe, 1994; Singh *et al.,* 2004), and state levels (Diez Roux *et al.,* 2000). The predominant socioeconomic variables within these studies are income, education, and occupation (INC, EDU, OCC). These variables contain discrete characteristics; that is, income levels are associated with access to medical care, diet, and housing quality, education is associated with lifestyle behaviors and problem solving capacity, and occupation status has been linked with workplace environment, exposure to toxins, and personal levels of control (see Liberatos *et al.,* 1988). Stated differently, income, education, and occupation represent distinct facets of the concept, socioeconomic disadvantage.

Obviously, these variables are also interrelated, for example, education is a prerequisite for occupation and income is the resultant compensation bestowed upon the individual. Jencks *et al.,* (1972) found the following correlations between these indicators: EDU-OCC (r=0.61), INC-OCC (r=0.40), and INC-EDU (r=0.33). Such covariance has been addressed by academic researchers (Abramson *et al.,* 1982; Liberatos *et al.,* 1988), with the variables of income, education, and occupation now constituting an accepted tripartite approach to measuring social class.. Socioeconomic disadvantage is, after all, a multidimensional concept, one that requires a multi-item measurement strategy.

Income (INC): Income is defined as the “flow of money from wages, salary, interest earned on savings, and various monetary windfalls like at tax rebate” (Bundrys, 2003, p. 163). Income is the most sensitive indicator of socio economic disadvantage, due in part to unexpected changes in life circumstances. As there is no consensus or standardization in quantifying income disadvantage, the selection of the measure must be dictated by the underlying theory. In this case, we are researching deprivation of income at the county level, i.e. the absolute deprivation hypothesis.

First, this implies that the income measure should be conducted at a broad level, such as the census household level. Research (Howard *et al.,* 1997; Mackillop *et al.,* 2000; van Rossum *et al.,* 2000) supports the validity of census data in measuring income within a given geographical area. Second, the latent concept of socio economic advantage includes consideration of an established poverty standard. While income is a reflection of the financial stability of an individual or household, poverty thresholds reflect the presence of economic disparity within a county. Fiscella and Franks (1997) discovered that poverty, rather than measures of inequality, determines mortality at the community level. Poverty being so pervasive that if it was listed as a cause of death it would be the third leading cause of death in black males (Hahn *et al.,* 1996).

Here, the poverty line is described as the point at which societal withdrawal escalates disproportionately to falling resources (Townsend, 1979). International organizations (such as the United Nations) and current academic researchers favor the operationalization of a poverty line in which the percentage of families gaining less than 50% of a nation's median income are documented (Raphael, 2003; United Nations Development Program, 2001). Similarly, the United States Census Bureau defines poverty as persons or families whose household income is below the threshold to cover basic needs, defined in relation to food. The poverty threshold is calculated based on the size and age composition of the family, and its relationship to household income. For example in 1990, the national median household income was $30,056 making the poverty threshold for a family of four - $16,700 (Coreil *et al.,* 2001). Current poverty thresholds can be located on the United States Census website (see United States Census Bureau, 2006).

These poverty thresholds are increased each year by the same percentage as the annual average Consumer Price Index (CPI); however, they are not adjusted by geographic variation thus the same thresholds apply to all 50 states and Washington, DC. The official poverty definition uses money income before taxes and does not include capital gains or non-cash benefits (such as public housing, Medicaid, and food stamps).

We follow the census poverty measure; "number of persons below poverty level / total number of persons in the county over the age 15 * 100". Here, the denominator, "number of persons in the county over the age 15", while the numerator, "number of persons below poverty level" refers to the number of people with income below the poverty level as a subset of those people for whom poverty status is determined. This measure has been validated through personal communication with a poverty expert employed at the United States Census Bureau (Bishaw, 2006).

Education (EDU): Education, whether defined as the number of years spent in formal education or the level of qualifications achieved, tends to be associated with an inverse gradient in mortality (Pappas *et al.,* 1993). Education reflects a direct measure of the material and social resources available in the parental home. It is also an indirect measure, with the higher educated being more receptive towards public health recommendations. Stated differently, higher levels of education are correlated with behavioral or lifestyle characteristics (Zurayk *et al.,* 1987), as well as the adoption of new medications and procedures (Mark & Kranzler, 2003). Education level determines earning potential over a long period of time. In contrast to other measures of socioeconomic disadvantage, education remains relatively stable over the adult lifespan (Krieger *et al.,* 1997). As a result of this measurement stability, education level can be valuable in cases of status inconsistency, for example, persons with a high degree of education but low-income status. This is because one would expect education to contain a minimal amount of variance over time. Rates of refusal for education questions on the census are very low; reinforcing the reliability of the measure.

The decennial census identifies low educational level in a geographic area as the "percentage of persons aged ≥ 25 years with less than a 12^{th}-grade education" (Census variable= P57). Likewise, this research measures education as the "number of persons aged ≥ 25 years with less than a 12^{th}-grade education / number of aged ≥ 25 years". This variable cut-off point was selected because of its real world meaning, that is, 12^{th} grade signifies a high school diploma.

Occupation (OCC): Traditionally, occupation has been the most frequently measured and most historic indicator of social class. The collection of occupation data began in the 1851 British Census, and remains the foundation of the British Registrar's General's measure of social class. In the United States, the Bureau of the Census groups over 23,000 job titles into a list of thirteen discrete occupational types. This system known as the Edwards social-economic grouping of occupation is still the most widely used measure of occupational ranking, one that is favored by epidemiologists (Miller, 1983). Here, census data collectors ask several questions regarding the type of business or industry in which the individual is employed. This technique correlates with academic research that ranks occupation according to its associated financial rewards and perceived status.

This study utilizes an operationalization of occupation, that was initially based on Wright's class typology, but further developed by Krieger (1997). For the 1990 decennial census, Krieger categorized the following thirteen occupational groups:

> (a) administrative support, including clerical (b) sales workers, (c) service workers - private household, (d) service workers - except protective and household, (e) mechanics and repair, (f) machine operators, assemblers, inspectors, (g) transportation and material moving operatives, and (h) handlers, equipment cleaners, helpers, laborers, (i) executives, administrators, and managers, (j) professional specialists, (k) technicians and related support, (l) farm operators and managers, and (m) protective service workers.

Krieger defined "working class" as persons within the first eight occupational groups, that is, groups "a" through "h". These eight occupational groups consist predominately of working class, primarily because most employees in these groups labor in non-supervisory roles. Conversely, occupations listed in the last five groups (i.e. groups "i" through "m") largely consist of employers, supervisors, and the self-employed.

While misclassifications are inevitable when categorizing a wide array of job-functions, several studies have documented the validity of this measure (Krieger, 1991, 1992). The reader should note that temporal changes occurred prior to the 2000 decennial census that produced new categories of occupations (when compared to the 1990 census). As such, Dr. Nancy Krieger, professor at Harvard University's Department of Public Health developed analogous groupings that are based on the same theoretical considerations (i.e., occupational categories that predominately contain non-supervisory employees). These variable groupings have yet to be published but were supplied with permission for use in this research. In brief, the measure of occupation consists of the numerator: employed civilian population age 16 and over in working class occupations, and the denominator: total universe of employed civilian population 16 years and over.

Composite measure: Measures of socioeconomic disadvantage contain inherent strengths and weaknesses. Income is clearly associated with access to social goods, such as medical care and the acquisition of knowledge that may inhibit disease. Education as a single indicator is the most widely used measure of socioeconomic disadvantage (Kaplan & Keil, 1993), primarily due to low non-response rates and its relatively stable nature (i.e. education tends not to fluctuate in adulthood). In our society, occupation is often viewed as an important status characteristic, with rank occupations used to identify prestige. While all important in their own right, these measures also contain inherent weaknesses when used as single variables.

Income measures suffer from high non-response rates (Turrell, 2000), and exclude inherited wealth and possession of assets like real estate or stocks. Education neglects cultural differences in valuation of schooling and the increasingly prevalence of advanced degrees (Galobardes & Morabia, 2003). Current occupation status fails to adequately describe the occupational history of an individual and relies on researcher discretion in grouping jobs. Due to the inherent weaknesses of utilizing a single socioeconomic measure, this research will employ a tripartite composite measure that includes income (at the county level this will be poverty), education and occupation. The rationale for using a composite measure of socioeconomic status is supported by a range of academic researchers (Colhoun *et al.,* 1998; Liberatos *et al.,* 1988; Osborn & Morris, 1979).

Based on the previous discussion, the operationalization of socioeconomic disadvantage is presented in Table 6: Operationalization of Socioeconomic Disadvantage Variables.

Table 6: Operationalization of Socioeconomic Disadvantage Variables

Label	Indicator	Defined	1990 Census	2000 Census
INC	Income	% persons below the federally defined poverty line	ST-3: Table DP-4 DP4.C46 / DP4.C45	ST-3: Table P-89 P089002 / P089001
EDU	Education	% persons 25+ no high school diploma	STF-3: DP-2 100% - DP2.C17	STF-3: DP-2 100% - DP2.C28
OCC	Occupation	% persons employed in working class occupations	STF-3: Table 78 *See 1990 formula	STF-3: Table 50 *See 2000 formula

*Occupation is operationalized as % of persons employed in the civilian work force aged 16 years or older within the following 8 of 13 census-based occupational groups: administrative support, sales, private household service; other service (except protective); precision production, craft, and repair; machine operators, assemblers, and inspectors; transportation and material moving; handlers, equipment cleaners, and laborers.

<u>Census 1990 formula</u>: ∑ (persons employed in working class census occupational categories) ÷ ∑ (all census occupational categories).
(P0780004 + P0780005 + P0780006 + P0780008 + P0780010 + P0780011 + P0780012 + P0780013) ÷ (P0780001 + … + P0780013)

<u>Census 2000 formula</u>: ∑ (persons employed in working class census occupational categories) ÷ ∑ (all census occupational categories).
(P050024 + P050027 + P050028 + P050029 + P050030 + P050031 + P050034 + P050035 + P050041 + P050071 + P050074 + P050075 + P050076 + P050077 + P050078 + P050081 + P050082 + P050088) ÷ (P050001)

Social Disorganization: Multi-dimensional measures of social disorganization that have been used in the past include the Townsend deprivation index (Bachman *et al.,* 2003; Caddick *et al.,* 1994; Duran-Tauleria & Rona, 1999), Carstairs Index (Thomson et al.), the Australian index of relative socioeconomic disadvantage (IRSD) (Bytzer *et al.,* 2001) and also independent researcher construction of a composite deprivation index (Connolly *et al.,* 2000). These measures tend to include considerations of the social context, for example, the inclusion of crime, urbanization, and divorce indicators, into a measure that also includes social economic disadvantage variables. We contend that these contextual factors are so significant that they necessitate the development of a separate latent construct.

Therefore, our measure of social disorganization includes only prominent variables selected from ecological studies that describe the contextual environment of the community. As such, socio-economic factors are not included in this composite measure. The indicators included in this research are: residential mobility, urbanization, female head of household, foreign born residents, and crime.

Residential Mobility (MOB): Stable neighborhoods tend to have a high percentage of persons who have lived in the same residence for the past five years (Ross *et al.,* 2000). As such, residential mobility is tested as the proportion of persons who lived in the same house for the past 5 years. This measure has been validated in several studies to date (Cubbin *et al.,* 2000; Siegel *et al.,* 1997).

Urbanization (URB): Urbanization is normally measured by "the percentage of people living in an urban area" (Howe *et al.,* 1993; Leaderer *et al.,* 2002; Siegel *et al.,* 1997). We follow this accepted measurement approach to measuring urbanization.

Female Head of Household (FHE): The Census Bureau records the reported "female house-holder, no husband present" and divides this number by the total number of identified households. This accepted measure is used in this research.

Foreign Born Resident (FBO): The decennial census also documents the number of residents who were born in a foreign country. This number is then divided by the total county population for purposes of this study.

Crime (CRM): The annual crime rate will be obtained from the Uniform Crime Report (UCR). This public data details the index crime rate of every United States County, and includes an aggregate measure of murder, rape, robbery, aggravated assault, burglaries, larcenies, motor vehicle theft and arson. The UCR sourcebook is accessed via electronic format (see University of Virginia Geospatial and Statistical Data Center, 2006).

Provided is a summary of the operationalization of social disorganization variables with reference to their location within the Decennial Census and Uniform Crime Report.

Table 7: Operationalization of Social Disorganization Variables

Label	Indicator	Defined	1990 Census	2000 Census
MOB	Residential Mobility	% persons different residence in previous five years	STF-3: Table DP-2 DP2.C21/DP2.C19	STF-3: Table DP-2 DP2.C74/DP2.C70
URB	Urbanization	% persons living in urban area	STF-1: TM-P004	STF-1: TM-P003
FHE	Female Head of Household	% households with female head, no husband present	STF-1: GCT-Pb	STF-2: GCT-P7
FBO	Foreign Born	% foreign born residents	STF-3: Table DP-2 DP2.C46/DP2.C43	STF-3: Table DP-2 DP2.C98/DP2.C86
CRM	Crime	UCR crime rate	UCR data	UCR data

Inadequacy of Health Care Resources: In keeping with the materialist approach to ecological research, this study focuses exclusively on the *presence* of health care resources within a given county. This research follows Dever's premise that,

> "Availability refers to the relationship of the volume and types of existing resources to what are required to fill the population's health needs – in other words, the adequacy of the supply of resources. A resource is available if it exists or is obtainable, without consideration of how easy of difficult it is to use. Availability of services obviously influences their utilization. A service can be used only if it is available" (Dever, 1984, p. 214).

As such, pathways to care that are frequently measured at the individual level such as the negotiation of health care guardians, transportation costs and distance, and personal perceptions of care are excluded from this analysis. Instead, availability is measured in terms of the volume of resources relative to the population served. This includes personnel/population ratios and population/bed ratios, an approach that is commonly accepted when analyzing community health (Rohrer, 1999). This research will examine inadequacy within a health system. Measures will include the distribution of primary care physicians, registered nurses, pharmacists, and hospital beds within a given county.

The measurement of a lack of health care resources is based on literature from the school of ecology that specifies variables that are essential to community health. As the concept discussed is the ***in***adequacy of resources, that is, a statement of paucity, these measures will be reversed to reflect person/personnel ratios and person/bed ratios. That is to say that higher numbers will reflect more inadequacy (or more competition for scarce resources). For example, the measurement of hospital beds reads “people per hospital bed”, in order that a larger output represents increased competition for scarce medical resources.

Lack of Primary Care Physicians: In the United States, primary care includes physicians in the following fields: family and general practice, general internal medicine, and general pediatrics. Primary care physicians are identified via the American Medical Association Physicians Master File, located within the Area Resource File (ARF). The measure is a primary care physician to population ratio, defined as primary care physicians who were in active office-based patient care per county population (Shi & Starfield, 2000, p. 544). This measure is reversed to reflect an absence of primary care physicians. As such, the measure consists of the population to primary care physician ratio. This approach has been used and validated by several academic studies (Shi, 1992; Starfield, 1998).

Lack of Registered Nurses: The number of registered nurses within a given county will also be obtained from the Area Resource File (ARF). This measure is the total county population divided by the sum of all full time equivalent (FTE) hospital nurses in the county. The restriction to only hospital nurses is due to a lack of data on nurses in other health sectors, although it should be noted that the hospital sector employs the vast majority of nurses. The number of registered nurses in a county is calculated using a formula that includes full-time (FT) and part-time (PT) nurses, as well as licensed practical nurses (LPNs). Both part-time nurses and licensed practical nurses provide a great deal of care and are valuable health care resources. According to Lee (1991), the formula for determining the number of registered nurses in a given county is best defined as: Nurse FTE = FT RN + (0.5 x PT RN) + (0.5 x FT LPN) + (0.25 x PT LPN). The county population is used the numerator while the nurse FTE number is the denominator, generating a population to registered nurse ratio. This number reflects an absence of registered nurses.

Lack of Pharmacists: The number of pharmacists within a given county will also be obtained from the Area Resource File (ARF). This measure is the population to pharmacist ratio, defined as the number of county population divided by the number of pharmacists per county. This number reflects an absence of pharmacists.

Lack of Hospital Beds: The absence of hospital beds is first defined as the county population divided by the total number of hospital beds. This number reflects an absence of county level hospital beds.

This information is provided in the following table that details the operationalization of inadequacy of health care resources with references to each definition and specific variable in the Area Resource File database.

Table 8: Operationalization of Inadequacy of Health Care Resources

Label	Indicator	Defined	1990 ARF variable	2000 ARF variable
PHS	Lack of Primary Care Physicians	County Population / Total primary care physicians *	County pop. / F04610-90 + F11996-95 + F11208-90 + F11704-90	County pop. / F04610-00 + F11996-00 + F11208-00 + F11704-00
NRS	Lack of Registered Nurses	County population / Total registered nurses **	County pop. / F09316-91	County pop. / F09316-00
PHM	Lack of Pharmacists	County population / Total pharmacists	County pop. / F08618-90	County pop. / F08618-00
BED	Lack of Hospital Beds	County population / Total hospital beds	County pop. / F08921-90	County pop. / F08921-00

*Primary care physicians include family practice, general practice, general internal medicine, and general pediatrics.
**Registered nurse includes full time registered nurses, part time register nurses and licensed practical nurses.

Control Variables: The studies associated with the school of ecology have documented the potential that certain variables have for confounding results. In order to support the validity of the causal model it is important that these variables are addressed.

The variable of race is a confounding variable in health research. Recently, the National Healthcare Disparity Report (Agency for Healthcare Research and Quality, 2004a) and the National Healthcare Quality Report (Agency for Healthcare Research and Quality, 2004b) documented the continued pervasiveness of health inequalities on race. These reports discovered that despite improvements in some areas, minorities like African Americans received poorer quality of care for about two-thirds of quality measures compared to whites, and low-income African American households had worse access to care for about 80 percent of measures than African American households with higher incomes. Therefore, this study will control for racial composition by including the percentage of the county that is African American.

Other variables that may confound the study results are gender and age. If a county possessing a disproportionate amount of one particular gender or elderly people, the results may in fact reflect a spurious relationship. Thus, it is important to control for potential differences in the gender and age structure at the county level. Gender is operationalized by the percentage of the county that is female, while age is operationalized by the percentage 65 years or older.

The coding used to operationalize the control variables of race, gender, and age are displayed in Table 9: Operationalization of Control Variables.

Table 9: Operationalization of Control Variables

Label	Indicator	Defined	1990 Census variable	2000 Census variable
RCE	Race	% African-American or Black	STF-1: Table P0006 P0060002	STF-1: Table P3 P003004
GND	Gender	% female county population	STF-1: Table QT-P1A QTP1A.C2 / QTP1A.C0	STF-1: Table P3 P012026 / P012001
AGE	Age	% county that is 65+ yrs	STF-1: Table P011 P0110027 +…+ P0110031 / P0010001	STF-1: Table P8 P008035 +…+ P008040 + P008074 +…+ P008079 / P003001

Analytical Model

This research utilizes secondary, deidentified data and follows a quantitative methodology. Here, patterns and determinants of variables that produce variation of sentinel health events in small areas are examined. This analytical approach is frequently described as "small area analysis". Small area analysis is a popular methodology in health research used to analyze the geographic and demographic composition of counties (Cain & Diehr, 1992). Through a comparison of high- and low-use areas, the analysis attempts to determine patterns, and identify variables that are associated with and contribute to the variation. It is important to note that small area analysis requires the formation of data at the aggregate level.

In addition to an analytical strategy that employs Small Area Analysis (SAA), the principal statistical methodology is Structural Equation Modeling (SEM). Following the analysis the findings are transformed into a presentable format using the mapping software, ArcGIS. We now present the univariate and bivariate correlation analysis of each variable.

Univariate and Correlation Analysis

One of the primary assumptions of structural equation modeling is that each univariate variable display normality. First, variables within the study are examined for the following descriptive statistics; frequency, mean, and standard deviation (SD). Second, an examination of the skewness and kurtosis ratios of univariate data provides insight into the normality of the data. An additional test of normality, the Kolmogorov-Smirnov procedure is recommended when sample size is less than 2,000 ($n<2,000$). Variables that display unacceptable levels of skewness or kurtosis, that is, greater than 2 or less than -2, will be transformed using either the square root or logarithm function.

Bivariate correlation analysis is also employed to measure the association between variables. Random relationships display a correlation coefficient close to 0, while perfect linearity is expressed as either 1 (positive relationship) or -1 (negative relationship). The univariate and correlation analysis is conducted with the software package, SPSS 12.0.

Multivariate Analysis

The multivariate analysis was performed using Structural Equation Modeling (SEM); a statistical technique that combines elements of confirmatory factor analysis and path analysis. The appropriateness of structural equation modeling in ecological studies has been well documented (Fellers, 2000). Ecological studies include variables that contain a high level of covariance, that is, social causes of ill health are thought to share a degree of commonality. Structural equation modeling represents an effective analytical strategy for dealing with such multicollinearity. Despite multicollinearity, SEM enables the inclusion of more flexible assumptions in the model and easier interpretation of the results. Other advantages of using SEM in ecological research include; the use of confirmatory factor analysis to address measurement error by having multiple indicators per latent variable, the efficacy of testing whole models and causality rather than coefficients individually, and the ability to model error terms.

Measurement Model: SEM is as much a theoretical endeavor as a mathematical process, with model-specification based exclusively on a set of causal assumptions. Thus, structural equation modeling begins with an exploration of the causal effects and interrelationships between and within hypothetical constructs and observed variables (Wan, 2002). Here, each construct in the model is conceptualized as a "latent", and measured by multiple indicators. Latent constructs that have no causal variable in the model are deemed "exogenous", while variables that are dependant or mediating are termed "endogenous". For each latent construct, confirmatory factor analysis (CFA) is employed to produce a measurement model. The final form of the measurement model represents, "the degree to which the indicator variables capture the essence of the latent factor" (Meyers *et al.*, 2006, p. 613).

Structural Equation Model: Following the development of acceptable measurement models, a structural equation model is created. The structural equation model process is designed to assess the relationships between latent variables. This process includes model construction, parameter estimation of the model, goodness of fit testing, model modification, and the generation of a final model. Model construction and parameter estimation are calculated using maximum likelihood estimation (MLE) procedure, a method designed to estimate the likelihood of the data matching the proposed model.

Goodness-of-fit Indices: In terms of assessing the fit of the hypothesized model, currently over 24 goodness-of-fit indices are in existence, with little consensus on what measures should be reported (Klem, 2000). Fortunately, Meyers *et al.*, (2006) provides an efficacious three-classification scheme that includes absolute, relative, and parsimonious measures of fitness.

Absolute-fit measures indicate the degree to which the proposed model fits the actual data. The most common absolute-fit measures are the chi-square, the goodness-of-fit (GFI), the root mean square residual (RMSR), and the root mean square error of approximation (RMSEA). The chi-square statistic may lead to detection of differences in observed and predicted covariance that are actually the result of larger sample sizes, particularly samples over 200 (Joreskog & Sorbom, 1989). Therefore, the chi-square statistic should be used with caution, as it has limited utility in assessing the fit of a single model. Rather absolute-fit measures such as GFI, RMSR, and RMSEA are preferred. GFI is the proportion of variation in the sample accounted for by the predicted model, with values greater than .90 signifying an acceptable model. RMSR and RMSEA assess the differences between the residuals of the actual data and the residuals in the hypothesized data covariance. Acceptable values for good absolute fit are less than .05 for RMSR, and less than .05 for RMSEA (note: RMSEA $\leq$ 0.8 is considered acceptable).

Relative-fit indices assess the hypothesized model in relation to an independence model (which assumes no relationships in the data) and also to a saturated model (which assumes perfect fit). A central relative-fit measure is the comparative fit index (CFI) which operates under the following guidelines: good fit > .95, adequate but marginal fit = .80 to .94, poor fit < .79 (Hu & Bentler, 1999). Other relative-fit indices are the normed fit index (NFI), the incremental fit index (IFI), and the relative fit index (RFI), with values greater than .90 indicating an acceptable fit.

Parsimonious-fit represents another important category of statistics, as they penalize larger models with more estimation parameters (Meyers *et al.*, 2006). The chief parsimonious measures are the parsimonious adjusted goodness-of-fit (AGFI) and the parsimonious goodness-of-fit (PGFI). Values for AGFI and PGFI would preferably be greater than .90, although values as low as .50 or greater have been deemed acceptable by statisticians (Muliak *et al.*, 1989). The three-classification scheme is presented in the following table, labeled Table 10: Absolute, Relative, and Parsimonious Fit Measures.

Table 10: Absolute, Relative, and Parsimonious Goodness-of-Fit Indices

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	p >.05	CFI	>.95	AGFI	>.05
GFI	>.90	NFI	>.90	PGFI	>.05
RMSR	<.05	IFI	>.90		
RMSEA	<.10	RFI	>.90		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

The goodness of fit indices are derived from the analysis and reported. This represents a key aspect of testing the theoretical validity of the Structural Equation Model.

Model modification and the final model: In the initial and subsequent revised models, the non-statistically significant causal relationships between control and latent endogenous variables were removed. Furthermore, new coefficients between factor and indictors were added, with this respecification being theoretically justifiable.

As discussed in the previous chapter, the three latent exogenous concepts of socio-economic disadvantage, social disorganization, and inadequacy of health care resources, are not independent of each other. Therefore, covariance among these three latent concepts is not controlled for (as in regression models); rather the interaction effects will be examined using structural equation modeling. Structural equation modeling is the method choice in these circumstances, particularly due to its functionality in assessing covariance in the model. For example, the functional relationship of the model will contain main effects and interaction effects as such: Y = F (X1, X2, X3, X21, X32, X31, X123). This model is simplified in figure 3, wherein A=Socioeconomic Disadvantage, B=Social Disorganization, C=Inadequacy of Health Care Resources. A, B, and C are exogenous latent variables, and I is the interaction terms (AB, BC, CA, and ABC). The examination of main and interactive effects is applicable to both the cross-sectional and longitudinal models.

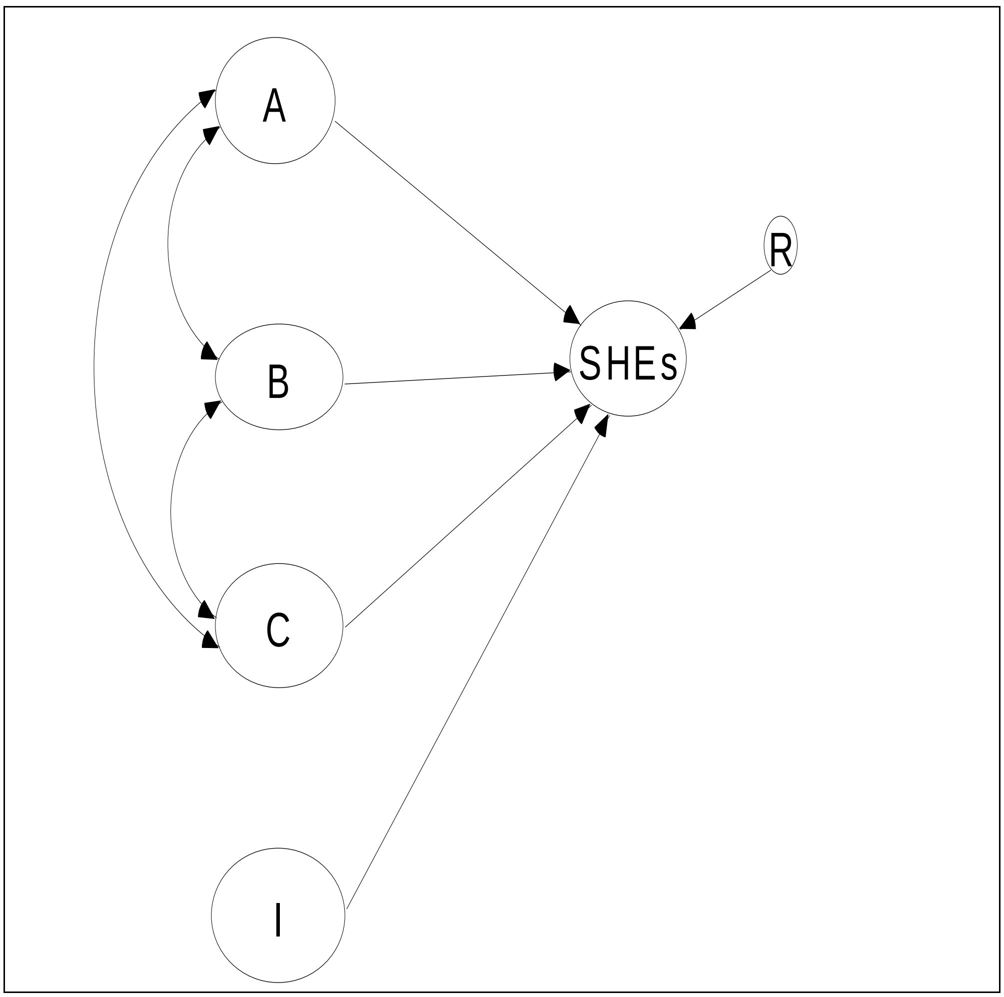

Figure 2: Analytical Strategy for Measuring Main and Interactive Effects.

Geographic Information Systems

Geographic Information Systems (GIS) are used to present the data in a practical and accessible manner. Due to the large number of counties within this study and the subsequent complexity in statistical methodology the application of choice will be ArcGIS. ArcGIS consists of the following applications: ArcView, ArcEditor, and ArcInfo (Ormsby *et al.,* 2001). ArcGIS will be utilized to construct a geographical map that represents areas that vary significantly and/or areas that change over time. Specific areas of interest for policy makers include the prevalence rates of individual diseases, patient utilization of services, and "hotspots" of system inadequacy. Moreover, GIS is use to provide more informative evidence of sentinel health events in the small area analysis. The mapping process will provide visual representation of the data in order for the policy implications to be more "user friendly". Due to the relevancy of geographic information systems to policy development, the output maps are presented in the Chapter 5: Policy Implication section.

Ecological Fallacy

An important consideration in any ecological study is the issue of the "ecological fallacy". A vast number researchers (Alker, 1969; Blakely & Woodward, 2004; Diez Roux, 1998; MacIntyre & Ellaway, 2003; Piantadosi *et al.,* 1988) and specific studies (Cohen, 1994; Feinleib, 1999; Gove & Hughes, 1980; Neumeyer, 2003; Raudenbush & Sampson, 1999) have addressed the inherent dilemma of the "ecological fallacy". The ecological fallacy is the "well established logical fallacy inherent in making inferences regarding individual level associations on group-level data" (Diez Roux *et al.,* 2002a, p. 493).

The ecological fallacy occurs in situations where group level data is used as a proxy measure because individual level data is unfeasible to obtain or prone to measurement error. The problem with such an approach is that without cautious methodology, the alteration of data between population and individual levels of analysis may cause the results to change in both statistical magnitude and direction. Thus, ecological studies that contain inferences about individual behavior are criticized as containing results that are both misleading and spurious (Robinson, 1950).

The most apt solution for the ecological fallacy is the development of an adequate causal model and to only draw conclusions about the unit of analysis studied. This research attempts to minimize this error by using purely ecologic variables (socioeconomic disadvantage, social disorganization, and inadequate health care resources) to predict a purely ecological outcome, sentinel health events at the county level.

Summary

This research examines variation in socio-economic disadvantage, social disorganization, health care resources, and their relationship to sentinel health events at the county level. United States counties are the unit of analysis, and all data is secondary and deidentified in nature. Three hundred and nine counties within nine U.S. states are analyzed for the years 1990 and 2000. Two models are presented in the analysis, a cross-sectional model (2000) and a longitudinal model (1990 – 2000). The analytical methodology employed in the study is primarily Structural Equation Modeling (SEM). Geographic Information Systems (GIS) is used for graphically illustrating the results.

CHAPTER FOUR: RESULTS

This study examines the relationship between ecological constructs and sentinel health events at the county level. In this section, we present the results of the data analysis, with specific reference to two time points, 1990 and 2000. Two models are discussed; a cross-sectional model (2000) and a longitudinal model (1990 – 2000).

First, univariate and correlation coefficients are examined and the resulting relationships discussed. Descriptive statistics include minimum/maximum values, mean, and standard deviation. Second, normality testing is used and values with unacceptable skew/kurtosis ratios are transformed using either the square-root or log function. Third, confirmatory factor analysis is used to assess the fit between the theoretical framework and the data. Four, goodness of fit indices are used to modify the model. Here, we examine if the covariance predicted by the model correspond to the observed covariance in the data, and continue to modify until a satisfactory structural equation model is achieved. Five, an example of geographic information system mapping is presented in order to demonstrate the policy implications of the research.

Descriptive Analysis

Select descriptive statistics (minimum, maximum, mean, and standard deviation) are provided in Table 11: Descriptive Statistics for Study Variables for 1990 and 2000. Listed are variables within the three exogenous constructs; socio economic disadvantage, social disorganization, and inadequate health care resources. Also listed are the variables within the endogenous variable, sentinel health events, and control variables.

Table 11: Descriptive Statistics for Study Variables for 1990 and 2000

Variable	Label	Minimum	Maximum	Mean	SD
Socio Economic Disadvantage Construct:					
Income (1990)	INC_90	2.569	37.716	14.815	6.678
Income (2000)	INC_00	2.567	37.689	14.201	5.801
Education (1990)	EDU_90	8.100	57.700	28.390	9.806
Education (2000)	EDU_00	5.600	50.000	22.202	8.305
Occupation (1990)	OCC_90	44.899	81.345	67.623	6.182
Occupation (2000)	OCC_00	41.795	81.591	68.475	7.600
Social Disorganization Construct:					
Res. Mobility (1990)	MOB_90	24.557	70.503	45.358	9.116
Res. Mobility (2000)	MOB_00	24.159	70.833	49.723	9.851
Urbanization (1990)	URB_90	0	100	49.830	30.713
Urbanization (2000)	URB_00	0	100	57.278	29.858
Female Head (1990)	FHE_90	5.100	25.700	11.057	3.351
Female Head (2000)	FHE_00	6.200	25.800	11.784	3.461
Foreign Born (1990)	FBO_90	.120	45.150	5.280	6.439
Foreign Born (2000)	FBO_00	.050	50.940	7.378	8.341
Crime Rate (1990)	CRM_90	.020	2.690	.997	.506
Crime Rate (2000)	CRM_00	.020	2.120	.811	.379
Inadequate Health Care Resources Construct:					
Physician (1990)	PHS_90	417.310	2982.000	1486.636	531.818
Physician (2000)	PHS _00	349.860	2807.080	1495.978	509.161
Reg. Nurse (1990)	NRS_90	70.690	358.840	183.505	66.995
Reg. Nurse (2000)	NRS _00	66.350	358.842	194.817	68.221
Pharmacist (1990)	PHM_90	463.690	3901.330	1826.185	754.879
Pharmacist (2000)	PHM _00	462.746	3903.302	1981.267	766.467
Hospital Beds (1990)	BED_90	15.450	770.170	386.733	160.091
Hospital Beds (2000)	BED _00	45.960	773.450	335.504	166.903

Variable	Label	Minimum	Maximum	Mean	SD
Sentinel Health Event Construct:					
Asthma (1990)	AST_90	.073	5.020	1.751	.901
Asthma (2000)	AST _00	.065	7.026	2.841	1.469
Cancer (1990)	CAN_90	.012	3.029	1.230	.475
Cancer (2000)	CAN _00	.051	4.013	1.303	.584
Diabetes (1990)	DIA_90	.012	3.373	1.326	.607
Diabetes (2000)	DIA _00	.011	3.711	1.586	.752
Hypertensive (1990)	HYP_90	.001	2.973	.849	.575
Hypertensive (2000)	HYP _00	.001	3.425	1.103	.729
Influenza (1990)	FLU_90	.097	12.725	3.748	2.026
Influenza (2000)	FLU _00	.118	12.972	3.925	1.979
Control Variables:					
Race (1990)	RCE_90	.015	67.975	11.513	15.043
Race (2000)	RCE _00	.010	71.002	11.631	15.241
Gender (1990)	GND_90	38.168	54.970	50.781	1.775
Gender (2000)	GND _00	35.330	55.633	50.404	2.101
Age (1990)	AGE_90	5.788	33.781	14.119	4.591
Age (2000)	AGE _00	5.908	34.716	14.319	4.541

An examination of the variables within the socioeconomic disadvantage construct reveal that the mean percentage of poverty found in the study-counties was 14%, though poverty did decrease between 1990 and 2000 (INC_90 = 14.8%, INC_00 = 14.2%). The mean lack of high school education decreased from EDU_90 = 28.4 % to EDU_00 = 22.2% and the mean blue collar worker percentage remained relatively constant at approximately 68% (OCC_90 = 67.6%, OCC_00 = 68.5%).

Social disorganization variables indicate that residential mobility increased from MOB_90 = 45.4 % to MOB_00 = 49.7%. Urbanization also increased from URB_90 = 49.8% to

URB_00 = 57.3%, and one should note that urbanization displayed extreme variance with counties ranging from 0% urban to 100% urban (i.e. standard deviation was 30.7% in 1990 and 29.9% in 2000). Female head of household remained constant, FHE_90 = 11.1% and FHE_00 = 11.8%, while foreign born residents increased from FBO_90 = 5.3% to FBO_00 = 7.4%. While traditional crime rates use a measure of the number of reported offenses per 100,000, this study simplifies the crime rate as the number of reported offenses per 100. The mean number of reported offenses declined from CRM_90 = .997 per 100 people to CRM_00 = .811 per 100 people.

Variables within the latent construct, inadequate health resources, are measured as the population to provider ratio. As such, there was a mean of 1,486 people per physician in 1990 (PHS_90) compared to a mean of 1,495 people per physician in 2000 (PHS_00). A mean of 184 people per nurse in 1990 (NRS_90) compared to a mean of 195 people per nurse in 2000 (NRS_00). A mean of 1,826 people per pharmacist in 1990 (PHM_90) compared to a mean of 1,981 people per pharmacist in 2000 (PHM_00). Additionally, the mean number of people per hospital bed was 386 in 1990 (BED_90) compared to 335 in 2000 (BED_00).

Sentinel health events are measured by the frequency of the disease/condition divided by the county population. The highest rates were exhibited by influenza (FLU_90 = 3.8, FLU_00 = 3.9), asthma (AST_90 = 1.8, AST_00 = 2.8), neoplasms of the colon, liver and lung (CAN_90 = 1.2, CAN_00 = 1.3). Other variables include diabetes (DIA_90 = 1.3, DIA_00 = 1.6), and hypertension (HYP_90 = 0.8, HYP_00 = 1.1).

Control variables include the mean percentage of the counties that are black (RCE_90 = 11.5%, RCE_00 = 11.6%), female (GND_90 = 50.7%, GND_00 = 50.4%), and over 65 years of age (AGE_90 = 14.1%, AGE_00 = 14.3%).

Univariate Analysis

Statistical experts and texts specify that prior to multivariate analysis, each variable must be checked separately for univariate normality (see Gnanadesikan, 1977; Seber, 1984). Two accepted tests for univariate normality include the skewness/kurtosis ratio, and the Shapiro-Wilk test. Skewness and kurtosis ratios are calculated by dividing the skewness/kurtosis statistic by the standard error of skewness/kurtosis. Values near zero are desirable, while values over three indicate non-normality based on the variance in the data. The Shapiro-Wilk test of normality is appropriate in studies where the sample size is less than 2,000. A Shapiro-Wilk p-value of .05 or higher indicates a normal distribution.

The transformation strategy for non-normal data is to first use the square root function, which is recommended for moderately skewed data (Mertler & Vannatta, 2005). The majority of variables in the study were not normal. As such, the variables INC, EDU, OCC, CRM, PHS, NRS, PHM, BED, AST, CAN, DIA, HYP, and FLU were transformed via the square root function. Some variables were more severely skewed, whereby the recommended method is log transformation (Mertler & Vannatta, 2005). Here, SPSS returns the base-10 logarithm of the original number. Variables transformed using this method include URB, FBO, and RCE. The variable GEND was excluded from the analysis as no transformation method could render it usable. The variables that exhibited normality and thus needed no transformation include MOB, and FHE. Table 12 lists the skewness, kurtosis, and normality test statistics for each of the study variables.

Table 12: Skewness, Kurtosis, and Normality Test for Study Variables

	Original Normality Ratios			Transformation	Transformed Normality Ratios		
Variable	**Skewness**	**Kurtosis**	**Shapiro-Wilk**		**Skewness**	**Kurtosis**	**Shapiro-Wilk**
INC_90	4.56	0.76	.000	Sqrt	0.22	-0.83	.650
INC_00	4.37	2.04	.000	Sqrt	0.12	-0.46	.800
EDU_90	2.20	-2.29	.000	Sqrt	-0.33	-2.30	.012
EDU_00	3.34	-1.23	.000	Sqrt	0.50	-2.12	.052
OCC_90	-3.00	2.03	.004	Sqrt	-2.31	0.88	.025
OCC_00	-7.74	4.64	.000	Sqrt	-2.10	0.50	.075
MOB_90	-0.33	-2.64	.003	None			
MOB_00	-0.45	-1.90	.041	None			
URB_90	10.97	10.73	.000	Lg10	4.04	2.39	.000
URB_00	10.33	8.31	.000	Lg10	4.85	1.02	.000
FHE_90	0.47	-4.42	.000	None			
FHE_00	-1.90	-3.85	.000	None			
FBO_90	17.33	27.71	.000	Lg10	-1.56	-2.41	.002
FBO_00	13.27	13.34	.000	Lg10	-1.99	-1.13	.002
CRM_90	3.62	-0.05	.000	Sqrt	0.14	-0.48	.102
CRM_00	4.42	1.49	.000	Sqrt	0.14	0.41	.914
PHS_90	2.75	-1.18	.001	Sqrt	-0.26	-1.65	.352
PHS_00	4.11	-0.06	.000	Sqrt	0.72	-1.41	.086
NRS_90	4.51	-1.36	.000	Sqrt	2.18	-2.47	.000
NRS_00	5.08	-1.29	.000	Sqrt	2.85	-2.68	.000
PHM_90	3.96	-0.83	.000	Sqrt	0.86	-2.22	.006
PHM_00	4.15	-1.29	.000	Sqrt	1.21	-2.52	.002
BED_90	2.54	-1.12	.002	Sqrt	-2.23	-0.58	.036
BED_00	1.14	-2.55	.002	Sqrt	-2.38	-1.78	.001

	Original Normality Ratios			Transformation	Transformed Normality Ratios		
Variable	Skewness	Kurtosis	Shapiro-Wilk		Skewness	Kurtosis	Shapiro-Wilk
AST_90	8.70	6.96	.000	Sqrt	2.12	2.40	.001
AST_00	2.89	-0.88	.000	Sqrt	-1.98	-1.26	.012
CAN_90	3.88	3.45	.000	Sqrt	-2.99	5.41	.000
CAN_00	7.37	6.89	.000	Sqrt	1.77	2.71	.008
DIA_90	6.42	3.16	.000	Sqrt	0.53	2.28	.020
DIA_00	5.38	1.61	.000	Sqrt	-0.52	1.65	.037
HYP_90	8.40	4.05	.000	Sqrt	2.43	-0.27	.005
HYP_00	6.87	2.04	.000	Sqrt	0.58	-0.73	.284
FLU_90	7.80	8.16	.000	Sqrt	0.18	1.78	.045
FLU_00	6.66	6.04	.000	Sqrt	-0.39	1.85	.227
RCE_90	13.07	9.87	.000	Lg10	-3.98	-1.42	.000
RCE_00	13.45	10.99	.000	Lg10	-3.19	-1.91	.000
GEND_90	-15.63	38.86	.000	N/A			
GEND_00	-20.30	51.36	.000	N/A			
AGE_90	12.11	15.16	.000	Lg10	2.73	3.88	.000
AGE_00	12.01	14.48	.000	Lg10	3.59	3.12	.000

Cross-Sectional Model Analysis (2000)

This section includes measurement models and a structural equation model based on the cross-sectional analysis only, that is, for the year 2000. The longitudinal analysis can be located in the next section.

Correlation Analysis (Cross-sectional Model)

Bivariate correlation coefficients were computed and the resulting Pearson correlation values and p-values are reported. Correlation coefficient values from the cross-sectional model are presented in Table 13: Zero-Order Correlations between all study variables in the cross-sectional model (n=309).

The concept of sentinel health events was previously refined via confirmatory factor analysis (see Chapter 3). As a result of this prior analysis, the remaining variables displayed moderate correlations (AST, CAN, DIA, FLU, HYP). The concept of socioeconomic disadvantage displayed a high level of correlation, with INC-EDU (r =.87), INC-OCC (r = .79), and EDU-OCC (r = .78). It is therefore appropriate to combine these variables into a single composite measure of socio-economic disadvantage. This procedure involved the allocation of factor loading weights to each socioeconomic disadvantage variable.

The concept of social disorganization included the variable female head of household (FHE), which demonstrated a weak correlation with both urbanization (FHE-URB, r = .08), and crime (FHE-CRM, r = .09). As such, FHE was excluded from subsequent analysis. The concept of inadequate health care resources displayed moderate correlations and all four variables were retained (PHS, NRS, PHM, BED).

The control variable, race (RCE) was moderately correlated with other study variables, however age (AGE) did not correlate with other study variables and was excluded from further analysis. The retained variables were all positively correlated at the $p < .05$ level.

Table 13: Zero-Order Correlations between all study variables in the cross-sectional model

	y_1	y_2	y_3	y_4	y_5	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}
AST_00 (y_1)	1.00																		
CAN_00 (y_2)	.71*	1.00																	
DIA_00 (y_3)	.79*	.82*	1.00																
FLU_00 (y_4)	.77*	.65*	.75*	1.00															
HYP_00 (y_5)	.73*	.78*	.86*	.63*	1.00														
INC_00 (x_1)	.58*	.67*	.68*	.58*	.68*	1.00													
EDU_00 (x_2)	.63*	.70*	.74*	.61*	.72*	.87*	1.00												
OCC_00 (x_3)	.53*	.64*	.63*	.52*	.62*	.79*	.78*	1.00											
MOB_00 (x_4)	.59*	.68*	.69*	.53*	.70*	.70*	.73*	.69*	1.00										
URB_00 (x_5)	.48*	.58*	.55*	.48*	.52*	.65*	.59*	.69*	.69*	1.00									
FHE_00 (x_6)	.34*	.28*	.47*	.35*	.42*	.42*	.49*	.32*	.29*	.08	1.00								
FBO_00 (x_7)	.36*	.54*	.51*	.29*	.60*	.58*	.54*	.64*	.68*	.74*	.14*	1.00							
CRM_00 (x_8)	.50*	.58*	.53*	.41*	.58*	.52*	.52*	.53*	.64*	.62*	.09	.62*	1.00						
PHS_00 (x_9)	.58*	.56*	.59*	.49*	.57*	.59*	.64*	.68*	.60*	.56*	.24*	.50*	.55*	1.00					
NRS_00 (x_{10})	.49*	.58*	.58*	.51*	.56*	.72*	.70*	.67*	.60*	.65*	.24*	.48*	.56*	.63*	1.00				
PHM_00 (x_{11})	.61*	.54*	.55*	.55*	.50*	.55*	.56*	.56*	.54*	.49*	.26*	.35*	.47*	.58*	.55*	1.00			
BED_00 (x_{12})	.39*	.37*	.38*	.38*	.31*	.39*	.38*	.37*	.39*	.40*	.21*	.23*	.31*	.48*	.45*	.37*	1.00		
RCE_00 (x_{13})	.30*	.10	.30*	.25*	.29*	.07	.20*	.07	.06	-.16*	.64*	-.09	-.05	.13*	-.03	.07	.04	1.00	
AGE_00 (x_{14})	.20*	.25*	.14*	.14*	.21*	.15*	.08	.23*	.21*	.18*	-.32*	.22*	.18*	.12*	.06	.10	-.06	-.16*	1.00

INC: Income; EDU: Education; OCC: Occupation; MOB: Residential Mobility; URB: Urbanization; FHE: Female Head of Household; FBO: Foreign Born Residents; CRM: Crime Rate; PHS: Physicians; NRS: Nurses; PHM: Pharmacists; BED: Hospital Beds; AST: Asthma/Bronchitis/Emphysema; CAN: Neoplasm of colon, rectum, liver, lung; DIA: Diabetes; FLU: Influenza, Pneumonia; HYP: Hypertensive Disease; RCE: Race; AGE: Age.

* Correlation is significant at the 0.05 level (2-tailed)

Confirmatory Factor Analysis (Cross-Sectional Model)

The construction of valid measurement models is essential in the development of a structural equation model (Wan, 2002). Measurement models under consideration include the endogenous construct: sentinel health events, and the exogenous constructs: socioeconomic disadvantage, social disorganization, and inadequacy of health care resources. As stated above, the concept of socioeconomic disadvantage demonstrated a high degree of multicollinearity between variables. These variables were subsequently merged into a single composite measure. As a result, it is not possible to present a measurement model on the construct of socioeconomic disadvantage. The remaining constructs are presented with appropriate Lambda coefficients and goodness-of-fit statistics. Lambda values being important as they specify the path from the indicators to their latent construct (Wan, 2002).

Measurement Model for Sentinel Health Events (2000)

The concept of sentinel health events includes the following five variables: asthma (AST), cancer of the colorectum/lung/liver (CAN), diabetes (DIA), hypertension (HYP), and influenza/pneumonia (FLU). All of the estimated path parameters are significant at the .05 level. Critical ratio values and standardized regression weights are AST (CR = 21.97, r = .82), CAN (CR = 24.67, r = .86), DIA (CR = N/A, r = .95), HYP (CR = 27.94, r = .89), and FLU (CR = 18.01, r = .73). Squared multiple correlations are AST (r^2 = .68), CAN (r^2 = .74), DIA (r^2 = .92), HYP (r^2 = .81), and FLU (r^2 = .53). The measurement model was also adjusted by correlating residual error terms on the following exogenous variables; AST – FLU (critical ratio = 6.4, p <

.05), and DIA – FLU (critical ratio = 2.7, $p < .05$). It is important to note that although strong multicollinearity between indicators should be avoided (Wan, 2002), all indicators are theoretically distinct and important to the study.

Goodness-of-fit statistics indicate no statistically significant difference between the data and the measurement model. This was consistent in absolute ($\chi 2$ = 6.46, GFI = .99, RMSR = .00), relative (CFI = .99, NFI = .99, IFI = .99), and parsimonious (AGFI = .96, PGFI = .20) indices of fit. Thus, the variables under consideration are an acceptable fit with the concept of sentinel health events. Table 14: Goodness of Fit Indices for Sentinel Health Events (2000) provides more information on these indices.

Table 14: Goodness of Fit Indices for Sentinel Health Events (2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	6.46 (p = .09)	CFI	.99	AGFI	.96
GFI	.99	NFI	.99	PGFI	.20
RMSR	.00	IFI	.99		
RMSEA	.06	RFI	.98		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Measurement Model for Social Disorganization (2000)

The concept of social disorganization includes the following five variables: mobility (MOB), urbanization (URB), female head of household (FHE), foreign born (FBO), and crime (CRM). FHE was removed from the analysis due to low correlation values. The remaining estimated path parameters are significant at the .05 level. Critical ratio values and standardized regression weights are MOB (CR = 16.70, r = .81), URB (CR = N/A, r = .86), FBO (CR = 17.57, r = .85), and CRM (CR = 24.68, r = .74). Squared multiple correlations are MOB (r^2 = .66), URB (r^2 = .73), FBO (r^2 = .72), and CRM (r^2 = .55).

Goodness-of-fit statistics suggests consistency in absolute ($\chi 2$ = 4.71, GFI = .99, RMSR = .04), relative (CFI = .99, NFI = .99, IFI = .99), and parsimonious (AGFI = .96, PGFI = .20) indices of fit. Therefore, the variables of MOB, URB, FBO, and CRM have an acceptable goodness-of-fit with the measurement model for social disorganization (see Table 15: Goodness of Fit Indices for Social Disorganization (2000) for more detail).

Table 15: Goodness of Fit Indices for Social Disorganization (2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	4.71 (p = .10)	CFI	.99	AGFI	.96
GFI	.99	NFI	.99	PGFI	.20
RMSR	.04	IFI	.99		
RMSEA	.07	RFI	.98		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Measurement Model for Inadequate Health Care Resources (2000)

The concept of inadequate health care resources includes the following four variables: population to physician ratio (PHS), population to nurse ratio (NRS), population to pharmacist ratio (PHM), and population to hospital bed ratio (BED). The lambda coefficients range from .57 (BED) to .82 (PHS), and all are statistically significant at the .05 level. Critical ratio values and standardized regression weights are PHS (CR = N/A, r = .82), NRS (CR = 12.61, r = .77), PHM (CR = 11.76, r = .71), and BED (CR = 9.46, r = .57). Squared multiple correlations are PHS (r^2 = .68), NRS (r^2 = .60), PHM (r^2 = .50), and BED (r^2 = .33).

Goodness-of-fit statistics are adequate in terms of absolute ($\chi2$ = 1.24, GFI = .99, RMSR = .04), relative (CFI = .99, NFI = .99, IFI = .99), and parsimonious (AGFI = .99, PGFI = .20) measures. Therefore, the variables of PHS, NRS, PHM, and BED have an acceptable goodness-of-fit (see Table 16: Goodness of Fit Indices for Inadequate Health Care Resources (2000).

Table 16: Goodness of Fit Indices for Inadequate Health Care Resources (2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi2$	1.24 (p = .54)	CFI	.99	AGFI	.99
GFI	.99	NFI	.99	PGFI	.20
RMSR	.04	IFI	.99		
RMSEA	.00	RFI	.98		

$\chi2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Structural Equation Model (Cross-Sectional Model)

Structural equation modeling was conducted to determine the causal effects of the latent exogenous constructs: socioeconomic disadvantage, social disorganization, and inadequate health care resources on the latent endogenous construct: sentinel health events. This model is cross-sectional in design, and based solely on data values from the year 2000.

The initial model displayed a high degree of multicollinearity and poor goodness of fit indices. Model fit was improved by correlating the following residual errors terms: (d2-d3, CR = 4.65, $p < .01$), (e1-e5, CR = 6.28, $p < .01$), and (e3-e5, CR = 2.71, $p = .01$).

The final covariance structure model contained one non-significant path parameter, inadequate health resources → SHE (CR = 1.22, $p = .224$). This path was retained due to its importance in theory testing. With the exception of this path, all other variables were positively related at a statistically significance level ($p < .05$). This includes three statistically significant paths for the endogenous variable, sentinel health events. These paths include: socioeconomic disadvantage → SHE (CR = 2.68, $p < .01$), social disorganization → SHE (CR = 5.32, $p < .01$), and race → SHE (CR = 7.89, $p < .01$). Additional paths parameters, with unstandardized path coefficients, standard errors, critical ratios, significance values, and standardized regression coefficients are presented in Table 17: Final Covariance Structure Model Path Parameter Statistics.

Table 17: Final Covariance Structure Model Path Parameter Statistics (2000)

Path Parameter	Unstd. Regression Coefficient	S.E.	C.R.	P value	Std. Regression Coefficient
SHE ← Socioeconomic Disadvantage	.037	.014	2.68*	p <.05	.212
SHE ← Social Disorganization	.026	.005	5.32*	p <.05	.529
SHE ← Inadequate Health Resources	.021	.017	1.22	.22	.140
SHE ← Race	.101	.013	7.89*	p <.05	.254
AST ← Sentinel Health Events	1.275	.059	21.72*	p <.05	.821
CAN ← Sentinel Health Events	.757	.031	24.62*	p <.05	.862
DIA ← Sentinel Health Events	1.000	****	****	****	.945
HYP ← Sentinel Health Events	1.075	.038	28.56*	p <.05	.906
FLU ← Sentinel Health Events	1.233	.004	15.79*	p <.05	.735
SED ← Socioeconomic Disadvantage	1.000	****	****	****	1.000
MOB ← Social Disorganization	1.000	****	****	****	.882
URB ← Social Disorganization	3.494	.199	17.57*	p <.05	.802
FBO ← Social Disorganization	.060	.004	15.79*	p <.05	.752
CRM ← Social Disorganization	.026	.002	15.69*	p <.05	.745
PHS ← Inadequate Health Resources	2.699	.293	9.20*	p <.05	.788
NRS ← Inadequate Health Resources	.990	.106	9.40*	p <.05	.828
PHM ← Inadequate Health Resources	2.856	.331	8.64*	p <.05	.698
BED ← Inadequate Health Resources	1.000	****	****	****	.526

SE: Standard Error; CR: Critical Ratio; P-value: Significance value; SHE: Sentinel Health Events; AST: Asthma/Bronchitis/Emphysema; CAN: Neoplasm of colon, rectum, liver, lung; DIA: Diabetes; FLU: Influenza, Pneumonia; HYP: Hypertensive Disease.; SED: composite measure of socioeconomic disadvantage; MOB: Residential Mobility; URB: Urbanization; FBO: Foreign Born Residents; CRM: Crime Rate; PHS: Physicians; NRS: Nurses; PHM: Pharmacists; BED: Hospital Beds;

***** Path parameter is significant at the .05 level

Measures of absolute fit indicate a moderate fit, with a high and significant chi-square value ($\chi 2 = 1.24$, $p > .05$), and a modest goodness of fit index (GFI = .86). Goodness-of-fit statistics are also moderate with regard to relative (CFI = .93, NFI = .91, IFI = .93), and parsimonious (AGFI = .79, PGFI = .59) measures. Overall, the data adequately fits the model, as presented in Table 18: Goodness of Fit Indices for Structural Equation Model (2000).

Table 18: Goodness of Fit Indices for Structural Equation Model (2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	364.44 (p = .00)	CFI	.93	AGFI	.79
GFI	.86	NFI	.91	PGFI	.59
RMSR	.84	IFI	.93		
RMSEA	.11	RFI	.88		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

It is also worth noting that a high degree of covariance between latent exogenous constructs was identified. Intercorrelations included social disorganization ↔ socioeconomic disadvantage (.823), inadequate health resources ↔ social disorganization (.864), and inadequate health resources ↔ socioeconomic disadvantage (.864). This multicollinearity suggests that the exogenous latent constructs are highly correlated and results should be approached with caution. With this in mind, the final structural equation model reveals that socioeconomic disadvantage and social disorganization are positively related to sentinel health events at a statistically significant level. The control variable, race, was also associated with sentinel health events at a statistically significant level. There was no significant relationship between inadequacy of health care resources and sentinel health events. These relationships can be seen in Figure 3: Cross-Sectional Structural Equation Model.

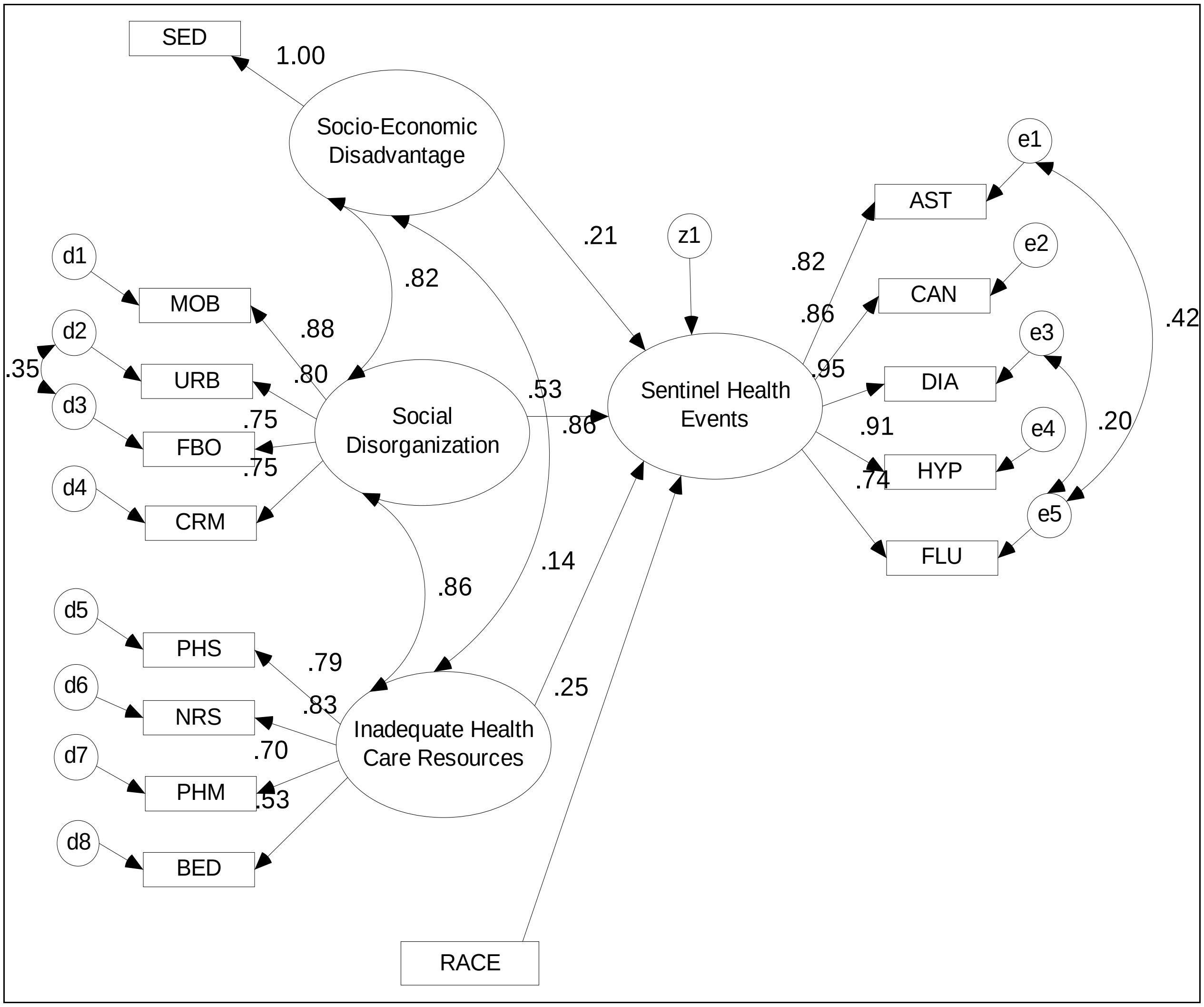

Figure 3: Cross-Sectional Structural Equation Model.

Longitudinal Model Analysis (1990 - 2000)

This section includes measurement models and a structural equation model based on the longitudinal analysis only, that is, changes in the variables between 1990 and 2000.

Correlation Analysis (Longitudinal Model)

Pearson correlation coefficient values for the longitudinal model are presented in Table 19: Zero-Order Correlations between all study variables in the longitudinal model (n=309). One should note that the longitudinal model is based on the degree of change in these variables over time (i.e. 1990 to 2000). As such, the "D" listed prior to variable names indicates difference or delta value associated with this change. All variables within the concept of sentinel health events, D_AST, D_CAN, D_DIA, D, FLU, D_HYP, displayed acceptable and significant ($p < .05$) correlation coefficients. The concept of socioeconomic disadvantage, included one variable (D_OCC) that was not significantly correlated with changes in income (D_OCC – D_INC, $r = .08$) and education (D_OCC _ D_EDU, $r = -.01$). Therefore, D_OCC was excluded from future models. The concept of inadequate health care resources, included D_BED which did not correlate significantly with changes in population to physician ratios (D_BED – D_PHS, $r = .09$), but was retained for theory testing. The remaining variables in the longitudinal model are significantly correlated at the $p < .05$ level.

Table 19: Zero-Order Correlations between all study variables in the longitudinal model

	y_1	y_2	y_3	y_4	y_5	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}
D_AST (y_1)	1.00															
D_CAN (y_2)	.32*	1.00														
D_DIA (y_3)	.55*	.41*	1.00													
D_FLU (y_4)	.33*	.33*	.36*	1.00												
D_HYP (y_5)	.47*	.38*	.54*	.20*	1.00											
D_INC (x_1)	-.13*	-.29*	-.10	-.14*	-.11*	1.00										
D_EDU (x_2)	-.10	-.30*	-.09	-.17*	-.08	.78*	1.00									
D_OCC (x_3)	-.11	-.07	-.13*	.08	-.21*	.08	-.01	1.00								
D_MOB (x_4)	.04	.27*	.04	.10	.09	-.27	-.32*	.06	1.00							
D_URB (x_5)	-.05	.14*	-.09	-.06	.05	-.14*	-.20*	.03	.69*	1.00						
D_FBO(x_6)	.09	.28*	.05	-.08	.15*	-.18*	-.20*	.07	.49*	.44*	1.00					
D_CRM(x_7)	-.09	.11	-.07	.00	-.02	-.23*	-.21*	-.01	.15*	.09	.16*	1.00				
D_PHS(x_8)	.09	.02	.11	.07	.02	-.10	-.05	-.19*	-.09	-.13*	-.06	-.02	1.00			
D_NRS(x_9)	-.03	-.02	.12*	.07	-.03	.08	.16*	.02	-.03	-.14*	-.02*	-.07	.22*	1.00		
D_PHM(x_{10})	.17*	.09	.11*	.04	.07	.01	.07	-.04	-.02	-.01	-.03	.01	.15*	.27*	1.00	
D_BED(x_{11})	.05	.00	.07	-.02	.02	-.07	.06	.01	.11	.10	.12*	-.08	.09	.17*	.13*	1.00

INC: Income; EDU: Education; OCC: Occupation; MOB: Residential Mobility; URB: Urbanization; FBO: Foreign Born Residents; CRM: Crime Rate; PHS: Physicians; NRS: Nurses; PHM: Pharmacists; BED: Hospital Beds; AST: Asthma/Bronchitis/Emphysema; CAN: Neoplasm of colon, rectum, liver, lung; DIA: Diabetes; FLU: Influenza, Pneumonia; HYP: Hypertensive Disease. D prior to variable refers to the difference between values for 1990 and 2000 (i.e. D = delta)

* Correlation is significant at the 0.05 level (2-tailed).

Confirmatory Factor Analysis (Longitudinal Model)

This section includes measurement models of the endogenous construct: sentinel health events, and the exogenous constructs: socioeconomic disadvantage, social disorganization, and inadequacy of health care resources. The analysis examines the change in variables over time, with data values reflecting the difference between the years 1990 and 2000. This is indicated by the delta label (delta = D) that precedes variable labels.

As stated earlier, bivariate correlation analysis identified unacceptable coefficient values for occupation (D_OCC), crime (D_CRM), and hospital beds (D_BED), resulting in the exclusion of these variables. The concept of socioeconomic disadvantage now includes two variables, change in lack of income (D_INC) and change in lack of education (D_EDU). With only two variables this measurement model is considered “just identified”, making goodness of fit statistics unattainable. The measurement models for the concepts of sentinel health events, social disorganization, and inadequate health resources are now presented.

Measurement Model for Sentinel Health Events (1990 - 2000)

The concept of sentinel health events in this longitudinal model examines the changes in rates of asthma (D_AST), cancer of the colorectum/lung/liver (D_CAN), diabetes (D_DIA), hypertension (D_HYP), and influenza/pneumonia (D_FLU) between 1990 and 2000.

All of the estimated path parameters are significant at the .05 level. Critical ratio values and standardized regression weights are D_AST (CR = 10.50, r = .69), D_CAN (CR = 8.27, r = .53), D_DIA (CR = N/A, r = .80), D_HYP (CR = 10.27, r = .67), and D_FLU (CR = 6.92, r =

.44). As shown, the lambda coefficient for D_FLU is low (.44) but the variables was included for theory testing. Other statistics include the following squared multiple correlation values: D_AST (r^2 = .69), D_CAN (r^2 = .53), D_DIA (r^2 = .80), D_HYP (r^2 = .67), and D_FLU (r^2 = .44).

The measurement model fit the data fit with regard to absolute ($\chi 2$ = 14.86, GFI = .98, RMSR = .00), relative (CFI = .97, NFI = .96, IFI = .97), and parsimonious (AGFI = .95, PGFI = .33) measures. The significance of the relationship between data and model was non-significant (p = .011), making this measurement model acceptable. Table 20: Goodness of Fit Indices for Sentinel Health Events (1990 - 2000) provides more information on these indices.

Table 20: Goodness of Fit Indices for Sentinel Health Events (1990 - 2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	14.86 (p = .01)	CFI	.97	AGFI	.95
GFI	.98	NFI	.96	PGFI	.33
RMSR	.00	IFI	.97		
RMSEA	.06	RFI	.92		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Measurement Model for Social Disorganization (1990 - 2000)

This measurement model includes measures of change in mobility (D_MOB), urbanization (D_URB), foreign born (D_FBO) and crime (D_CRM). Three paths (D_MOB, D_URB, and D_FBO) are significant at the .05 level, while change in crime (D_CRM) was significant at the .01 level. Critical ratio values and standardized regression weights include: D_MOB (CR = N/A, r = .88), D_URB (CR = 10.46, r = .78), D_FBO (CR = 8.86, r = .56), and

D_CRM (CR = 2.58, r = .16). Squared multiple correlations are D_MOB (r^2 = .77), D_URB (r^2 = .61), D_FBO (r^2 = .32), and D_CRM (r^2 = .03).

There is a good fit between the model and data, with a low chi-square value ($\chi 2$ = 14.86, p = .19), adequate comparative fit index (CFI = .99), and acceptable adjusted parsimony comparative fit index (AGFI = .97). See Table 21: Goodness of Fit Indices for Social Disorganization (1990 - 2000) for more information.

Table 21: Goodness of Fit Indices for Social Disorganization (1990 - 2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	3.29 (p = .19)	CFI	.99	AGFI	.97
GFI	.99	NFI	.99	PGFI	.20
RMSR	.02	IFI	.99		
RMSEA	.05	RFI	.97		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Measurement Model for Inadequate Health Care Resources (1990 - 2000)

Data in this measurement model measures the change of population to physician ratios over time. It includes change in physician ratio (D_PHS), nurse ratio (D_NRS), pharmacist ratio (D_PHM), and hospital bed ratio (D_BED). The critical ratio values and standardized regression weights (lambda coefficients) are: D_PHS (CR = 3.02, r = .35), D_NRS (CR = N/A, r = .62), D_PHM (CR = 3.11, r = .43), and D_BED (CR = 2.67, r = .27). Squared multiple correlations are D_PHS (r^2 = .12), D_NRS (r^2 = .39), D_PHS (r^2 = .12), and D_BED (r^2 = .07).

This measurement model displays an acceptable chi-square value ($\chi2$ = .760, p = .96), good comparative fit index (CFI = 1.00), and good adjusted parsimony comparative fit index (AGFI = .99). See Table 22: Goodness of Fit Indices for Inadequate Health Resources (1990 - 2000) for more information.

Table 22: Goodness of Fit Indices for Inadequate Health Resources (1990 - 2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi2$	.076 (p = .96)	CFI	1.00	AGFI	.99
GFI	1.00	NFI	1.00	PGFI	.20
RMSR	.05	IFI	1.00		
RMSEA	.00	RFI	.99		

$\chi2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

Structural Equation Model (Longitudinal Model)

Structural equation modeling was performed to examine the effect of the latent exogenous constructs: socioeconomic disadvantage, social disorganization, and inadequate health care resources, on the latent endogenous construct: sentinel health events. This model is longitudinal in design, and based on the difference of values from 1990 to 2000.

The initial covariance structure model suggested a moderate good of fit. In terms of absolute fit, the chi-square value was adequate but significant ($\chi2$ = 261.18, p <.05) and the good of fit index was adequate (GFI = .90). Relative fit indices indicated an adequate but marginal fit (CFI = .86, NFI = .80, IFI = .84), while parsimonious indices are adequate (AGFI = .87, PGFI =

.67). Taken as a whole, these indices necessitate model modification, particularly the removal of non-significant path parameters. Therefore, the variables of delta-crime (D_CRM, $p = .01$), and delta-hospital beds (D_BED, $p = .09$) were removed from the model. Additionally, the intercorrelation between socioeconomic disadvantage and social disorganization was accounted for. The final covariance model features a much lower chi-square value ($\chi 2 = 139.97$, $p < .05$), as well as improved good of fit index (GFI = .94), comparative fit index (CFI = .93), and parsimony index (AFGI = .90).

In the final covariance structure model, the parameter path of social disorganization to sentinel health events was not significant (CR = .77, $p = .440$). This indicates that changes in social disorganization between 1990 and 2000 were not associated with changes in rates of sentinel health events (SHE). The path between socioeconomic disadvantage and SHE's was significant at the .05 level; however this relationship was unexpectedly in the negative direction (unstandardized regression coefficient = -.119, $p < .05$). In short, as socioeconomic disadvantage declined between 1990 and 2000, the rate of sentinel health events increased. Lastly, the path between inadequate health resources and SHE's was significant at the .05 level, and in the expected positive direction. Path parameters for all variables are listed in Table 23: Final Covariance Structure Model Path Parameter Statistics (1990 - 2000).

Table 23: Final Covariance Structure Model Path Parameter Statistics (1990 - 2000)

Path Parameter			Unstd. Regression Coefficient	S.E.	C.R.	P value	Std. Regression Coefficient
SHE	←	Socioeconomic Disadvantage	-.119	.042	2.80*	p <.05	-.199
SHE	←	Social Disorganization	.003	.003	.77	.44	.056
SHE	←	Inadequate Health Resources	.061	.027	2.26*	p <.05	.235
D_AST	←	Sentinel Health Events	1.807	.171	10.57*	p <.05	.821
D_CAN	←	Sentinel Health Events	.712	.083	8.58*	p <.05	.545
D_DIA	←	Sentinel Health Events	1.000	****	****	****	.798
D_HYP	←	Sentinel Health Events	.933	.091	10.28*	p <.05	.663
D_FLU	←	Sentinel Health Events	.967	.137	7.07*	p <.05	.448
D_INC	←	Socioeconomic Disadvantage	1.000	****	****	****	.821
D_EDU	←	Socioeconomic Disadvantage	1.138	.138	8.26*	p <.05	.948
D_MOB	←	Social Disorganization	1.000	****	****	****	.908
D_URB	←	Social Disorganization	2.368	.218	10.87*	p <.05	.756
D_FBO	←	Social Disorganization	.028	.003	8.82*	p <.05	.553
D_PHS	←	Inadequate Health Resources	3.114	1.011	3.08*	p <.05	.368
D_NRS	←	Inadequate Health Resources	1.000	****	****	****	.547
D_PHM	←	Inadequate Health Resources	4.977	1.627	3.06*	p <.05	.483

SE: Standard Error; CR: Critical Ratio; P-value: Significance value; SHE: Sentinel Health Events; AST: Asthma/Bronchitis/Emphysema; CAN: Neoplasm of colon, rectum, liver, lung; DIA: Diabetes; FLU: Influenza, Pneumonia; HYP: Hypertensive Disease.; INC: Income; EDU: Education; MOB: Residential Mobility; URB: Urbanization; FBO: Foreign Born Residents; PHS: Physicians; NRS: Nurses; PHM: Pharmacists. Note: The "D" label preceding the path parameters refers to the change between 1990 and 2000 (or delta value).

***** Path parameter is significant at the .05 level

As indicated in Table 24: Goodness of Fit Indices for Structural Equation Model (1990 - 2000) the data fit the model at an acceptable level. The goodness of fit is acceptable with regard to absolute fit ($\chi 2$ = 139.97, GFI = .94, RMSR = .56), relative fit (CFI = .93, NFI = .88, IFI = .93), and parsimony (AGFI = .99, PGFI = .63).

Table 24: Goodness of Fit Indices for Structural Equation Model (1990 - 2000)

Absolute		Relative		Parsimonious	
Test	Value	Test	Value	Test	Value
$\chi 2$	139.97 (p = .00)	CFI	.93	AGFI	.90
GFI	.94	NFI	.88	PGFI	.63
RMSR	.56	IFI	.93		
RMSEA	.07	RFI	.85		

$\chi 2$ = Chi-square test; GFI = Goodness of Fit Index; RMSR = Root Mean Square Residual; RMSEA = Root Mean Square Error of Approximation; CFI = Comparative Fit Index; NFI = Normed Fit Index; IFI = Incremental Fit Index; RFI = Relative Fit Index; AFGI = Adjusted Parsimony Comparative Fit Index.; PCFI = Parsimony Comparative Fit Index (Adapted from Meyers et. al., 2006).

A diagrammatic representation of the final covariance structure model is presented in Figure 3: Longitudinal Structural Equation Model. It is apparent that socioeconomic disadvantage and inadequate health care resources contribute to sentinel health events. Yet, socioeconomic disadvantage displays a gamma coefficient value that was unanticipated (Γ = -.20, p < .05). Inadequate health care resources were associated with sentinel health events, with increases in population to provider ratios leading to increased rates of sentinel health events (Γ = .24, p < .05). Interestingly, while social disorganization was a contributor in the cross-sectional model, it was non-significant in the longitudinal model (Γ = .06, p = .440).

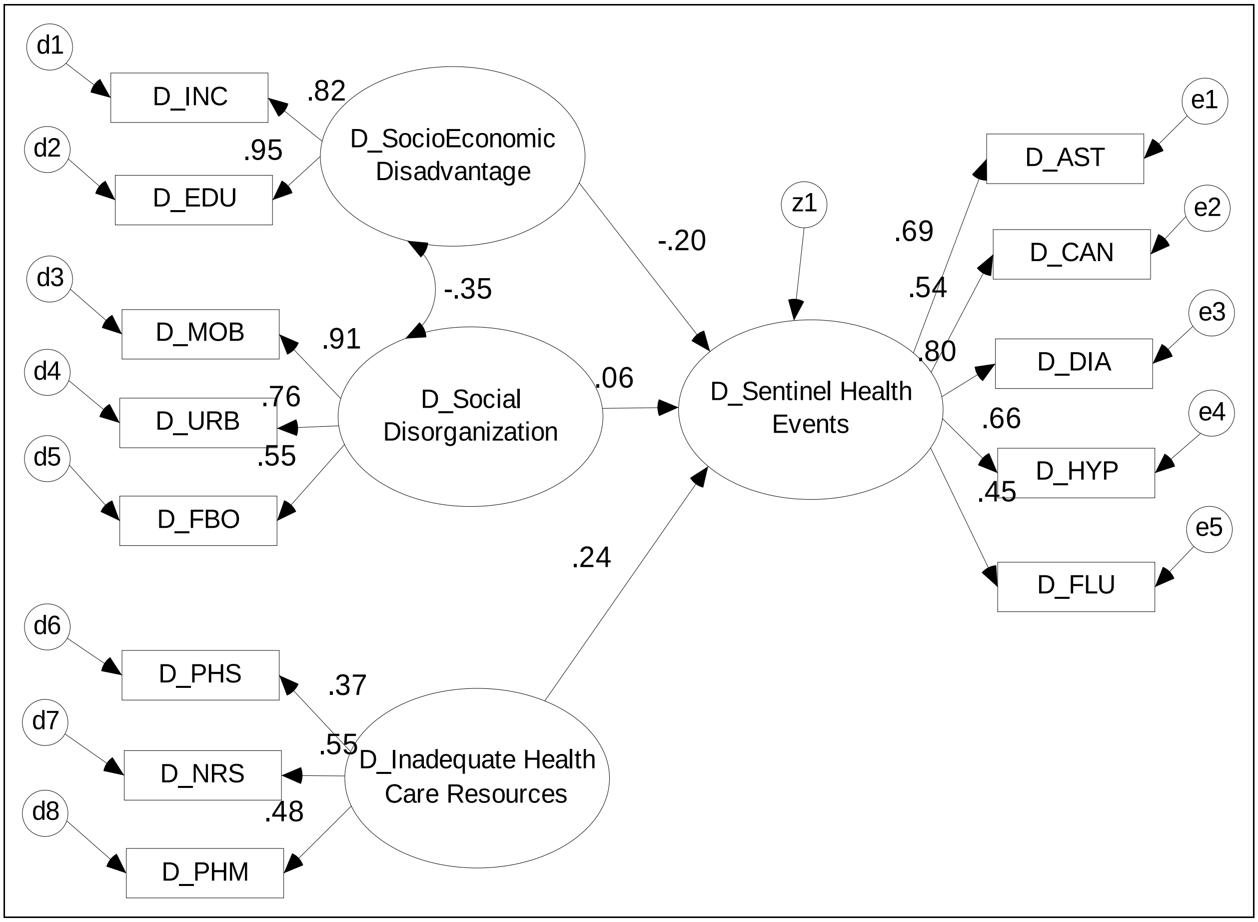

Figure 4: Longitudinal Structural Equation Model.

Hypotheses Testing

This study examined four hypotheses that are fundamental to the school of ecology. The results of these hypotheses will now be examined:

H_1: The variability of sentinel health events is positively associated with socioeconomic disadvantage, social disorganization, and a lack of health care resources, irrespective of time period.

H_1 is partial supported. The cross-sectional model (2000) clearly indicates a positive association between sentinel health events and the constructs of socioeconomic disadvantage and social disorganization. However, no relationship was identified between health care resources and sentinel health events.

H_{1a}: Relatively speaking socioeconomic disadvantage will have a greater impact on sentinel health events than social disorganization and a lack of health care resources.

H_{1a} is partial supported. While the ecological literature supports the notion that socioeconomic disadvantage is the single most important contributor to poor county health, the results are less definitive. The cross-sectional model (2000) indicates that the dominant contributor to sentinel health events is social disorganization ($\Gamma = .529$), followed by socioeconomic disadvantage ($\Gamma = .212$). The reduced impact of socioeconomic disadvantage could be attributed to the large covariance exhibited by exogenous constructs. Stated differently, the exogenous variables contribute to sentinel health events in an overlapping and synergistic fashion. As predicted, a lack of health care resources was not associated with sentinel health events at a statistically significant level.

H_2: The exogenous variables of socioeconomic disadvantage, social disorganization, and a lack of health care resources are expected to remain relatively constant over time, at the county level.

H_2 is not supported. As demonstrated in H_1, the cross-sectional model (2000) reveals that two exogenous constructs (socioeconomic disadvantage and social disorganization) influenced sentinel health events, whereas one exogenous construct (inadequate health resources) did not influence sentinel health events. However, the longitudinal model indicates that over time (1990 – 2000) two exogenous constructs (socioeconomic disadvantage and inadequate health resources) influence sentinel health events, whereas one exogenous construct (social disorganization) did not influence sentinel health events. Clearly, the exogenous variables that are strong contributors to sentinel health events at a specific time point (2000) fluctuate over time, becoming more or less significant.

H_3: Any change in one of the exogenous constructs (socioeconomic disadvantage, social disorganization, or a lack of health care resources) is positively associated with change in the rates of sentinel health events, holding the non-change variables constant.

H_3 is partially supported. The construct of socioeconomic disadvantage was significant in both models; however socioeconomic disadvantage displayed an unexpectedly negative relationship with sentinel health events in the longitudinal model (1990 – 2000). Improvements in county-level socioeconomic status between 1990 and 2000 correlated with increases in sentinel health events. In terms of inadequate health resources, the ratios of population to health care providers increased between 1990 and 2000, and in turn sentinel health care events increased. Lastly, while social disorganization increased between 1990 and 2000, the construct was not associated with changes in sentinel health events in the longitudinal model.

Summary

The relationship between three latent exogenous constructs (socioeconomic disadvantage, social disorganization, and inadequate health resources) and one endogenous construct (sentinel health events) was examined. Descriptive statistics, specifically minimum, maximum, mean, and standard deviation are reported. Univariate normality statistics were examined and data values with excessive skewness or kurtosis ratios were adjusted via square root or log transformations. Bivariate correlation coefficients enabled the researcher to exclude non-significant variables. The resulting data was analyzed in two models; one cross-sectional (2000) and the other longitudinal (1990-2000). Measurement models were developed for both approaches.

The cross-sectional covariance model (2000) indicates a positive, statistically significant relationship between the exogenous constructs: socioeconomic disadvantage and social disorganization and the endogenous construct: sentinel health events. No significant relationship was found between inadequate health care resources and sentinel health events in this model. The longitudinal covariance model (1990 - 2000) identified a statistically significant relationship between socioeconomic disadvantage and sentinel health events, although this relationship was unexpectedly in a negative direction. Additionally, no relationship was found between changes in social disorganization and changes in rates of sentinel health events. A positive, statistically significant relationship was found between increases inadequate health care and increases in rates of sentinel health events, at the county level.

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

This study was designed to investigate the theoretical underpinnings of the ecological school of thought. More specifically, propositions integral to the ecological school of thought were examined through an innovative research design and robust statistical approach. This chapter consolidates the key aspects of the research, with sections pertaining to a discussion of findings, contributions of the study, and policy implications. The limitations of the study are presented, as well as direction for future research.

Discussion of Findings

To date, no study has documented the relative influence of key theoretical constructs within the school of ecology. This research examined the relationship between the constructs of socio-economic disadvantage, social disorganization, and the inadequacy of health care resources, and their influence on sentinel health events. Findings will now be discussed with reference to originating research questions.

1. *Can socioeconomic disadvantage, social disorganization, and a lack of health care resources account for the variability in sentinel health events, at the county level (cross-sectional model)?*

The exogenous constructs under consideration all displayed acceptable measurement models, which is indicative of reliability. Furthermore, an extensive academic literature search reinforced the validity of the constructs. Findings suggest that as a whole, the final covariance structure model is acceptable, with the constructs of socioeconomic disadvantage and social disorganization attributing to rates of sentinel health events. The construct of inadequate health resources was not identified as significantly associated with sentinel health events. Altogether, we are confident that the research accurately identifies and examines the antecedents to sentinel health events.

1. a. What are the relative importance of socioeconomic disadvantage, social disorganization, and a lack of health care resources in explaining the variability?

Standardized estimates indicate that the relative contribution of social disorganization (std. regression coefficient = .529) was the most influential on rates of sentinel health events. Of interest, the second greatest contributor in the study is the control variable “race” (std. regression coefficient = .254). This suggests that racial characteristics are fundamentally linked to ecological predictors of health. The third contributor to rates of sentinel health events is socioeconomic disadvantage (std. regression coefficient = .212). This is also an interesting finding, as the majority of ecological researchers identify economic factors as the fundamental cause of disease (Link & Phelan, 1995). The construct of inadequate health resources displayed a non-significant, though positive relationship with rates of sentinel health events (std. regression coefficient = .140). The non-significance of health care resources in influencing disease rates is common in academic literature.

The responses to research questions *1* and *1.a.* represent advancement over past ecological research that used an eclectic mix of variables without theoretical justification. To answer these research questions, we first identified key ecological components and then employed structural equation modeling, a statistical approach that requires theoretical specification.

By grouping variables into specific constructs we observed a high degree of multicollinearity. More specifically, the research identified a synergistic effect between socioeconomic disadvantage and social disorganization on rates of sentinel disease. The researchers acknowledge that the direct effect of social disorganization was stronger than that of socioeconomic disadvantage. However, when the final covariance model is examined, the indirect influence of economic factors (socioeconomic disadvantage) and "place" factors (social disorganization) on sentinel health events are very similar. Therefore, the attempt to disentangle "economic" and "place" effects largely failed; a finding that becomes important for future ecological research.

The implication of this finding is that economic forces, specifically the stratification of income, education, and occupation, are truly analogous to social forces, such as mobility, urbanization, foreign born residents, and criminality. This validates the Marxist perspective that vast networks of social and economic relations govern human behavior (see Marx, [1844] 1964). In practical terms, this finding suggests that future ecological studies must include measures of economic forces in conjunction with consideration of the social environment.

With regard to inadequate health care resources, the non-significance of this construct was expected and retained for theoretical reasons. As demonstrated in Chapter 2 of this study, a large body of health research and policy making is guided by the assumption that increasing the level of health care resources into a geographic area leads to better health outcomes. This assumption was not supported by the cross-sectional model (2000). We concur with the proposition of Adler et al., (1993) that, "socioeconomic status relates to health at all levels of the SES hierarchy, and access to care accounts for little of this association (p. 3140). Though, we add the caveat that socioeconomic status represents a dynamic construct if linked to neighborhood effects.

It is also important to note the significance of race on sentinel health events. Racial characteristics, in this study simplified as percentage of the county identified as African-American, had a positive and statistically significant relationship with rates of sentinel health events. While race was included as a control variable in the analysis, it demonstrated potential for inclusion as a distinct exogenous construct for future study. Now we turn to research questions 2 and 3 for a discussion of the longitudinal model (1990 – 2000).

2. Are socioeconomic disadvantage, social disorganization, and a lack of health care resources relatively constant over time (longitudinal model)?

No, it is clear that the exogenous constructs fluctuate over time and as such are amenable to policy intervention. The period of 1990 to 2000 witnessed an increase socioeconomic status for the counties under study. Indeed, this time period witnessed particularly strong economic growth, as demonstrated by mean poverty levels for counties dropping from 14.8 % (1990) to 14.2 % (2000). In a county with a population of 100,000, this would have resulted in 600 individuals moving above the poverty threshold. While education levels witnessed similar improvements, the variable of occupation is less sensitive than income, due primarily to a dichotomy of employment type (i.e. blue or white collar).

Indicators of social disorganization also fluctuated between 1990 and 2000. More specifically, the mean percentage of residential mobility, urbanization, and foreign born residents increased for almost all counties. For example, the mean percentage of foreign born residents was 5.2% in 1990 and 7.3 % in 2000. Female head of household percentages increased slightly during this time period, but not at a significant level. The level of reported crime within each county dropped significantly during the decade under consideration, in fact, crime declined at an unprecedented rate (see Blumstein & Wallman, 2000). In short, crime moved in the opposite direction to other indicators of social disorganization.

With regard to inadequate health care resources, the population to provider ratios increased for physicians, nurses, and pharmacists between 1990 and 2000. For example, the mean number of individuals per county competing for one pharmacist increased from 1,826 in 1990 to 1,981 in 2000. The population per hospital bed ratio actually decreased during this time period.

To review, between 1990 and 2000 the counties under consideration faced increases in socioeconomic status, social disorganization, inadequate health care resources, and rates of sentinel health events. It is evident that constructs regularly used by the school of ecology fluctuate over time. This is important for the ecological researcher as causation may be drawn between the variance in these exogenous constructs over time and the resulting health events. It is also important as each exogenous construct contains distinct policy solutions.

3. Do any changing rates in socioeconomic disadvantage, social disorganization, and a lack of health care resources account for the change in sentinel health events (longitudinal model)?

Changing rates of specific ecological constructs are now explained with reference to unstandardized regression coefficients. Unstandardized regression coefficients represent the amount of change in the endogenous construct for each one unit change in the exogenous construct.

Here, socioeconomic disadvantage yielded the unexpected finding of being negatively associated with rates of sentinel health events. Stated simply, for every one unit increase in socioeconomic status between 1990 and 2000 there was a corresponding increase of .119 units in sentinel health events. This represents a new finding that counters the existing literature and requires further research. It also begs the question: Why did a reduction of poverty and less 12th grade educational attrition lead to an increase in sentinel health events?

Initially, we speculated that this unexpected relationship was a methodological artifact. First, it is feasible that increases in socioeconomic factors produced greater access to health care and greater receptivity to public health campaigns, which in turn lead to increased reporting of sentinel health events. Related to this conjecture, this study included a methodological approach that combined rates of morbidity and mortality into a single construct. However, mortality may be a more stable measure of sentinel health events than measures of morbidity. For example, a diabetic death represents a catastrophic event and reported via death certificate, whereas the decision to report complications due to diabetes mellitus (e.g. foot care, eyesight problems, erectile dysfunction etc) may be contingent upon socioeconomic resources.

A second methodological issue is the use of "absolute deprivation hypothesis". Several ecological researchers (Kawachi *et al.*, 1997; Wagstaff & Van Doorslaer, 2000; Wilkinson, 1996) have offered convincing arguments that the base or mean level of socioeconomic resources is secondary to the issue of inequality. This "relative deprivation hypothesis" states that inequality in the overall distribution of socioeconomic resources is the major contributor to poor county health. Instead of measuring base levels of socioeconomic resources, the relative deprivation approach utilizes the Gini coefficient; a measure of inequality of a distribution. We acknowledge the strengths and weaknesses of these different methodological approaches.

While these methodological issues may be partly responsible for the unexpected relationship between socioeconomic growth and increased sentinel health events, the validity of the finding has been supported by economic literature. In an article titled, "Are Recessions Good for your Health?" Christopher Ruhm conducted an econometric analysis of aggregate data from 50 states (Ruhm, 2000). The longitudinal analysis focused on the period of 1972 to 1991, and included 10 specific mortality sites responsible for 80 percent of all mortality. Ruhm discovered a dramatic mortality decline during the 1975, 1982, and 1983 recessions while an increase in mortality during the economic resurgence of the 1980's. In fact, a $1,000 increase in personal income was associated with a 0.4 to 0.6 percent increase in mortality. Ruhm then added micro-data from the Behavioral Risk Factor Surveillance System (BRFSS) to the analysis. This data indicated that economic increases are associated with increased rates of smoking and obesity, a reduction in physical activity, and less healthy diets. In accordance with our study, Ruhm (2000) concludes that, "these findings raise questions about the common belief that health declines during economic contractions" (p. 626).

Ruhm hypothesizes that the relationship between economic upturn and poor health is caused by "opportunity cost of time" (i.e. leisure time and health producing behaviors are more costly within a strong economy and thus less likely) and "health as an input to production" (i.e. a strong economy increases exposure to hazardous working conditions, job-related stress and physical exertion). Yet, this rationale largely ignores sociological considerations. Here, we return to sociologist Emile Durkheim who first proposed that *heightened* prosperity can disturb the collective social order in the same manner as national *declines* of wealth (Durkheim, 1964 [1895]). Obviously, this intriguing area of study requires further research.

Turning to the construct of social disorganization we find no evidence that it accounted for changes in sentinel health events between 1900 and 2000. Of note, social disorganization demonstrated great explanatory power in the cross-sectional model, yet was non-significant over time. Conversely, the construct of inadequacy of health care resources was non-significant in the cross-sectional model, yet demonstrated explanatory power in the longitudinal model. Here, a one unit increase in the inadequacy of health care resources was associated with a .061 unit increase in rates of sentinel health events.

In summary, both the cross-sectional and longitudinal models reveal a significant relationship between socioeconomic disadvantage and sentinel health events. The magnitude of socioeconomic factors within a given geographic area has been demonstrated in seminal studies, like the Alameda studies, Whitehall, and the Black Report (Berkman & Syme, 1979; Black *et al.*, 1993; Marmot *et al.*, 1991). We concur with the large number of cross-sectional studies (see Literature Review section) that exhibit the vital role of socioeconomic forces in county-level health. However, we also conducted one of the few longitudinal studies of county level health and had unexpected findings. Improvements in socioeconomic status over time actually produced more sentinel health events. This finding requires further examination.

The cross-sectional model revealed that social disorganization correlated with sentinel health events, yet the longitudinal model found no significance. Thus, at a given time point (2000) the variables within social disorganization may be malleable to social policy, while over time these policies may be less effective. Conversely, the cross-sectional model revealed that inadequate health care resources were not significantly related to sentinel health events, yet the longitudinal model found a moderate association between increases inadequacy in the system and sentinel health events. In this case, social policy may be more effective as part of calculated, long-term approach.

Contributions of the Study

This study makes important contributions in three key areas: theory, methodology, and policy.

As discussed in previous chapters, researchers in the ecological school of thought have generated a host of studies often with little theoretical justification. This study grouped commonly used ecological variables into three distinct latent constructs: socioeconomic disadvantage, social disorganization, and inadequate health care resources. Multicollinearity between socioeconomic disadvantage and social disorganization suggests that these constructs are integrally connected, and that future ecological research must include neighborhoods effects with economic variables. The vital importance of socioeconomic factors was identified in both cross-sectional and longitudinal models. Another important contribution is the different explanatory power offered by the following two constructs: social disorganization and inadequate health resources. Social disorganization was significant in the cross-sectional model but not the longitudinal model, whereas the construct of inadequate health resources was non-significant in the cross-sectional model but significant in the longitudinal model. These findings dispute previously held theoretical assumptions that rely solely on cross-sectional research designs. Furthermore, these contributions provide an element of clarity in a field often devoid of theoretical reasoning.

In terms of methodology, this research filled a void by utilizing a longitudinal, multivariate design that examined the changes in sentinel health events at the county level. Few studies to date examined specific sentinel health events over time, and no previous studies grouped variables into a latent construct for analysis. Equally, no previous study employed structural equation modeling to study sentinel health events. This represents an advancement of previous research that often used incongruent ecological variables in a linear regression equation. Structural equation modeling is important as it requires the researcher to formulate and test latent constructs, which in turn adds to the theoretical knowledge base.

Finally, the use of standardized, comprehensive databases available at the national level represents a considerable advancement over past efforts to document sentinel health events. Prior to this research, the most rigorous study on sentinel health events was restricted to counties in the state of Virginia (see Ibrahim, 1997). While a commendable effort, this study has limited generalizability and is cross-sectional in design. Whereas, the inclusion of both cross-sectional and longitudinal research designs to study 309 counties yielded much needed insight into the dynamic and complex nature of ecological constructs.

In terms of policy implications this research contributes in two key areas: general policy formation and geographic information systems (GIS). These two contributions will be discussed in more detail in the next section.

Policy Implications

This study produced two key areas of development with regard to policy implications. The first pertains to general policy formation at the county level, while the second area is more specific and involves the generation of maps using geographic information systems.

(a) General policy formation

Policy directed towards the inequitable distribution of social goods must first challenge the reductionist perspective that over-emphasizes the value of free-will. Klein (2000) describes a continuing trend whereby, “the burden of ill-health and premature mortality has shifted from the diseases of poverty to those related to individual behavior” (p. 569). For many, the link between poverty and diseases like tuberculosis is apparent, on the other hand, sentinel health events are more likely to be perceived as the result of poor choices in diet, lifestyle, smoking, and inactivity. This study adds support to the significance of ecological determinants in county-level health. By increasing our understanding of these processes it is hoped that policy makers balance “free-will” perspectives with “deterministic” perspectives, resulting in successful health outputs for the county. With this in mind we now turn to the latent constructs under consideration of this study.

The issue of stratification in society has plagued philosophers, economists, and sociologists for centuries. Policies aimed at countering socioeconomic disadvantage are linked through a common goal of reducing disparities in income, education, and occupational status; however, the means to achieving this goal are wide-ranging. The most drastic policy implication are attempts to eliminate of social stratification altogether. As discussed in the literature review section, Karl Marx and Fredrich Engels proposed that the inherent problems associated with social class would be dissolved through the adoption of a new political system, one they termed Communism. Key aspects of a Communist political structure include a one-party system, the decentralization of government, a collective ownership of the means of production, and a drastic reduction in the alienation and exploitation of the worker (Marx, [1844] 1964; Marx & Engels, 1998 [1872]).

While radical alterations of the political structure obviously fall outside the capacity of county-level administrators and managers there are important lessons to be learnt. Countries that have advocate equity in political and economical structure continue to produce better health outcomes than other countries that sponsor individualism and inequality (World Health Organization, 2000). Case in point, the state of Kerala in India is governed by a "Communist" party that was democratically elected; therefore the state is best defined as welfare-based, democratic and socialist. Due to policies guided by economic and social egalitarianism, Kerala has for some time experienced life expectancy, health levels, gender-equity, and literature rates unsurpassed by other developing regions. One should also note that similar economic arrangements in Cuba and Costa Rica have also produced superior health outcomes. Within the United States, the importance of equity in the distribution of economic goods has been documented repeatedly at the county-level (Feinstein, 1993; Soobader & LeClere, 1999; Wagstaff & Van Doorslaer, 2000). Our study reaffirms the relevance of economic and social equity in policy development, with the goal being a vast reduction in socioeconomic disadvantage. This represents a clear goal for county-level policy makers.

In addition to the political, social and economic ramifications discussed there are also more subtle methods to reduce socioeconomic disadvantage. As Syme (1991) states;

> "With reference to socio-economic status, for example, perhaps the crucial component is money and it might be reasonable to assume that there is nothing we can easily do to change the income distribution in society. On the other hand, the crucial ingredient in socioeconomic status distributions might be education or nutrition or sanitation and these may be far more amenable to intervention. Indeed, it may be more realistic to think about changing these characteristics than deeply entrenched behaviors and beliefs" (p. 26).

Here, we are guided by Max Weber's notion of "life chances", specifically, the opportunity extended to an individual to maximize the likelihood of living a healthy life (see Weber, [1922] 1968). To Weber, socioeconomic disadvantage facilitates a lack of status and prestige in lower class groups, which can be reduced through social mobility. That is, policies must "level the playing field", allowing all groups equitable access to socioeconomic resources. The most straightforward policy implication is equal access to safe and high-quality schools where each child can access the necessary resources to achieve. With this in mind we now turn to the related policy implications associated with the construct, social disorganization.

Social disorganization, specifically residential mobility, urbanization, foreign born residents, and crime are considered neighborhoods effects. As such, policy implications are directed towards developing healthy environments where residents can establish community ties and strengthen social bonds.

We adapt the work of MacIntyre and colleagues (2002) in order to demonstrate five key policy strategies that can counter social disorganization:

1. *Physical features of the environment shared by all residents in a locality*: Fundamental concern for quality of water and air.
2. *Availability of healthy environment at home, work, and play*: Provision of decent housing, secure and non-hazardous employment, and safe play areas for children.
3. *Services provided, publicly or privately to support people in their daily lives*: Improvements in the quality of social institutions, that is, education, transport, street cleaning, policing, welfare services, libraries, community centers, child car facilities, recreational settings, and family support centers.
4. *Socio-cultural features of a neighborhood*: This is the most essential condition, as it facilitates local participation in formal and voluntary organizations, a prime antecedent to increasing collective efficacy (Sampson & Groves, 1989). This includes all programs designed to increase levels of community support. For example, the recognition of ethnic history can be achieved through cultural festivals while free English classes for foreign-born residents can promote social integration. Another example is the reduction of incivilities and crime through community policing strategies that encourage mutual trust and cooperation.
5. *The reputation of an area*: Perceptions of neighborhoods not only impact residents but also investment bankers and city planners. Despite being an abstract category, attention should be paid towards the promotion of a strong sense of "neighborhood" in its residents.

These five categories represent important policy solutions that are intended to promote collective efficacy, and reduce social disorganization. Lastly, we turn to the policy implications for the latent exogenous construct; the inadequacy of health care resources.

The logical policy implication of inadequate health resources is the rapid increase in provider to population ratios, that is, to saturate counties with health care providers in order to provide access to care. This policy solution is frequently viewed with pessimism due to the failures associated with universal health care efforts. As such, the majority of ecological studies have relegated the construct of inadequate health care resources to the peripheral (Pincus et al., 1998). Yet, this perspective is constricted to an unrealistic dichotomy of "resources" or "no resources"; we proposed that health care resources play a crucial role in reducing sentinel health only when used in conjunction with the aforementioned socioeconomic and social disorganization policies. With this in mind, we now demonstrate how this research can be used to provide specific guidance to county-level policy makers.

(b) Geographic Information Systems (GIS)

A specific policy application involves the use of geographic information systems for the dissemination of results to key community stakeholders. Here, the quantification of spatial-temporal phenomenon is transformed into a user friendly format that is can direct policy.

In this case, we examine a graphical representation of the various hospitalization rates for Diabetes Mellitus and variation in socioeconomic disadvantage for Florida counties (see Figure 5: Hospitalization Rates for Diabetes Mellitus and County Socioeconomic Disadvantage-2000). This geographical map is based solely on 2000 data.

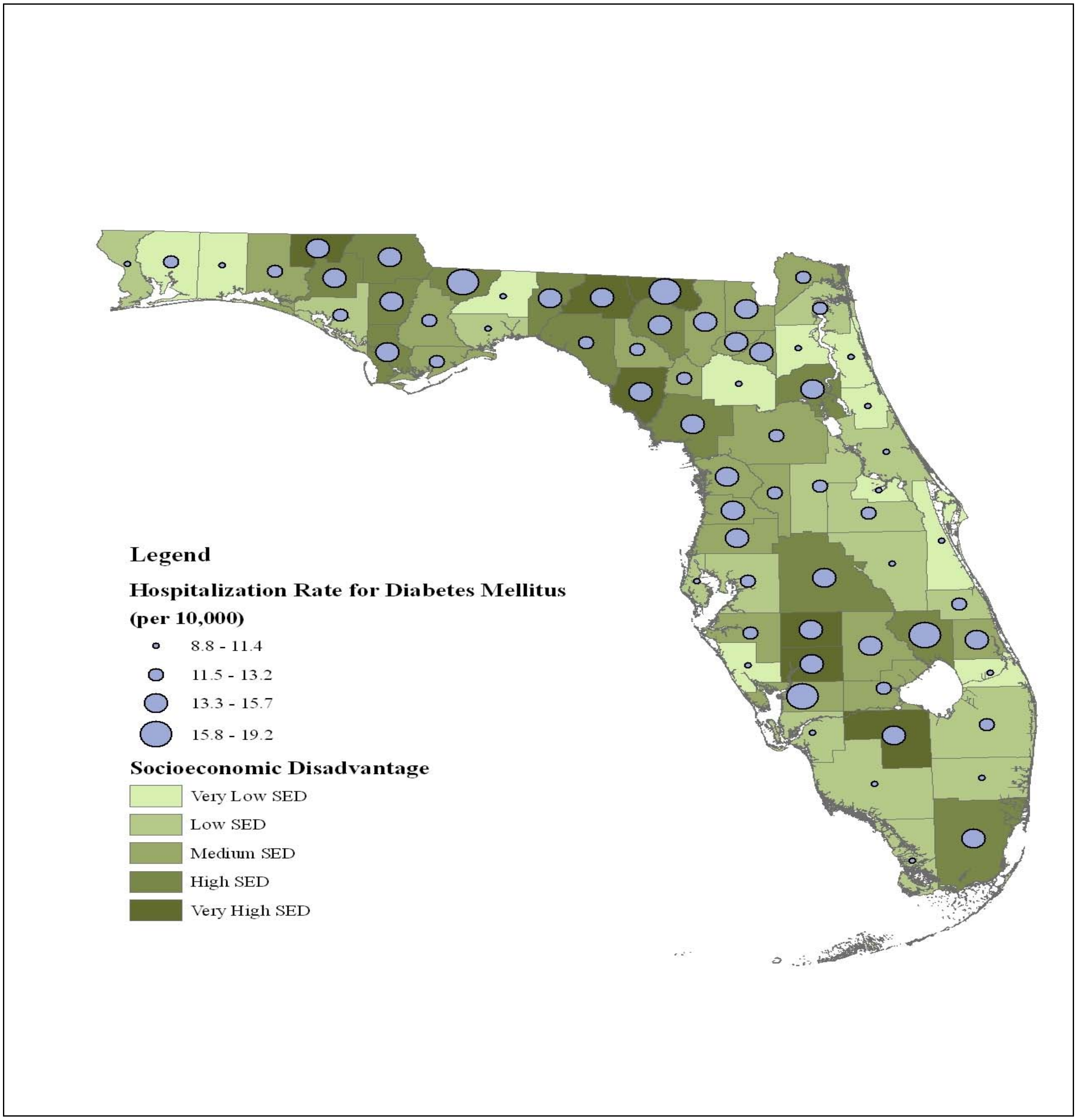

Figure 5: Hospitalization Rates for Diabetes Mellitus and County Socioeconomic Disadvantage (2000 data only)

This map clearly demonstrates a relationship between socioeconomic disadvantage and hospitalization rates for Diabetes Mellitus. Counties within the map that are shaded with darker colors indicate progressively higher levels of socioeconomic disadvantage. Similarly, the graphical representation of larger dots signifies counties with higher rates of hospital visits due to diabetic complications. A stakeholder is able to quickly ascertain that clusters of problematic counties exist within the south-central and north-central areas of the state. Several counties in particular display chronically high socioeconomic disadvantage and very high hospitalization rates for diabetes. These counties could be effectively targeted through diabetes education campaigns and socioeconomic reforms.

The map also indicates that coastal counties in Florida are more likely to possess low levels of socioeconomic disadvantage and low hospitalization rates for diabetes. With coastal properties typically being more desirable and expensive this finding is not surprising. Disparities in economics and health outcomes could be remedied through synergistic relationships with other counties. For example, stakeholders could partner neighboring county resources in order that low SED counties benefit from their proximity to high SED counties.

A final aspect of the Florida map is the presence of counties that display incongruent characteristics. For example, higher than average SED with lower hospitalization diabetes rates, or conversely, lower than average SED with higher hospitalization diabetes rates. These counties are assumed to contain important contextual factors that require further investigation. With these policy implications in mind we now discuss aspects of the research that possessed inherent weaknesses.

Limitations of the Study

Several key limitations of this study are evident and are now addressed. First, this research did not contain a mediating construct that could link ecological variables indirectly to poor health. While potential mediating constructs like psycho-social stress are discussed, no genetic or biological markers were collected. As a result, the relation between variables like income and health are assumed to be direct. Similarly, this data cannot possibly be used to explore the multitude of contextual influences on the community, that is, disease pathways that occur through individual behaviors were simply not feasible for this study.

Second, this research relies on secondary, aggregate level data as a proxy measure for ecological constructs. While the data was examined by a health care expert for validity and reliability, caution must be used with data originally collected for purposes other than the study at hand.

Third, while substantial effort was made in obtaining sentinel health data from the entire United States this goal was not achieved. As such, the study was limited to counties within nine states with populations greater than 10,000. Analyses of basic economic and social characteristics reveal no statistically significant differences between study counties and non-study counties. However, other differences in economics, demographics, and rates of health events may exist between study and non-study counties.

Four, the construct of sentinel health events contains measures of both mortality and morbidity. Measures of mortality, commonly used in past ecological research, tend to be valid and reliable due to the seriousness and legality of reporting a death. Morbidity measures are more likely to be influenced by insurance coverage, faulty medical coding, and provider/patient characteristics.

Lastly, this research measures the availability of health care resources by what is physically present in the community. This measurement strategy does not necessarily reflect the pathways, such as insurance type, access to transportation, and the influence of gatekeepers, that individuals must negotiate in order to receive health care. As a result, individuals who failed to successfully negotiate the health care system may not be included in the analysis.

Future Research

This researched endeavor contributed to the advancement of theory within the school of ecological through an innovative methodological approach and clear policy implications. At the same time, the examining of rates of sentinel health events has raised questions suitable for future research.

Perhaps the most intriguing finding was the increase in county level socioeconomic status between 1990 and 2000 that lead to an increase in sentinel health events. Due to a lack of longitudinal modeling there is little research on this phenomenon. We speculate that increased socioeconomic status at the county level, yields increased access to care and receptively to public health campaigns which in turn leads to more reported sentinel health events. Future research could separate morbidity and mortality measures in order to validate this finding. Additionally, future research would benefit through the inclusion of independent cross-level effects, that is, the inclusion of behavior variables as mediating factors.

Future research should be directed by the theoretical development used within this study. Numerous ecological studies rely on wide, often unrelated variables to study specific sentinel health events. These past efforts only attend to the “what” and “when” aspects of sentinel health events. New efforts must provide a theoretical rationale that answers the “why” question. Related to this suggestion, there is a need for longitudinal research designs that can assess causation.

Summary

This study makes a significant contribution to the ecological school of thought in the areas of theory, methodology, and policy implications. Discussion of findings detail that socioeconomic disadvantage influences county-level sentinel health events. The constructs of social disorganization and inadequate health care resources are also considered important, though there impact is dependant on the time period of the analysis. Policy implications are discussed with a specific example of a geographic information system (GIS) map displayed. The limitations of the study are addressed with direction for future research.

APPENDIX A: A BRIEF HISTORY OF ECOLOGICAL RESEARCH

Year	Author	Title	Findings
400 B.C.	Hippocrates	On Airs, Waters, and Places.	Examined variation in geographical location and disease.
1662	John Graunt	Bills of Mortality.	Ecological variables contribute to infant mortality, plague, and seasonal variation in mortality.
1690	William Petty	Political Arithmetik.	Discovered that medical actions and sanitation levels in hospitals produced more mortality than disease itself.
1790	Johann Peter Frank	The Peoples Misery: Mother of Diseases.	Poverty is the primary determinant of public health.
1842	Edwin Chadwick	Report on the Sanitary Conditions of the Laboring.	Higher socio-economic status negatively correlated with mortality. Geographic location also strong predictor of health.
1845	Fredrich Engels	Conditions of the Working Class in England.	Capitalism promotes the social and political stratification of citizens which leads to unhealthy behaviors and disease.
1851	Herbert Spencer	Social Statics.	Conditions of social order ultimately direct human progress.
1852	William Farr	Report on the Mortality of Cholera in England, 1848-49.	Demographic, social and economic conditions influence the spread of cholera.
1855	John Snow	On the Mode of Communication of Cholera.	Poor water quality and sanitation responsible for cholera epidemic. Broad Street Pump, is an exemplar of ecological research.
1858	Rudolf Virchow	Die Cellularpathologie.	Cellular processes linked to macro-social and political events.
1897	Emile Durkheim	Suicide.	Deregulation in social conditions produces patterns in suicides.
1925	Park & Burgess	The City.	Concentric zone theory predicts that social pathologies occur disproportionately in transitory areas. Importance of "place".
1960	Faris & Dunham	Mental Disorders in Urban Areas.	Social disorganization increased mental illness hospitalizations. Discredited "drift" hypothesis.
1965	Alameda Study	Alameda Study.	Residence in poverty area correlated with increased risk in all-cause mortality, while controlling for individual level variables.
1965	Whitehall Study	Whitehall Study.	Social gradient of health correlated with health outcomes across all social classes. Low job control correlated with poor health.
1971	Thomas Wan	Status Stress and Morbidity.	Inconsistency theory revealed that when income, education, and occupation become 'inconsistent' morbidity increases.
1980	Black Report	Black Report	Governing explanation for health inequality is material deprivation. Provides policy implications and guidelines.
1996	Susser & Susser	Choosing a Future for Epidemiology.	Changing health patterns and technological advancements have produced a need for eco-epidemiology (i.e. ecological variables).

APPENDIX B: FACTOR ANALYSIS OF SENTINEL HEALTH EVENTS

Confirmatory Factor Analysis was conducted to identify the latent structure for these eleven sentinel health variables:

Label	Condition	ICD-9 Codes	Formula
APP	Appendicitis, Intestinal Obstruction, and Hernia	540-553	Cases / total county population
AST	Asthma, Bronchitis, and Emphysema	490-493	Cases / total county population
CAN	Malignant Neoplasms of the (a + b + c)		
	a. Colo, rectum, and recto-sigmoid junction	153-154	Cases / total county population
	b. Liver and intra-hepatic billary duct	155	Cases / total county population
	c. Trachea, bronchus, lung	162	Cases / total county population
CAN-B	Malignant Neoplasms of the (a + b)		
	a. Female breast	174	All Female Cases / Total female county population
	b. Cervix Uteri	180	All Female Cases / Total female county population
CER	Cerebrovascular Disease	430-438	Cases / total county population
DIA	Diabetes Mellitus	250	Cases / total county population
FLU	Influenza and Pneumonia	480-487	Cases / total county population
HYP	Hypertensive Diseases	401-405	Cases / total county population
INF	Other Infectious Diseases	001-009, 033, 036-038, 050, 055, 084	Cases / total county population
LBW	Low Birth Weight	764-765	All Female (mother) Cases / Total Females between 15-44 years
LIV	Chronic Liver Disease and Cirrhosis	571	Cases / total county population
ULC	Ulcers: Gastric, Duodenal, and Peptic Ulcer	531-533	Cases / total county population

Principal components analysis was conducted via a varimax rotation method. The analysis produced a single-component solution, which was identified through inspection of eigenvalues, variances, and residuals. Following rotation the component accounted for 75.85% of the total variance in the sentinel health variables. This component includes five of the original eleven variables; AST, CAN, DIA, HYP, and FLU. These variables had positive loadings and share an acceptable level of communality.

SHE Variables	Component Loadings
HYP	**.894**
DIA	**.878**
CAN_A	**.866**
AST	**.791**
FLU	**.690**
LIV	.541
INF	.420
CER	.352
LBW	.278
ULC	.245
CAN_B	.038
APP	-.205

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

APPENDIX C: PREVALANCE & SIGNIFICANCE OF SENTINEL HEALTH EVENTS

1. *<u>AST - Asthma, Bronchitis, and Emphysema.</u>*
   (ICD-9 codes 490-493)

Bronchitis refers to an inflammation of the bronchi of the lungs, whereas emphysema refers to a loss of elasticity in the lungs.

In 2001, 20.3 million Americans had asthma, and 12 million had had an asthma attack in the previous year (Center for Disease Control, 2005a). In 2002, asthma costs for health care and lost productivity totaled 14 billion dollars (Environmental Protection Agency, 2004). Asthma is a chronic disease that affects the airways leading to the lungs. Environmental irritants, such as cigarette smoke, mold, and fumes can all trigger an asthmatic event. Asthma (and chronic emphysema) cannot be cured, but these conditions can be controlled through medications and/or bronchodilators. Smoking is strongly associated with the chronic forms of both, bronchitis and emphysema. Steroid medication, supplemental oxygen and the complete cessation of smoking is used to treat these disorders.

This group of breathing disorders is specified in the ICD-9 as: bronchitis not specified as acute or chronic, chronic bronchitis, bronchitis chronic without acute exacerbation, bronchitis chronic with acute exacerbation, bronchitis chronic unspecified, emphysema, asthma, asthma extrinsic with status asthmaticus, asthma extrinsic with acute exacerbation, asthma intrinsic without status, asthma intrinsic with status asthmaticus, asthma intrinsic with acute exacerbation, exercise-induced bronchospasm, cough variant asthma, asthma unspecified, and asthma unspecified with acute exacerbation.

2. *<u>CAN</u> - Malignant Neoplasms of the colo, rectum, and recto-sigmoid junction (153-154), liver and intra-hepatic billary duct (155), or trachea, bronchus, lung (162).*

Cancer (malignant neoplasm) is a class of diseases characterized by uncontrolled cell division and the ability of these cells to invade other tissues, either by direct growth into adjacent tissue (invasion) or by migration of cells to distant sites. Cancer is identified as either benign or metastasized, only metastasized cancer can spread to other body parts. Cancer is one of the leading causes of death in all developed countries. It is the second leading cause of death in the United States, responsible for one of every four deaths (Center for Disease Control, 2005b). In the year 2005, it is expected that over 1.4 million new cases of cancer will be diagnosed, and more than 570,000 Americans will die of cancer. This does not include over 1 million cases of non-melanoma skin cancer. Risk factors for cancer include tobacco use, lack of physical activity, excess weight, poor nutrition, and sun exposure. Neoplasms are commonly treated with surgery, chemotherapy, and/or radiation.

a. *<u>Colo, rectum, and recto-sigmoid junction.</u>*
(ICD-9 codes 153-154)

Colorectal cancer is the second leading cause of cancer-related deaths in the United States. According to the American Cancer Society approximately 145,290 people will be diagnosed with colorectal cancer in the year 2005, resulting in 56,920 deaths (American Cancer Society, 2005b). During the year 2002, there was a reported 1,051,682 individuals with malignant colon and rectum cancer (National Cancer Institute, 2005). Colorectal cancer is very costly with estimates of health are expenditures for 1996 approximately $5.4 billion dollars (Brown *et al.,* 2002).

Colorectal cancer is highly preventable with adequate screening. Reducing the number of deaths from colorectal cancer depends on detecting and removing precancerous colorectal polyps, as well as detecting and treating the cancer in its early stages. Removing precancerous polyps or growths, which can be present in the colon for years before invasive cancer develops, can prevent colorectal cancer. Four tests are recommended for colorectal cancer screening these include the fecal occult blood test, flexible sigmoidoscopy exam, colonoscopy exam, double-contrast barium enema test, and digital rectal examination.

In 2000, the National Health Interview Survey, indicated that only 42.5% of U.S. adults aged 50 years or older had undergone a sigmoidoscopy or colonoscopy within the previous 10 years or had used an FOBT home test kit within the preceding year (Center for Disease Control, 2003). Screening for colorectal cancer was particularly low among those respondents who lacked health insurance, those with no usual source of health care, and those who reported no doctor's visits within the preceding year. Age is also associated with colorectal cancer with more than 90% of cases occurring in individuals over 50 years old. Other risk factors include inflammatory bowel disease, family history of cancer, and lifestyle factors (levels of exercise, diet, alcohol and tobacco use).

The ICD-9 codes this form of cancer as either malignant neoplasm of colon or malignant neoplasm of rectum, rectosigmoid junction and anus.

b. *<u>Liver and intra-hepatic billary duct.</u>*
(ICD-9 code 155)

Cancer of the liver is associated with chronic liver infections, cirrhosis, aflatoxin, being male, family history and older age. In the year 2002, there was a reported 15,512 individuals with malignant cancer of the liver and intrahepatic billary duct. (National Cancer Institute, 2005).

The ICD-9 codes liver cancer as malignant neoplasm of liver and intrahepatic bile ducts.

c. *Trachea, bronchus, lung.*
(ICD-9 code 162)

Lung cancer is the leading cause of cancer related death. In fact, lung cancer accounts for more deaths each year than breast cancer, prostate cancer, and colon cancer combined. During the year 2002, there was a reported 350,679 cases of malignant lung and bronchial cancer (National Cancer Institute, 2005). It is estimated that in year 2005 there will be 172,570 diagnoses of lung cancer, leading to 163,510 deaths (American Cancer Society, 2005a). The financial costs of lung cancer are high. A recent study estimated that the cost of treating lung cancer in the United States in 1996 was about $4.9 billion per year (Brown *et al.,* 2002). Treatment of lung cancer is often negligible due to its high case-fatality rate, yet in terms of prevention, lung cancer remains the worlds leading cause of preventable death (Alberg & Samet, 2003).

Risk factors for lung cancer include exposures to tobacco smoke, occupational substances like radon, and radiation exposure. Avoidance of these harmful substances is the best form of prevention.

The ICD-9 codes trachea, bronchus, and lung cancer as the following: malignant neoplasm of trachea, bronchus, and lung, and lung unspecified.

3. *DIA - Diabetes Mellitus.*
(ICD-9 code 250)

Diabetes mellitus is a condition characterized by varying or persistently elevated blood sugar levels. There are two main forms of diabetes: Diabetes mellitus 1 (caused by decreased production of insulin) and Diabetes mellitus 2 (caused by a decreased sensitivity of body tissues to insulin). Both forms of diabetes are more common in developed countries, many of which have seen an explosion of diabetes in recent years. In the year 2002, it was estimated that 18.2 million people or 6.3 % of the population of the United States had diabetes (National Diabetes Information Clearinghouse, 2005). This represents total annual costs of $132 billion dollars, due to direct medical costs as well as indirect costs due to disability, work loss, and premature mortality (National Diabetes Information Clearinghouse, 2005). Diabetes carries inherent risk of kidney failure, blindness, heart disease, and limb amputation. Although there is currently no cure for diabetes, disease management occurs through lifestyle change in diet and exercise, insulin injections, and foot care.

Diabetes is coded in the ICD-9 as the following: diabetes mellitus, diabetes II unspecified without complications not controlled, diabetes I uncomplicated, diabetes II unspecified without complications uncontrolled, diabetes I uncontrolled, diabetic ketoacidosis uncontrolled, diabetes I with renal changes, diabetic retinopathy background, diabetes I with neurological changes, neuropathy diabetic, diabetes II unspecified with neurological manifestation uncontrolled, hypoglycemia diabetes II unspecified not uncontrolled, hypoglycemia diabetes I, diabetes II with unspecified complications, and diabetes I with unspecified complications.

4. *FLU - Influenza and Pneumonia.*
(ICD-9 codes 480-486, 487)

Pneumonia is an inflammation of the lungs, usually caused by a bacteria, virus, fungus, or parasite. There are two categories of pneumonia, hospital acquired pneumonia and community acquired pneumonia. Hospital acquired pneumonia occur in 5% of individuals in hospitals, typically in individuals with risk factors such as mechanical ventilation, malnutrition, underlying cardiac and pulmonary disease, and immune disorders. Community-acquired pneumonia occurs outside the hospital environment, this form of pneumonia represents the sixth most common cause of death in the United States. It is estimated that each year the United States has 40,000 deaths and 500,000 cases of pneumonia (National Institute of Health, 2004).

The influenza is a common disease that has considerable economic costs in health care and lost productivity. The 20th century has had several large-scale pandemics leading to the deaths of millions of people. Within the United States, approximately 5-20% of the population suffers from the influenza each year. This leads to over 200,000 hospitalizations and 36,000 deaths each year (Center for Disease Control, 2005c). People with chronic medical conditions, the elderly and very young children are at increased risk. Influenza reaches it peak prevalence in winter. It is a viral condition therefore antibiotics are ineffective, instead adequate rest, rehydration and medications are used to treat the symptoms.

Influenza and Pneumonia are coded in the ICD-9 in the following manner: viral pneumonia, pneumonia SARS associated coronavirus, pneumonia viral unspecified, pneumococcal pneumonia, other bacterial pneumonia, pneumonia bacterial unspecified, pneumonia due to other specified organism, mycoplasma pneumonia, bronchopneumonia organism unspecified, pneumonia organism unspecified, influenza, influenza with pneumonia, and influenza with other respiratory manifestations.

5. *HYP - Hypertensive Diseases.*
(ICD-9 codes 401-403)

Hypertension or high blood pressure is a medical condition where the blood pressure in the arteries is chronically elevated. Persistent hypertension is one of the risk factors for strokes, heart attacks, heart failure and arterial hypertension, and is a leading cause of chronic renal failure. Cardiovascular disease remains the most common cause of death in industrialized countries, and hypertension is the most frequent treatable risk factor. It is estimated that 28% of residents of the United States are hypertensive (Wolf-Maier *et al.*, 2003).

Mild to moderate hypertension can be treated through weight loss, regular exercise, and the elimination of smoking Moderate to severe hypertension may add drug therapy to the course of treatment. The ICD-9 lists hypertensive diseases in the following categories: essential hypertension, hypertension malignant, hypertension benign, hypertensive heart disease, hypertensive renal disease, hypertensive renal disease unspecified with renal failure, hypertensive heart and renal disease, hypertension renovascular malignant, and hypertension renovascular benign.

APPENDIX D: ICD-9 CODES FOR OF SENTINEL HEALTH EVENTS

(Source: American Medical Association, 2004)

Sentinel Health Event	ICD-9 Code	Specific ICD-9 Codes	
(AST) *Asthma, Bronchitis, and Emphysema*	(490-493)	490	Bronchitis, not specified as acute or chronic
		491.2	Bronchitis, chronic, w/o acute exacerbation
		491.21	Bronchitis, chronic, w/ acute exacerbation
		492	Emphysema
		493	Asthma
		493.01	Asthma, extrinsic, w/status asthmaticus
		493.02	Asthma, extrinsic, w/acute exacerbation
		493.1	Asthma, intrinsic w/o status
		493.11	Asthma, intrinsic w/status asthmaticus
		493.12	Asthma, intrinsic w/acute exacerbation
		493.81	Exercise-induced bronchospasm
		493.82	Cough variant asthma
		493.9	Asthma, unspecified
		493.92	Asthma, unspecified, w/ acute exacerbation
(CAN) *Malignant Neoplasms of*			
▪ *colo, rectum, and recto-sigmoid junction*			
	(154-154)	153	Malignant neoplasm of colon
		154	Malignant neoplasm of rectum, rectosigmoid junction, and anus
▪ *liver and intra-hepatic billary duct*			
	(155)	155	Malignant neoplasm of liver and intra-hepatic billary ducts
▪ *trachea, bronchus, lung*			
	(162)	162	Malignant neoplasm of trachea, bronchus, and lung
		162.9	Lung, unspecified
(DIA) *Diabetes Mellitus*	(250)	250	Diabetes mellitus
		250.00	Diabetes II/unspecified., w/o complications, not uncontrolled
		250.01	Diabetes, I, uncomplicated
		250.02	Diabetes, II/unspecified., w/o complications, uncontrolled
		250.03	Diabetes, I, uncontrolled
		250.13	Diabetic ketoacidosis, uncontrolled
		250.23	Diabetes, I, w/ hyperosmolarity, uncontrolled

		250.41	Diabetes, I, w/ renal changes
		250.51	Diabetic retinopathy, background
		250.61	Diabetes, I, w/ neurological changes
		250.62	Diabetes, II/unspecified., w/neurological manifestations, uncontrolled
		250.8	Hypoglycemia, diabetes, II/unspecified., not uncontrolled
		250.81	Hypoglycemia, diabetes, I
		250.9	Diabetes, II, w/unspecified complications
		250.91	Diabetes, I, w/unspecified complications
(FLU) *Influenza and Pneumonia*	(480-487)	480	Viral pneumonia
		480.31	Pneumonia, SARS associated coronavirus
		480.9	Pneumonia, viral, unspecified
		481	Pneumococcal pneumonia
		482	Other bacterial pneumonia
		482.9	Pneumonia, bacterial, unspecified
		483	Pneumonia due to other specified organism
		483.0	Mycoplasma pneumoniae
		485	Bronchopneumonia, organism unspecified
		486	Pneumonia, organism unspecified
		487	Influenza
		487.0	Influenza, w/ pneumonia
		487.1	Influenza, w/ other respiratory manifestations
(HYP) *Hypertensive Diseases*	(401-405)	401	Essential hypertension
		401.0	Hypertension, malignant
		401.1	Hypertension, benign
		402	Hypertensive heart disease
		403	Hypertensive renal disease
		403.91	Hypertensive renal disease, unspecified., w/ renal failure
		404	Hypertensive heart and renal disease
		405.01	Hypertension, renovascular, malignant
		405.11	Hypertension, renovascular, benign

APPENDIX E: PARTICIPATING STATE HEALTH DEPARTMENTS AND AGENCIES.

State	Sponsoring Agency	Contact Person	Website
California	Healthcare Information Resource Center	Louise Hand	http://www.oshpd.ca.gov/HQAD/hirc.htm
Florida	Agency for Health Care Administration	Arlene Schwahn	http://www.fdhc.state.fl.us/
Maine	Maine Health Data Organization	Eugene Stanton	http://www.healthweb.state.me.us/start.asp
Maryland	Health Services Cost Review Commission	Brian Jacque	http://www.hscrc.state.md.us/
Nevada	Center for Health Information Analysis	Joseph Greenway	http://health2k.state.nv.us/
New Jersey	Healthcare Cost and Utilization Project	HCUP	http://www.hcup-us.ahrq.gov/home.jsp
South Carolina	SC State Budget & Control Board	Wendy Cimino	http://www.ors.state.sc.us
Washington	Washington State Department of Health	Richard Ordos	http://www.doh.wa.gov/data/data.htm
West Virginia	West Virginia Health Care Authority	Robin Ryder	http://www.hcawv.org

APPENDIX F: UNIFORM CRIME REPORT (UCR) DEFINITION OF CRIME

(Source: Bureau of Justice Statistics, 2005)

Crime	Definition
Murder and Nonnegligent Manslaughter	The willful (nonnegligent) killing of one human being by another
Forcible Rape	The carnal knowledge of a female forcibly and against her will. Included are rapes by force and attempts or assaults to rape. Statutory rape offenses (no force used-victim under age of consent) are excluded.
Robbery	The taking or attempting to take anything of value for the care, custody, or control of a person or persons by force or threat of force of violence and/or by putting the victim in fear.
Aggravated Assault	An unlawful attack by one person upon another for the purpose of inflicting severe or aggravate bodily injury. This type of assault usually is accompanied by the use of a weapon or by means likely to produce death or great bodily harm. Simple assaults are excluded.
Burglary (Breaking or Entering)	The unlawful entry of a structure to commit a felony or theft. Attempted forcible entry is included.
Larceny (Theft except motor vehicle theft)	The unlawful taking, carrying, leading, or riding away of property from the possession or constructive possession of another. Examples are thefts of bicycles or automobile accessories, shoplifting, pocket picking or stealing of any property or article, which is not taken by force and violence, or fraud. Attempted larcenies are included. Embezzlement, 'con' games, forgery, worthless checks etc. are included.
Motor Vehicle Theft	The theft or attempted theft of a motor vehicle. A motor vehicle is self propelled and runs on the surface and not on rails. Specifically excluded from this category are motorboats, construction equipment, airplanes, and farming equipment.
Arson	Any willful or malicious burning or attempt to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.

APPENDIX G: STUDY VARIABLES

Label		Definition	ICD-9 Codes	Formula
EXOGENOUS VARIABLE: Socioeconomic Disadvantage				
INC	Income	% persons below the federally defined poverty line	ST-3: Table DP-4 DP4.C46 / DP4.C45	ST-3: Table P-89 P089002 / P089001
EDU	Education	% persons 25+ no high school diploma	STF-3: DP-2 100% - DP2.C17	STF-3: DP-2 100% - DP2.C28
OCC	Occupation	% persons employed in working class occupations	STF-3: Table 78	STF-3: Table 50
EXOGENOUS VARIABLE: Social Disorganization				
MOB	Residential Mobility	% persons different residence in previous five years	STF-3: Table DP-2 DP2.C21/DP2.C19	STF-3: Table DP-2 DP2.C74/DP2.C70
URB	Urbanization	% persons living in urban area	STF-1: TM-P004	STF-1: TM-P003
FHE	Female Head of Household	% households with female head, no husband present	STF-1: GCT-Pb	STF-2: GCT-P7
FBO	Foreign Born	% foreign born residents	STF-3: Table DP-2 DP2.C46/DP2.C43	STF-3: Table DP-2 DP2.C98/DP2.C86
CRM	Crime	UCR crime rate	UCR data	UCR data
EXOGENOUS VARIABLE: Inadequacy of Health Care Resources				
PHS	Lack of Primary Care Physicians	County Population / Total primary care physicians *	County pop. / F04610-90 + F11996-95 + F11208-90 + F11704-90	County pop. / F04610-00 + F11996-00 + F11208-00 + F11704-00
NRS	Lack of Registered Nurses	County population / Total registered nurses **	County pop. / F09316-91	County pop. / F09316-00
PHM	Lack of Pharmacists	County population / Total pharmacists	County pop. / F08618-90	County pop. / F08618-00
BED	Lack of Hospital Beds	County population / Total hospital beds	County pop. / F08921-90	County pop. / F08921-00

*Primary care physicians include family practice, general practice, general internal medicine, and general pediatrics.
**Registered nurse include full time registered nurses, part time register nurses and licensed practical nurses.

Label	Definition	ICD-9 Codes	Formula
ENDOGENOUS VARIABLE: Sentinel Health Events			
AST	Asthma, Bronchitis, and Emphysema	490-493	Cases / total county population
CAN	Malignant Neoplasms of the (a + b + c)		
	a. Colo, rectum, and recto-sigmoid junction	153-154	Cases / total county population
	b. Liver and intra-hepatic billary duct	155	Cases / total county population
	c. Trachea, bronchus, lung	162	Cases / total county population
DIA	Diabetes Mellitus	250	Cases / total county population
FLU	Influenza and Pneumonia	480-487	Cases / total county population
HYP	Hypertensive Diseases	401-405	Cases / total county population

ENDOGENOUS VARIABLE: Control Variables

RCE	Race	% African-American or Black	STF-1: Table P0006 P0060002 / P0010001… P0010005	STF-1: Table P3 P003004 / P003001
GEND	Gender	% female county population	STF-1: Table QT-P1A QTP1A.C2 / QTP1A.C0	STF-1: Table P3 P012026 / P012001
AGE	Age	% county that is 65+ yrs	STF-1: Table P011 P0110027 +…+ P0110031 / P0010001	STF-1: Table P8 P008035 +…+ P008040 + P008074 +…+ P008079 / P003001

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