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The Association of Spatial Accessibility to Health Care Services with Health Utilization and Health Status Among People with Disabilities

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THE ASSOCIATION OF SPATIAL ACCESSIBILITY TO HEALTH CARE SERVICES WITH HEALTH UTILIZATION AND HEALTH STATUS AMONG PEOPLE WITH DISABILITIES

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ABSTRACT

The purpose of this cross-sectional analysis was to determine the importance of spatial accessibility to health care services utilization and to the health status of persons with disabilities. This study utilizes two datasets (Survey of Access to Outpatient Medical Service in the Rural Southeast and Ohio Family Health Survey) to analyze. *ArcGIS* 9.2 was use to measure spatial accessibility to health care services. Bivariate analysis for health services utilization and health status included *t*-tests, and Chi-square, as appropriate for the level of measurement. Logistic regression models identified for the three outcomes (health care visit, regular check up visit, and perceived poor health status).

The multivariate analyses of "Survey of Access to Outpatient Medical Service in the Rural Southeast" dataset revealed that those residing within an area that had a higher primary physician to population ratio were less likely to have made a health care services visit in the past year. Perceived travel time was significantly associated with poor health status; adults who had to drive longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who were faced with a

shorter drive.

The analyses of the “Ohio Family Health Survey” dataset indicate that participants of the survey who resided within areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Likewise, those residing in areas that had a hospital located within a 30-minute commute were also less likely to report being in poor health.

Further analyses of the Ohio Family Health Survey dataset, which is comprised of data collected from urban and rural areas, revealed that those driving longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who were faced with a shorter drive in urban area. The model of rural areas revealed that those residing within an area that had a higher primary physician to population ratio were less likely to have made a health care services visit in the past year. Adults who had to drive longer time to get health care service were more likely to perceive themselves to be in poor health compared to adults who had a shorter drive. Participants who lived within areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Those having hospital within a 30-minute commute were less likely to report being in poor health.

These results show the importance of spatial accessibility in health care utilization and health status for people with disabilities. These also indicate that spatial accessibility must be addressed in public policy.

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CHAPTER I

INTRODUCTION

1.1 Statement of Purpose

Persons with disabilities are, in general, relatively constrained by a lack of mobility due to the limitations imposed by the disabilities and are thus less likely to travel long distances from their place of residence to access suitable health care services. Consequently they may obtain fewer health care services and medications than they would were health care services distributed in a more spatially accessible pattern. In addition, they are likely to develop more serious illnesses, and require lengthier recovery times. The goal of this study is to determine the importance of spatial accessibility to health care services utilization and to the health status of persons with disabilities.

The U.S. Department of Health and Human Services in its report, “Healthy People 2010” makes an extensive reference to disparities in healthcare between people with disabilities and those without. However, there is little attention paid to this issue in the national health policy and services arena. Only one out of the 212 pages of the 2006 National Health Disparities Report issued by the agency for Health Care Research and

Quality (U.S. Department of Health and Human Services, 2006) is devoted to the health concerns of persons with disabilities, and even that is limited to oral health. Further strengthening this disconnect, persons with disabilities are not recognized by the Health Disparities Collaboratives under the Health Resources and Services Administration (Health Resources and Services Administration, 2007) as a population that faces health disparities.

The National Health Interview Survey of 2004 reports that approximately 34.2 million people in the United States are limited from participating in the usual activities characteristic of day-to-day living (such as walking up ten steps, going shopping, attending club meetings, visiting friends, sewing, reading, bathing, dressing, etc.) on account of their suffering from one or more chronic health conditions. Of the 34.2 million, approximately 17.5 million (almost 51%) are between the ages of 18 to 64 (Adams and Barnes, 2006). Further, per the report, individuals with the lowest levels of education and the lowest earned income are more likely to have an activity limitation. This raises a serious concern regarding spatial access to health care for individuals who have a heightened need for assistance due to their disabilities status that frequently renders them increasingly less mobile.

The Report of the National Advisory Commission on Health Manpower concluded that the reason for observed spatial mal-distributions of health care professionals is their preference for being located in wealthy neighborhoods (National Advisory Commission on Health Manpower, 1967). The issue of spatial accessibility, or the lack thereof, in urban and rural areas has therefore been on the national policy agenda since the late ʹ60s. Since then, considerable research has been conducted to measure the spatial accessibility of health care services, identify areas of provider shortage and reveal disparities in spatial accessibility regarding rural areas (Joseph & Bantock, 1982; Connor, Hillson, & Krugman, 1995; Goodman, Fisher, Stukel, & Chang, 1997; Shi, Starfield, Kennedy, & Kawachi, 1999; Fortney, Rost, & Warren, 2000; Netmet & Bailey, 2000; Lou & Wang, 2003; Arcury, Gesler, Preisser, Sherman, Spencer, & Perin, 2005; Arcury, Preisser, Gesler, & Powers, 2005). These primarily rural area-focused research studies all concluded that distance or the number of health care service providers within a specified area was a definite impediment to the access of health care in sparsely populated areas.

Although concern about spatial accessibility to health care services in urban areas has remained high (Council on Graduate Medical Education, 1998; Heinrich, 2001; Smedley, Stith, & Nelson, 2002), following the mid-`70s very few studies have examined cities in the United States. Guargliardo, Ronzio, Cheung, Chacko, and Joseph (2004) provide two reasons that could explain this discrepancy. First, attention was increasingly focused on the dramatic rise in the cost of care, and the attendant upheaval in health care financing and organization. Second, the spatial accessibility problems have been considered to have remained germane in rural areas but less relevant in congested urban areas. Some researchers, nevertheless, found that distance and time strongly influence health care choice in metropolitan areas where alternatives are readily available (McGuirk & Porell, 1984; Gesler & Meade, 1988).

The role of spatial accessibility in the access to health care depends in part upon population characteristics. People differ in their ability to overcome the friction of distance and in how locational constraints affect their health care service use. Research indicates that people whose mobility is limited by low income or poor access to transportation are relatively sensitive to distance, and are thus more likely to use the nearest health care service (Bashshur, Shannon, & Metzner, 1971; Haynes & Bentham, 1982). In addition, persons with disabilities, in comparison to the general population, have a disproportionate socioeconomic burden. This subset of the population exhibits higher rates of poverty incidence and unemployment, lower educational attainment, slightly higher rates of lack of health insurance or inadequate health insurance (Hanson, Neuuman, Dutwin, & Kasper, 2003) and fewer opportunities to access transportation (Drainoni, Lee-Hood, Tobias, Bachman, Andrew, & Maisel, 2006; Iezzoni, Killeen, & O'Day, 2006). It is therefore, relatively difficult for persons with disabilities to access health care services. These limitations are thus a pernicious combination of socioeconomic disadvantages coupled with limited mobility.

Primary care physicians or health care professionals affiliated with physicians' offices, clinics and hospitals are typically the providers of health care services for persons with disabilities. Difficulties associated with accessing these health care services may result in persons with disabilities obtaining a less than optimal level of health care services. Consequently, their health status may not be on par with that of those who have greater ability or fewer limitations to access services. In other words, for persons with disabilities, availability of adequate access to health care services can increase the possibility of their availing themselves of the health care services and could result in a betterment of their health status. To determine the validity of these lines of reasoning, this study will examine the association of spatial accessibility of health care services (i.e. primary care physicians, doctors, hospital) to the utilization of health care services and health status of persons with disabilities. By employing Geographical Information

Systems (GIS) to develop a quantitative measure of the spatial accessibility to health care services for persons with disabilities and utilizing a measure that captures perceived spatial accessibility this study will address the gap in literature associating spatial accessibility to health care service with health care services utilization and health status for persons with disabilities.

This study utilizes two datasets to analyze: (1) the association between health care services use as experienced by persons with disabilities and spatial accessibility to health care service, given a set of predisposing variables (gender, age, education, race, marital status and tobacco use),[1] and enabling variables (income, health insurance coverage, usual source of care); (2) the association between the health status experienced by persons with disabilities and spatial accessibility to health care service, given a set of predisposing variables (gender, age, education, race, marital status and tobacco use), enabling variables (income, health insurance coverage, usual source of care),[2] and health care services use (health care visit and regular checkup); (3) the association between health care use as experienced by persons with disabilities and spatial accessibility to health care service, given a set of predisposing variables (gender, age, education, race, marital status and tobacco use), enabling variables (income, health insurance coverage, usual source of care), and differing geographical region of residence; (4) the association between the health status experienced by persons with disabilities and spatial accessibility to health care service, given a set of predisposing variables (gender, age, education, race, marital status and tobacco use), enabling variables (income, health

[1] Predisposing component is defined as variables that exist before the onset of the illness that describe the individual propensity to use services (Andersen, 1995).
[2] Enabling component are the means or resources individual have available for the use of services (Andersen, 1995).

insurance coverage, usual source of care), health care use (health care visit and regular checkup) and differing geographical region of residence.

1.2 Methodological Framework for the Study

The philosophy and theoretical framework for this study have been derived from a revised version of the Andersen Behavioral Model (Andersen, 1995). The advantages of applying this model to the study have to do with its relative simplicity, inclusiveness, and usefulness in the literature for both the general and vulnerable populations (Andersen, Rice, & Kominski, 2001; Gelberg, Andersen, & Leake, 2000; Lim, Andersen, Leake, Cunningham, & Gelberg, 2002; Swanson, Andersen, & Gelberg, 2003). While this model has been frequently used in the assessment of health care utilization (Bradley, McGraw, Curry, Buckser, King, & Kasl, 2002; Chou & Chi, 2004; Lin, Wu, & Lee, 2003, 2004; Krahn, Farrell, Gabriel, & Deck, 2006; Pruchno & McMullen, 2004) and health status determination (Gelberg et al., 2000; Suzuki, Krahn, McCarthy, & Adams, 2007), it has rarely been adapted for studying persons with disabilities. The model has been utilized in studies conducted in the United States as well as those internationally and is most often cited as being useful in capturing health access measures and health care services utilization (Thind, 2004; Arcury et al., 2005a, 2005b; Ricketts & Goldsmith, 2005). The model is amenable to modification in a manner which would enable it to be applied to studying persons with disabilities; a discussion of this follows in Chapter 2.

This study utilizes two dataset for secondary analyses, and the unit of analysis is the individual. The first dataset is from the South Rural Access Program Survey of Access to Outpatient Medical Services. This dataset was collected as part of an evaluation of the Southern Rural Access Program (SRAP), a Robert Wood Johnson Foundation (RWJF) initiative to improve access to health care services in select rural areas of eight states: Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, West Virginia, and Texas (Beachler, Holloman, & Herman, 2003). The survey collected baseline data to assess adult's use of outpatient physician services, reported barriers to care, and health status. Herein, the information collected regarding respondents' place of residence and their health care providers' location was used to estimate, by utilizing GIS, the time taken to travel to the provider of outpatient physician services. This calculated travel time, as well as perceived travel time, ratio of primary care physician to population within Primary Care Service Areas (PCSA), and federal qualified hospital within PCSA is used to examine the importance of spatial accessibility to health care services in use of health care services and health status for persons with disabilities in the rural South.

The second dataset is derived from the Ohio Family Health Survey of 2008. This dataset has been obtained from The Center for Community Solutions in Cleveland. The dataset was populated through a statewide telephone survey that was conducted between August 2008 and January 2009, by the Ohio Department of Job and Family Services in collaboration with several other state agencies. The Ohio Family Health Survey provides data that is essential for understanding health care and insurance issues in Ohio and for creating an informed strategy for health care reform. It supplies policy makers with information about the health insurance coverage, health status, health care services utilization and health care access for Ohioans. This dataset only includes the information on respondents' residence; travel time to health care service providers is estimated based on secondary data and is therefore not precise. Information on the interaction between participant and health care provider is compiled using *ArcGIS* 9.2 based on spatial data of health care services in Ohio (e.g., point shapefile of hospital and zip code shapefile of primary care physician). These measures of spatial accessibility and perceived travel time to obtain health care services are used to examine the importance of spatial accessibility to health care services utilization by persons with disabilities in Ohio. A discussion of the two datasets and the calculation of spatial accessibility follow in Chapter three.

1.3 Concepts of the Study

In order to maintain clarity in the following discussion, a few key terms are defined.

1.3.1 Persons with disabilities

A distinguished impairment, disabilities, and handicap according to the definitions of health from the World Health Organization are as follows: impairment refers to reduced physical or mental capacities that result from some organic disturbance or malfunction, such as impaired vision. Many of these impairments can be corrected. If impairments are not corrected, disabilities (a restriction on a person's ability to perform his or her normal physical and social roles or functions) may result. Handicaps reflect situations that result in social disadvantages (such as social stigma or loss of one's job) arising from the person's disabilities (Aday, 1989, p. 149).

The American Medical Association's (AMA) *Guides to the Evaluation of Permanent Impairment* helps physicians evaluate a patient's impairment. The AMA specifically defines different impairments: a condition where a person's limb, organ, muscular system, or skeletal system does not function in the normal fashion. The *Guides to the Evaluation of Permanent Impairment* reiterates that permanent disabilities implies a condition whereby a person's impairment could prevent him or her from working or even from conducting activities of day to day living (Cottman, 1995).

The *Americans with Disabilities Act* (ADA) of 1992 defined disabilities to include pathology/impairment as well as functional and social role limitations. Per the ADA's perspective; a person with disabilities is an individual who: (1) has a **physical or mental impairment** (orthopedic, visual, speech and hearing impairments, cerebral palsy, epilepsy, muscular dystrophy, multiple sclerosis, cancer, heart disease, diabetes, mental retardation, emotional illness, specific learning disabilities, HIV disease, tuberculosis, drug addiction, and alcoholism) that substantially limits at least one of the **major life activities** (performing manual tasks, caring for oneself, walking, seeing, hearing, speaking, breathing, learning, working, and participating in daily community living), or (2) has a record of such an impairment, or (3) is regarded as having such impairment (29 U.S.C. 705). The ADA Amendments of 2009 expanded the interpretation of the ADA's coverage and the definition of what "disabilities" entailed. The ADA Amendments Act provides an extensive list of those tasks that constitute "major life activities," including physical tasks such as walking, standing, and lifting; mental tasks such as learning, reading, and thinking; and even the operation of major bodily functions, such as immune system function, cell growth, and reproductive function. The ADA's definition provides the most encompassing civil rights public policy affecting the lives of persons with disabilities to date (Meyen & Skrtic, 1995, p.69). Thus, the study will adapt ADA's viewpoint to focus on **people with any condition that substantially limits life activities, but will not consider the question of the nature of the disabilities.**

1.3.2 Access

In the health care services research literature, "access" has multiple definitions, and its meaning in a given context is too often assumed (Khan & Bhardwaj, 1994). Access is defined by Aday and Andersen (1981) as the "ability to use health care services when and where they are needed". They consider wider definitions of accessibility that go beyond spatial accessibility to consider financial, informational and behavioral influences.

Penchansky and Thomas argue that "access is most frequently viewed as a concept that somehow relates to consumers' ability or willingness to enter into the health care system" (Penchansky and Thomas, 1981, p. 128). Therefore, they define access as "a concept representing the degree of 'fit' between the clients and the system" (Penchansky and Thomas, 1981, p. 128). This definition not only provides a broad definition of access, but also describes access as a multifaceted construct that balances features of the system of health care provision, the expectations and perceptions of consumers (both potential and actual), and the resources available to both. The authors categorize "access" as consisting of five dimensions (Penchansky and Thomas, 1981): ***availability***, or the resources and supplies available and provided by the health care system; ***accessibility***, or the transportation, distance and time to the health care service; ***accommodation***, or the health care system's responsiveness to consumer constraints and needs, as in wait times and response to service requests; ***acceptability***, or the extent to which health care delivery meets consumer expectations; and ***affordability***, or the cost of health care. Of these five dimensions, spatial considerations figure most prominently in the first two. Availability refers to the number of health care service providers from which a client can choose. Accessibility is travel impedance (distance or time) between patient location and health care service providers. These two dimensions — availability and accessibility — are partially spatial in nature. They address the adequacy of the supply of health care providers inside a region and travel impedance to health care providers outside the region, respectively. The last three dimensions are essentially non-spatial. They address health care financing arrangements and access barriers created by socio-economic and cultural factors (Guagliardo, 2004). Thus, spatial access emphasizes the importance of spatial separation between supply and demand of health care services as a barrier or a facilitator, whereas non-spatial access stresses non-geographic barriers of facilitators (Joseph and Phillips, 1984).

Following the conclusions articulated in the literature, access is defined for the purposes of this study as including two dimensions: non-spatial access and spatial access. (1) non-spatial access refers to socioeconomic access and is achieved when user characteristics (e.g., demographics such as income, age, gender, ethnicity or behavior) facilitate access; (2) spatial access refers to geographic or physical access and is a function of user characteristics pertaining to geographic factors (e.g., distance and travel time, the number of health care services providers from which a client can choose within a certain area) and the physicians per capita ratio within an area. As these two dimensions are inter-related, to reach any definitive conclusion on the association between spatial access factors and health care utilizations among persons with disabilities, any confounding effects caused by non-spatial factors will be controlled for.

1.3.3 Spatial Accessibility

Spatial accessibility for GIS-based analysis is focused on the interaction between the individual seeking health care services and the provider of health care services. Joseph and Phillips (1984) classified accessibility into two categories: revealed accessibility and potential accessibility. Revealed accessibility focuses on actual use of a service, whereas potential accessibility signifies the probable utilization of a service. Therefore, revealed spatial accessibility is calculated based on actual interaction between demand (patient) and supply (health care services provider), such as travel time from patient's residence to the place where patient received service. On the other hand, because there is no actual interaction between demand and supply, potential spatial accessibility is defined as the availability of that service moderated by space, or the distance variable (Khan, 1992). The measure of potential spatial accessibility generally assumes that given a reasonable range, the individual seeking health care service can obtain the service, and that every member of the population is a potential user of the health care service.

Of the two datasets that this study utilizes the South Rural Access Program Survey dataset provides detailed information on the interaction between participants and health care providers, and the revealed spatial accessibility will be represented by travel time, which can be calculated using GIS or estimated based on the perception of the participants. The primary care physician to population ratios and Primary Care Service

Area with federal qualified health care center,[3] which are included in the dataset of the survey, will represent potential spatial accessibility. The Ohio Family Health Survey 2008, unlike the South Rural Access Program Survey of Access to Outpatient Medical Services 2002, does not provide sufficient information on the interaction between participant and health care services provider, to enable estimation of actual travel time to health care services. The measure "perceived travel time" to health care services provider is used instead to estimate spatial accessibility. Potential spatial accessibility is represented by the potential ratio of primary care physician to population within a 30 minute driving area,[4] and a 30-minute driving radius with hospital.

1.3.4 Health Care Utilization

Utilization of health care services is a multifaceted concept. Aday and Andersen (1981) define utilization of health care services as being characterized by the type, site, and purpose of the service provided as well as the time intervals (unit of analysis) between visits. The "type" of healthcare service utilization refers to the category of service rendered (e.g., physician's, dentist's, or other practitioner's services; hospital services). "Site" refers to the location of the health care service. The "purpose" refers to the reason the health care service was sought: for health maintenance in the absence of symptoms or the presence of mild symptoms (primary care), for the diagnosis or

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[3] Primary care service area was created by Dartmouth Medical School and Virginia Commonwealth University for the entire U.S. by linking patient home and physician office zip codes from national Medicare outpatient visit claims data for 1996. Federal qualified health centers (FQHCs) must provide primary care services for all age groups. FQHCs must provide preventive health services on site or by arrangement with another provider. Other requirements that must be provided directly by an FQHC or by arrangement with another provider include: dental services, mental health and substance abuse services, transportation services necessary for adequate patient care, hospital and specialty care.

[4] The US federal government uses the physical distance equivalent of 30-min travel time by road as a foundational component of definition of accessibility (Luo, 2004, p. 7; US Department of Health and Human Services, 2006).

treatment of illness in the interest of returning to a previous state of well-being (secondary care), or rehabilitation or maintenance in the case of a chronic health condition (tertiary care). The unit of analysis refers to measures of: (1) contact, based on whether the services were received during a particular time period (e.g., seeing a physician within the previous year); or (2) volume, the total units of service received during that period (e.g., number of visits to a physician within a year) (Ady and Awe, 1997, p. 157-158). For the purposes of this study, health care services utilization is defined as visits paid by the patient to the physician or other health care professionals for a health condition or routine checkup within the past 12 months, not considering the number of visits paid, i.e., the consideration is whether a visit was made or not and not necessarily how many visits were made.

1.3.5 Health Status

Health outcomes are results of interactions among individual biology and behavioral variables, the physical and social environments, interventions of health policy, and access to good health care services (Eberhardt, Ingram, & Makus, 2001). Moreover, there are many structural, financial, and socio-cultural factors which function as impediments for people to have access to good health care services. These factors and impediments are integrated into a complex causational relationship, and they affect people's health-seeking behavior, as well as health services utilization, which in turn can lead to adverse health outcomes (Aday & Andersen, 1974; Eberhardt, Ingram, & Makus, 2001). In their study Aday and Andersen (1974) defined and measured health outcomes as a composite of the patient's health status, patient's satisfaction with the quality of the health care services received, and the patient's quality of life. Health status can be measured by the rate of improvement in the condition of the illness or a patient's personal rating of health. Measures of consumer satisfaction refer to such variables as the percentage of the study population who were satisfied or dissatisfied with the convenience, cost, coordination, courtesy, medical information, and overall quality of care received and the percentage of patients who sought but did not receive medical care and the reasons behind it (Aday and Andersen, 1974). In this study measures pertaining only to the patient's personal ratings of health are considered, consumer satisfaction is not included in the analysis.

In addition, definition of health status concepts and measures differ depending on the paradigm in which they are defined and as such they may be objective or subjective. The public health field has generally favored a more objective focus to health status definitions. This preference is originally based on the argument that subjective ratings are not reliable and objective measures are more valid. However, subjective measures of how people regard the status of their health, regardless of whether that perceived assessment is correct or incorrect, have proven to be valid for understanding patient-initiated demand for medical care (Manning, Newhouse, & Ware, 1982). Another argument in favor of the more subjective measures is that they permit finer discriminations among people throughout the full range of the health status continuum (Ware, Davies-Avery, & Donald, 1979). Therefore, subjective, self-reported health status information may include bias but may also be more accurate as that subjective assessment is what leads a patient to seek medical attention and since that this the crux of what this study examines the definition of health status as applied in this study refers to a patient's subjective evaluations of his/her own health status.

1.4 Delimitations

Both males and females, over 18 years of age, with any condition that substantially limits life activities are included in this study. The case study of Southern Rural Access Program Survey of Access to Outpatient Medical Service only focuses on 150 non-metropolitan counties, all of which demonstrated greater socioeconomic need than other non-metropolitan counties in Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, West Virginia, and Texas (approximately 50 percent higher average poverty rates, 30 percent higher unemployment, and 40 percent greater minority proportions). The study region in Ohio Family Health Survey includes all counties of Ohio.

Primary care physicians or health care professionals affiliated with hospitals are typically the source of physical health care services for persons with disabilities. Primary care physicians provide both the first contact for a person with an undiagnosed health concern as well as continuing care for varied medical conditions, not limited by cause, organ system, or diagnosis. Hospitals utilize specialist knowledge/skills, or provide more intensive care than can be provided by primary care physicians. Therefore, primary care physicians and hospitals are two important resources for health care services. The spatial accessibility to health care services of this study will refer to spatial accessibility of primary care physicians and hospitals. As the definition of health status in this study refers to the patient’s own perceived “general” health condition, the concept of health care services does not include special services.

1.5 Implications of Study

Southern states consistently rank among the least healthy states in the United States. *America's Health: State Health Rankings* (United Health Foundation, 2002) ranks Louisiana as the unhealthiest state, followed by Mississippi, South Carolina, and Arkansas. Other Southern states also ranking among the top ten least healthy states are Alabama, West Virginia, and Georgia. The case study of the Southern Rural Access Program Survey of Access to Outpatient Medical Service can provide evidence of the importance of spatial accessibility to outpatient physician care in health care services utilization and health status for persons with disabilities and in so doing can serve as an useful tool for policymakers, health care providers, the public, and researchers in their efforts to improve access to health care services among persons with disabilities in rural areas of the southern states.

The existing disparities in the access to health care services and the resulting adverse health outcomes are public health issues of concern. The Institute of Medicine (IOM) and the Department of Health and Human Services (USDHHS, 2000) have both articulated the need for policies to improve access to health care services in order to support the improvement of health outcomes (Agency for Health care Research and Quality, 2004). The report *Healthy People 2010* suggests two goals that go toward the betterment of the health status of the citizens of the United States; (1) to increase quality and years of healthy life, and (2) to eliminate health disparities. This study explores the relationship among spatial access, health status, age, education, race and ethnicity, gender, income and socioeconomic status (SES), and place of residence or location of health care services among people with disabilities. The results of the Ohio case study can demonstrate whether spatial accessibility to primary health care services are likely to affect health care services utilization and health status of persons with disabilities residing in Ohio. The analyses of this data could guide the government of Ohio toward; (1) developing policies that are aimed at improving transit options for persons with disabilities to commute to health care service providers or (2) focusing on the distribution of health care services in a manner that reduces transit time for persons with disabilities.

The research applies a health behavioral model to study the health status of persons with disabilities, and considers the spatial dimensions that are apt to affect people's health care seeking behavior. As one of very few studies in the academic literature that addresses these concerns, the study aims to bolster the body of knowledge on the relationship between spatial accessibility and health care services utilization as well as health status, of persons with disabilities. It is hoped that the explicit consideration of spatial dimensions in this analysis will enhance the existing models described in the literature.

1.6 Summary

The United States Department of Health and Human Services (USDHHS, 2000) stipulates in its national health initiative that all people, including the most vulnerable, should have access to health care services that would allow them to lead a productive life. Major health care reform continues to modify the provision of health care services. Improving health care access has become a major social and political issue, and as such it merits careful scientific and geographical analysis.

Persons with disabilities appear to be more sensitive to spatial and socioeconomic barriers to access to primary care service, and these barriers are apt to reduce their ability to utilize health care services. Reduced access among persons with disabilities tends to result in a worsening of their health status.

Application of this model to the assessment of health care services access for people with disabilities will provide an opportunity to evaluate the specific relationship that exists between spatial accessibility to health care services, health care services utilization and health status. In addition, the results carry significant implications for health care planners, policy makers, and other decision-makers involved in decisions regarding optimal location of health care services to consider spatial accessibility to health care service for people with disabilities.

CHAPTER II

REVIEW OF LITERATURE

The literature review is structured as follows; a discussion of Andersen's Behavioral Model (the model that the study employs to test its hypotheses) is followed by a review of the existing literature on the predisposing and enabling health behavioral factors as identified by applying the framework of the model.[5] The focus of this study is on persons with disabilities, a review of the literature pertaining to access to health care services and the degree of disabilities is also presented. The few studies that exist in the current body of knowledge that focus on the association between access to health care services and health status are discussed. Spatial accessibility is an important variable in this study and thus merits a detailed description of spatial accessibility and access to health care services, as well as measures of spatial accessibility.

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[5] Online reference databases used to conduct this literature review included EBSCOhost and Ohiolink. The key contructs included in the literature search were the use of spatial accessibility to health care services, access to health care services, health behavioral model, and persons with disabilities. Studies pertaining to child care or special needs health care were excluded.

2.1 Previous Framework for the Study of Access to Health Care

Andersen's Behavioral Model of Health Services Use is frequently used as a framework for predicting health care services utilization by the general population, the homeless, and persons with disabilities. While the Andersen's behavioral model has evolved and undergone changes over the years (Aday, 1993; Andersen, 1995; Andersen & Newman, 1973; Andersen, 1968), its basic construct still remains the oft-used model of choice to study health care services use in both the sociological and public health literatures. The original iteration of the Andersen Model represents a systems approach to understanding a population's access to health care services and consists of four major constructs: external environmental factors (later renamed as contextual in the 1995 revision of the model), individual or population characteristics, health behaviors and health outcome (Figure 2-1).

As defined by the Andersen's Health Behavioral Model, "e*xternal environment"* was taken to include the prevailing health care policy and the characteristics of the health care delivery system. Health care policy is considered the starting point for the consideration of access to health care services. Aday and Andersen, (1974) suggest that it is the evaluation of the effect of health care policy in altering access to medical care that health planners and policy makers are most concerned with. "*Characteristics of the health care delivery system"* describes the components of the health care delivery system in general. Specifically, "delivery system" is defined as "those arrangements for the potential rendering of health care services to consumers (Aday and Andersen, 1974). This concept is further divided into two main elements: (1) "Resources"—defined as the labor and capital devoted to health care services provision. Resources include health care personnel, physical infrastructure, equipment, and materials for the provision of health care services and health care education and are assessed by both volume and distribution of services. (2) "Organization" – is described as the manner in which the system utilizes/allocates its resources. It also refers to the coordination and control of medical personnel and facilities toward the provision of medical services (Aday and Andersen, 1974). Two subcomponents classified under organization are "entry" and "structure"; entry being the process whereby one gains entrance into the health care system and structure being that which includes all that is encompassed within the patient's experience i.e., what happens to the patient once s/he enters the system. Entry can be measured in terms of travel time, waiting time, etc. while structure can be measured as a function of whom the patient consults and how the patient is treated.

"*Characteristics of the population"* is described as the individual's determinants of health care services use; therefore, in this instance the individual is the unit of analysis. The individual's determinants of health care services use are categorized into predisposing components, enabling components and need components (Aday and Andersen, 1974): (1) "Predisposing component" includes all the variables that existed prior to the onset of the illness that describe the individual's propensity to seek health care services. Variables that constitute this component include age, sex, race, education and values about health and illness. (2) "Enabling component" are the financial means and other available resources (such as health insurance) an individual can access to avail themselves of the health care services. Also included are; the attributes of the community of residence (such as rural or urban, demographic characteristics of the region, etc.) as they have been shown to promote or hinder health care services seeking behavior. (3)

“Need component” refers to the degree of ill-health that spurs a patient to seek health care services. The notion of the need to seek health care services could be either as perceived by the patient him/herself or as pronounced by an evaluation by a professional health care agent (Aday and Andersen, 1974). The former is referred to as “perceived health need” while the latter is referred to as “evaluated health need”.

“*Utilization of health care services***”** is characterized by the type, site and purpose of the service provided as well as the time intervals involved between subsequent visits (Aday and Andersen, 1974). Type refers to the kind of services received (hospital, physician, pharmacy, etc.). Site refers to the place where the service is received. Purpose refers to whether care is preventive in nature, illness related, or custodial. Time interval is measured in terms of contacts, volume, or continuity measures.

“*Health outcomes”* are measured and defined by the health status and consumers’ satisfaction about health care services received, and quality of life (Aday & Andersen, 1974). Health status can be measured by the level of improvement in the medical condition (objective), or through the patient’s personal rating of health (subjective). Measures of consumer satisfaction refers to such variables as the percentage of the study population who were satisfied or dissatisfied with the convenience, cost, coordination, courtesy, medical information, and overall quality of care and the percentage who sought medical care but did not receive it, and the reasons for the gap between the two (Aday and Andersen, 1974). As such these measures include both objective and subjective evaluations.

Per the model then, it follows that health outcomes are a function of an individual’s predisposition to health care services, factors that enable or impede the use of health care services, the individual’s need for care, and the utilization of health care services. Each one of these components makes an independent contribution to the utilization of health care services. The combined effects of environmental characteristics, predisposing characteristics, enabling characteristics, and need are mediated by health care services use to predict health outcomes such as health status. The model is designed to predict and explain utilization of health care services by providing an understanding of the relationship between access, utilization, and health status (Andersen, 1995; Andersen & Davidson, 2001).

This model is used as a framework to review existing literature on the predisposing (including age, gender, race, education, marital status, level of disabilities), and enabling (including insurance, income, usual source of care) components that are particularly useful for the goals of this study. For the purpose of this study, tobacco use is regarded as a predisposing characteristic, because smoking affects health directly (Arcury et al., 2005a).

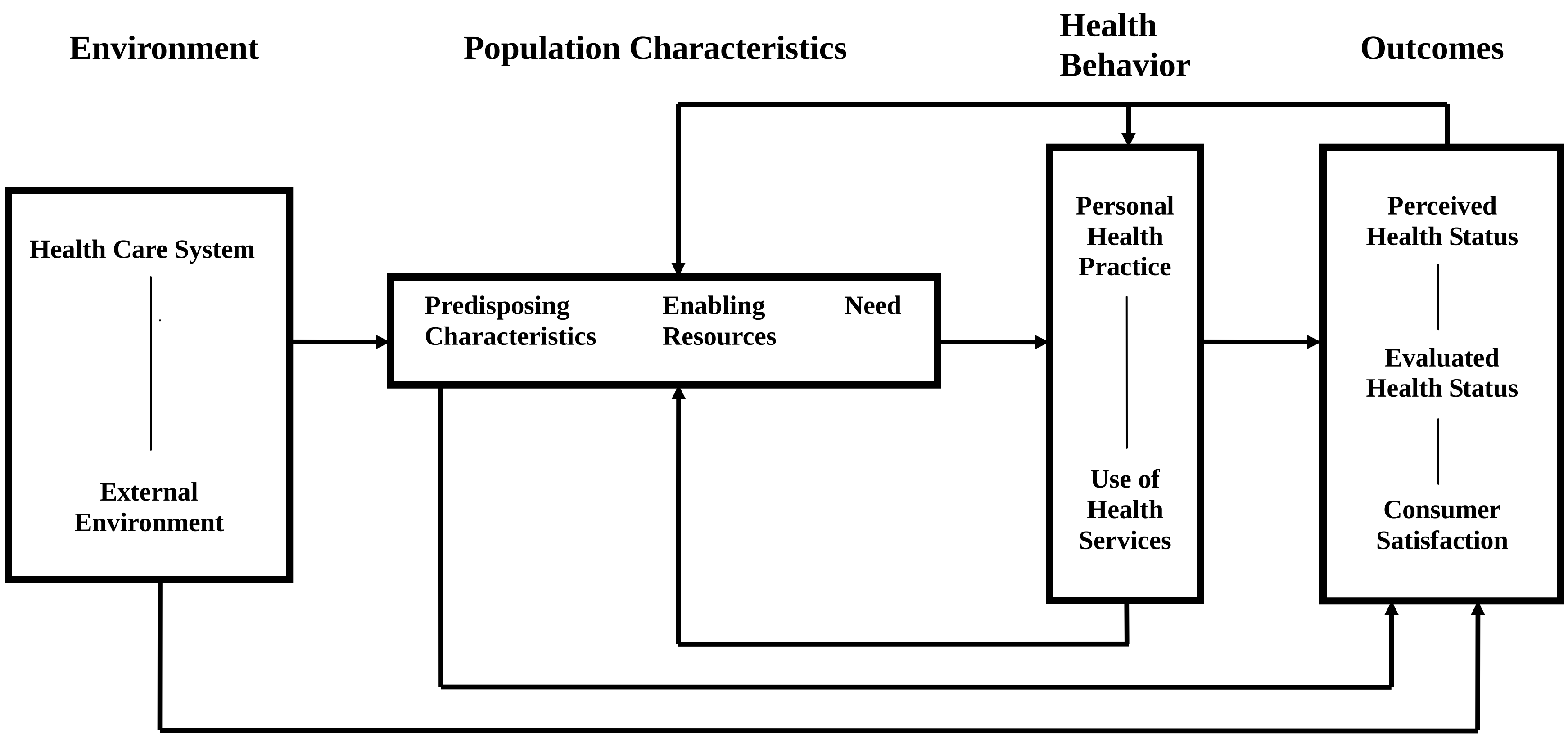

Figure 2-1 Behavioral Model of Health Care Services Use (Andersen, 1995)

Arrows = hypothesized causal orderings;
Solid lines = separate components in the environment, heath behavior, and outcomes. Solid lines do not imply causality or relationship.

2.2 Predisposing Characteristics and Access to Health Care

Particularly pertinent to a description of the conceptual framework utilized for this study, is a review of the existing literature on predisposing and enabling factors as these factors are foundational components of the framework.[6]

2.2.1 Age

General logic dictates that patients of advanced age access health care services on a more frequent basis on account of ailments that are age-related. However, less clear is the question of whether age has a statistically significant effect on the utilization of health care services. Results in the literature appear mixed. For instance, Goodwin and Andersen (2002) used the Behavioral Model of Health Care Use to identify predisposing factors associated with health care service use for treatment of panic attacks[7] among adults in the United States. The sample was drawn from the National Comorbidity Survey (n=8098) between September 1990 and February 1992, a community-based household sample representative of the United States adult (ages 15–54) population. The results of stepwise logistic regression models showed that respondents had 1.1 times more use of psychotropic medication for every year they advance in age (odds ratio = 1.1, 95% confidence interval = 1.03 to 1.1). The results held regardless of gender, race, marital status, education, income level, county availability of psychiatrists, support from friends

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[6] The model presents some difficulties with circularity of need and health status as noted by Andersen (1995), particularly for cross-sectional studies. Because of this, we elected to eliminate the variables of need from the analysis design.

[7] This study only defined panic attacks as a mental health problem. They used three questions to investigate prevalence and correlates of use of primary care, specialized mental health services, and use of psychotropic medication for panic attacks. The questions included: "Have you ever told a physician about these attacks?", "Have you ever seen a mental health professional for these attacks?", and "Have you ever received medication or have you ever taken medication more than once for these attacks?" (Goodwin and Andersen , 2002, p. 213).

and family, perceived health, and evaluated health. Therefore, the study determined that being older was a determinant of medical care use. However, as the study included the use of self-reported data on psychopharmacologic treatment, the conclusions are subject to validity concerns.

In addition, a study by Arcury et al. (2005b) examined the association between individual transportation access characteristics and number of health care visits for chronic care and routine checkups using survey data from a sample of 1059 households located in 12 western North Carolina counties in 1999. The conceptual definition of "transportation access" for the purposes of the study was measured using variables such as possession of a driver's license, knowledge about transit options, use of public transportation, and willingness of a relative to provide transportation to the health care provider. Health care utilization was measured in terms of the total number of visits paid to the health care services provider in the past 12 months, differentiated on the basis of the purpose of the visit; routine check-up or chronic care visits. Arcury et al. (2005) employed multivariable logistic regression models to test if having access to personal or public transportation increased health care service utilization for chronic conditions and for routine checkups among the residents of rural communities. The data was adjusted for personal characteristics, health characteristics, and distance characteristics (2005). The chronic conditions considered in their analysis were: arthritis, diabetes, heart disease, cancer, and asthma. The study found that age was associated with increase in the number of health care visits made. The elderly had 1.17 times more visits for chronic care (odds ratio = 1.17, 95% confidence interval = 1.03 to 1.34) and 1.14 times more visits for routine checkups than those who were younger (odds ratio = 1.14, 95% confidence interval = 1.06 to 1.24). Although the region of observation for this study has many characteristics that make it typical of rural areas in the United States, it also has some unique characteristics that limit the generality of the conclusions of the study.

On the other hand, the study by De Boer, Wijker, and De Haes (1997) found that age is not a significant predictor of health care utilization in the chronically ill.[8] This study employed meta-analysis to review 53 studies published between 1966 and 1997 identified by MEDLINE and ClinPSYCH databases with both univariate and multivariate analyses on hospitalizations and physicians visits.[9] The results of this study showed that a little over half the studies and analyses (18/32) investigated hospital visits by the chronically ill reported no relationship between hospital visits and age. Ten of the thirty-two studies reported that older patients had hospital visit rates that were higher and four studies found that younger patients are higher users of hospital services. Projects concerned with physician visits also obtained ambiguous results: only half (8) of the 15 studies identified age as a statistically significant predictor of physician visits.

In conclusion, a review of these prior published studies indicates that the effect of age on health care services use is hard to predict. Due to the ambiguity in results reported by different studies, this study examines the association between spatial accessibility and health care use while controlling for the effects of age.

2.2.2 Gender

Research on patterns of self-reported health status and health care service use

[8] They defined chronic disease as being permanent, leaving residual disabilities, being caused by a non-reversible pathological alteration and needing special training of the patients for rehabilitation or a long period of supervision, observation, or care (De Boer, Wijker, and De Haes, 1997, p.103).
[9] The measure of hospitalization is volume of outpatient visits, and the measure of physician visits is volume of physician visits (De Boer, Wijker, and De Haes, 1997, p.103).

suggests that females report having poorer health and that after controlling for health measures, females are more likely to obtain formal health care service as opposed to their male counterparts. Green and Pope (1999) explored the effects of gender, self-reported health status, mental and physical symptom levels,[10] health knowledge,[11] illness behaviors[12] and health concerns on utilizations of medical services all of which in combination is defined as "all medical care contacts" (office visits, emergency room visits, hospital admissions, telephone calls and letters). The study compared telephone survey data of a random sample of 2,603 adult members of the Northwest region (the northwest Oregon and southwest Washington) of Kaiser Permanente between 1970—1971 to 22 years of medical record data. The results of the linear regression model demonstrated that being female is a statistically significant determinant of health care services utilization for those over 22 years of age, after controlling for the aforementioned factors. Females accounted for approximately 16% of the variance in all utilization between 1970—1991 (coefficient = 0.156, $p < 0.05$). However, this study did not account for some important variables, such as income and health insurance ownership.

In addition, the aforementioned study by Arcury et al. (2005) found that gender was positively associated with access to health care service utilization. The results of the logistic regression demonstrated that women made 1.26 times more routine health care visits than men (odds ratio = 1.26, 95% confidence interval = 1.03, 1.55). However, gender was not significantly associated with chronic care visit.

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[10] They constructed summated physical and mental health symptom indices.
[11] The study developed a scale of appropriate responses to symptoms to measure the health knowledge.
[12] They conducted two illness behavior indices: the first is based on self reports of illness behaviors and the second on participants' perceptions of their spouses' illness behaviors.

The study by Arcury et al. (2005) examined the significance of distance to the health care service provider as a determinant for routine visits and the possession of a driving license as predisposing and enabling factors respectively, in rural health care service utilization. The study controlled for age, gender, race, tobacco use, income, insurance, mental health, physical health, and number of visits related to a chronic condition. Health care service utilization was the total number of health care service visits in the past 12 months classified based on whether the visit was for a routine check-up visit related to a chronic medical condition, or visit related to an acute medical condition (heart attack, broken bone, sudden fever, severe chest pains, severe asthma attack, etc.). The data for this analysis were based on 1059 survey interviews completed by the Mountain Accessibility Project (MAP) in 12 rural North Carolina mountain counties (Cherokee, Clay, Graham, Haywood, Henderson, Macon, McDowell, Mitchell, Polk, Swain, Transylvania, and Yancey) in 1999 by Research Triangle Institute (2000). The results of logistic regression showed that the females had 1.19 times more chronic care visits (odds ratio = 1.19, 95% confidence interval = 1.03 to 1.38) than males but gender was not significantly associated with routine health care or acute health care visits. The results have to be viewed in a more cautious light, given that participants in the survey could potentially suffer from recall bias in recounting the number of health care visits that they had over a year and under/over-estimate visits.

Long, Coughlin, and Kendall (2002) used a telephone survey of 816 adult Supplemental Security Income (SSI) beneficiaries with disabilities fielded in New York City in 1999—2000 to explore differences in access to and use of health care services among key subgroups of the Medicaid population: adults with physical disabilities, mental illness, and Mental Retardation/Developmental Disabilities (MR/DD).[13] For the purposes of this study, the authors measured "potential access" as the presence of a usual source of care and unmet need. "Realized access" was measured by the actual use of health care services, including visits to the emergency room (ER), hospital stays, outpatient visits for physical and mental health care, and receipt of three preventative health care services—a dental care visit, an immunization against influenza, and for females, a Pap smear. Moreover, "level of disabilities" was measured by the need for help with Activities of Daily Living (ADLs) i.e., bathing, dressing, eating, transferring, using the toilet, or getting around the home and/or Instrumental Activities of Daily Living (IADLs) i.e., preparing a meal, shopping, finances, housework, using the telephone, or managing medications. The results of logistic regression showed that gender had no influence on the use of health care services. Again, like some other studies cited this study failed to control for some variables of potential significance, such as income.

Likewise, 6 of the 13 studies reviewed by De Boer et al. (1997) found that gender had no influence on the frequency of visits made to physicians. While the findings of previous studies regarding the effect of gender on health care services are far from unequivocal this study will use the findings of the Acury et al. (2005) and the Green and Pope (1999) studies to hypothesize that gender may have a statistically significant effect on health care services utilization, and it will therefore be treated as a control variable.

2.2.3 Race

There are well-documented findings and an established literature base on the

[13] The authors do not define MR/DD. Mental retardation is a term that was once commonly used to describe someone who learns and develops more slowly than other kids. Developmental disabilities are birth defects that cause lifelong problems with how a body part or system works.

existence of racial disparities in the access to and use of health care services. Research has consistently shown that Caucasians are more likely to have higher rates of health service utilization than African-Americans and other minorities despite the increased risks these groups have for particular health conditions and differences in health status. Mayberry, Mili, and Ofili (2000) reviewed 400 articles on racial and ethnic differences in health care services utilization published in peer-reviewed journals between 1985—2000. The key words *racial stocks*, *ethnic groups*, *United States*, *health services accessibility*, *barriers to care*, *utilization*, *treatment*, and *diagnosis* were used to conduct an initial search of the MEDLINE database. A second search was then conducted specific to key patient conditions or health service areas, such as cancer, cardiovascular disease and stroke, diabetes, infant mortality, child health, HIV and AIDS, mental health, psychiatric disorders, emergency care, preventive services, and health services utilization. Their review of the literature thus gleaned revealed that racial and ethnic minorities often lack access to health care services at the same rates as Caucasians.

Differences in the performance of cardiac procedures in hospitalized myocardial infarction patients were the focus of the study by Weitzman, Cooper, Chambless, Rosamond, Clegg, and Marcucci (1997). Using population data from the Atherosclerosis Risk in Communities Study the researchers compared cardiac procedure rates across sex, race, and geographical locations in patients hospitalized with myocardial infarction. The sample consisted of 5462 subjects, aged 35 to 74 years, in four different states—North Carolina, Mississippi, Maryland, and Minnesota—who had been hospitalized for definite myocardial infarction. The results of the logistic regression also indicated that the rates of performance of cardiac procedures were associated with gender (Weitzman, Cooper, Chambless, Rosamond, Clegg & Marcucci 1997). The authors defined performance of cardiac procedures as use of cardiac diagnostic or therapeutic procedures. Procedures accounted for include coronary angiography, percutaneous transluminal coronary angioplasty, coronary artery bypass grafting, and intravenous thrombolysis. The results of their logistic regression showed that African-Americans were significantly less likely than Caucasians to have coronary angiography (odds ratio = 0.3, 95% confidence interval = 0.1 to 0.5), coronary bypass graft surgery (odds ratio = 0.4, 95% confidence interval = 0.1 to 0.9), and thrombolytic therapy (odds ratio = 0.4, 95% confidence interval = 0.2 to 0.7). Variables not included in the analysis, include those such as education, income, and usual source of care.

The study by Arcury et al. (2005) determined that African-American respondents had 41 percent of the number of regular care visits of Caucasian respondents (odds ratio = 0.41, 95% confidence interval = 0.24 to 0.71). African-American respondents had 2.31 times as many chronic care visits as Caucasian respondents (odds ration = 2.31, 95% confidence interval = 1.29 to 4.13).

Few studies have however, addressed the effects of race among adults with disabilities. In a study of 816 adult Medicaid beneficiaries with disabilities in New York City, Long et al. (2002) found no difference in physician visits by race (non-Hispanic White, non-Hispanic Black, Hispanic, and other non-Hispanic racial groups) for all disabilities groups included in the study (i.e., physically disabled, mentally disabled, and those with mental retardation and other developmental disabilities).

In all, these researchers used the behavioral model as a theoretical framework for their studies. The literature on race and health care service use is inconsistent for general populations: some researchers found that ethnic minorities often do not have access to health care services at the same rate as their Whites counterparts (Mayberry, Mili, & Ofili, 2000; Weitzman, Cooper, Chambless, Rosamond, Clegg, & Marcucci, 1997) whereas some found that African-American adults utilize more health care services than White adults (Arcury et al., 2005a). Only one study focused on the population with disabilities, but they found no difference in health care use by race. Based on the findings of the majority of the studies that indicate that race is a significant factor in health care services utilization, the effect of race on the use of health care services will be controlled for in the study.

2.2.4 Education

Evidence in the literature indicates that educational attainment is associated with physical health and well-being outcomes, with lower educational attainment being linked to lower health status and well-being. General logic would suggest that higher educational attainment would be associated with better employment prospects and therefore the procurement of necessary resources to obtain adequate health care. However, in studies on the general population, the effect of level of educational attainment on frequency of physician visit has been mixed. In 8 out of the 10 studies reviewed by De Boer and her colleagues (1997) to examine educational attainment and health care service utilization, educational attainment was found to have no effect on the number of physician visits. Educational attainment was not associated with volume of outpatient visits in 9 out of 14 studies. In those inquiries in which education did appear to be a predictor of hospital use, the direction of the influence was unclear. Three studies found that the less educated were more frequent users of health care services while two other studies found that patients with higher educational attainment were more frequent users.

Gelberg et al. (2000) tested the Behavioral Model for vulnerable population in a prospective study designed to determine predictors of the health care services use[14] and physical health status within homeless adults. The sample consisted of 363 homeless[15] individuals living along Skid Row and the Westside areas of Los Angeles who were interviewed and examined for four health conditions (high blood pressure, functional vision impairment, skin/leg/foot problems, and tuberculosis skin test positivity). The logistic regression results showed that educational attainment had no effect on health service use, after controlling for other factors (age, gender, race, work, criminal history, mental status, health status, drug and alcohol use, regular source of care, insurance, income etc.).

Long et al. (2002) used a telephone survey of 816 adults with disabilities in New York City between 1999—2000 to explore differences in access to and use of health care services among adults with physical disabilities, mental illness, and MR/DD. They found that education had no effect on physician visits by the population with disabilities studied (i.e., the physically disabled, mentally disabled, and those with mental retardation and developmental disabilities).

On the other hand, the study by Arcury et al. (2005), cited earlier, found that

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[14] Use of health services was defined as having seen a clinician for high blood pressure, skin or leg problems, or vision impairment.

[15] Individuals were considered to be homeless if, at some point in the past 30 days, they had spent at least one night in (1) a setting that was either defined as a temporary shelter, a location not designed for shelter, or an impermanent arrangement for which they did not pay; or (2) a program for homeless individuals that defined stays as temporary.

levels of educational attainment were associated with differences in health care services utilization. Patients with higher levels of educational attainment were found to be more likely to visit health care service providers than those who had lower levels of educational attainment. This effect was observed particularly with visits for chronic health care, with participants making 1.16 times more visits associated with chronic care for each additional year of education (odd ratio = 1.16, 95% confidence interval = 1.12 to 1.22) however, education had no effect on visits for routine check-ups.

While the results of these studies taken into are inconclusive, the burden of proof suggests that levels of educational attainment are associated with health care services utilization (Arcury et al., 2005). For this reason level of educational attainment is included as a variable in the model.

2.2.5 Others

Recent studies have included marital status and tobacco use in their analyses of health care services utilization behavior. In the majority of studies (10 of 13) that included marital status as a variable, marital status was found to have no effect on utilization of health care services (De Boer et al., 1997). Three studies concluded that single patients accessed health care services on a more frequent basis. Coughlin et al. (2002) relied on Andersen's Behavioral Model to examine health care access, use, and satisfaction within the working age, and Medicaid population with disabilities. Interviews were conducted by telephone and 1797 observations were recorded (840 from New York City and 957 from Westchester County) in 1998 by the Mathematica Policy Research, Inc. Three categories of disabilities were used—physical or sensory impairment, mental illness, and MR/DD impairment,[16] and the level of disabilities was measured by the need for help with ADLs and/or (IADLs). The results of logistic regression showed that living alone had no effect on the frequency of health care services utilization. As the study was restricted to subjects who resided in a urban area, the results cannot be non-urban areas.

Persons with disabilities are especially reliant on family and loved ones for their mobility; therefore, it is extremely pertinent to include the marital status variable for the purposes of this study. In so doing, it is expected that any bias arising from omitted variables can be avoided.

The results of the logistic regression analysis in the study by Arcury et al. (2005) demonstrated that tobacco users, as opposed to non-users, had a 72 percent higher rate of health care services visits for routine check-ups compared to nonusers (odds ratio = 0.72, 95% confidence interval = 0.54 to 0.97) thus indicating that the variable "tobacco use" is associated with health care services utilization behavior and would be a good addition to the model.

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[16] The authors do not define MR/DD. Mental retardation is a term that was once commonly used to describe someone who learns and develops more slowly than other kids. Developmental disabilities are birth defects that cause lifelong problems with how a body part or system works.

Table 2-1 Summary of Predisposing Characteristics and Access to Health Care Literature

Authors	Sample	Method	Independent variables	Finding
Arcury, Preisser, Gesler, and Powers 2005	1059 participants located in 12 western North Carolina rural counties	Logistic regression, GIS	Driver's license, family ride, gender, age, education, physical health, mental health, health insurance	Individuals of advanced age utilize health care services for routine checkups and chronic care more often than younger individuals.
Goodwin and Andersen 2002	8098 adults (15-54) drawn from the National Comorbidity Survey	Logistic regression	Gender, race, marital status, education, income level, county availability of psychiatrists, support from friends and family, perceived health, evaluated health	Individuals of advanced age utilize psychotropic medications more than younger individuals.
De Boer, Wijker, and De Haes 1997	53 studies with both univariate and multivariate analyses on hospital and physicians visits	Literature review		Age is not a predictor of hospital and physicians visit.
Green and Pope 1999	2603 (adult members of northwest Oregon and southwest Washington of Kaiser Permanente)	Liner regression	Gender, self-reported health status, mental and physical symptom levels, health knowledge, illness behaviors and health concerns	Females are more likely to access health care services (office visits, emergency room visits, hospital admissions, telephone calls and letters) than males.
Arcury, Gesler, Preisser, Sherman, Spencer and Perin 2005	1059 participants located in 12 western North Carolina rural counties	Logistic regression, GIS	Driver's license, family ride, gender, age, income, physical health, mental health, distance to care for regular visit, tobacco use	Females access health care services for chronic care more often than males. Gender was not a significant predictor for routine checkups and acute care visits.

Authors	Sample	Method	Independent variables	Finding
Arcury, Preisser, Gesler, and Powers 2005	1059 participants located in 12 western North Carolina rural counties	Logistic regression, GIS	Driver's license, family ride, gender, age, education, physical health, mental health, health insurance	Females access health care services for routine checkups more often. Gender was not a significant predictor for chronic care visits.
Long, Coughlin and Kendall 2002	816 adult SSI (Supplemental Security Income) beneficiaries with disabilities fielded in New York City	Logistic regression	Mental illness, MR/DD, age, gender, race, health status, mobility limitation, number of activity limitations	Gender was not a significant predictor.
Mayberry, Mili, and Ofili 2000	400 articles on racial differences in health care services utilization	Literature review		Minorities often do not have access to health care services at the same rates as Whites.
Weitzman, Cooper, Chambless, Rosamond, Clegg, and Marcucci 1997	5462 hospitalized MI patients in four different states: North Carolina, Mississippi, Maryland, and Minnesota	Logistic regression	Race, gender, geographical area	African-American's utilization of health care services for cardiac procedures is at a rate less than that as utilized by Whites.
Arcury, Gesler, Preisser, Sherman, Spencer and Perin 2005				African-Americans access health care services for routine checkups and chronic care more often.
Long, Coughlin and Kendall 2002				Race was not a significant predictor of health care utilization.
De Boer, Wijker, and De Haes 1997				Three studies found that individuals with lower levels of educational attainment were more frequent users of health care services, but two other studies found that individuals with higher levels of educational attainment were more frequent users.

2.3 Enabling Characteristics and Access to Health Care

"Enabling characteristics" are those attributes that enable an individual's need or perceived need to utilize health care services and as such it has two major dimensions; (1) an individual's ability to pay for health care services consumed and (2) the availability of the required health care service in the vicinity of the individual's residence. Socioeconomic status is (SES) linked to resource availability, and individuals with a higher SES are therefore, expected to have greater access to material (e.g., income) and nonmaterial resources (e.g., health insurance) that can enable greater access to health care services utilization. With the costs associated with medical care being significant, individuals of a lower SES are hypothesized to possess attributes that do not enable greater access to health care services.

2.3.1 Income

Arcury et al. (2005) concluded that household income was associated with utilization of health care services; individuals with an annual household income of more than $40,000 were associated with 2.93 as many chronic care visits as individuals with a household income less than $20,000 (odds ratio = 2.93, 95% confidence interval = 1.63 to 5.21).

Relying on Andersen's Behavioral Model to examine health care access, utilization, and satisfaction within the working age Medicaid population with disabilities Coughlin et al. (2002) through the results of logistic regression of 1797 observations (840 from New York City and 957 from Westchester County) demonstrated that annual income less than $10,000 had no significant influence on the frequency of utilization of physician services.

De Boer et al. (1997) found that of the studies reviewed three indicated that a lower household income was linked to greater utilization of health care services. However, six of the studies reviewed indicated that household income was not a significant predictor of health care services utilization. Five out of the six studies that investigated the influence of household income on frequency of physician visits also found no statistically significant relationship between the two.

Studies conducted on the general people and people with disabilities employing socioeconomic status as a potential predictor of medical care use have showed mixed results. However, as researchers maintain that a lower household income is most certainly a significant barrier to obtaining health care services (Arcury et al., 2005) this study will incorporate household income in its model.

2.3.2 Insurance

Removing the cost barrier by extending health insurance coverage to the uninsured has been shown to increase the use of physician and other health care services. Mitchell, Haber, Khatutsky, and Donoghue (2002) used an expanded version of the Andersen's Behavioral Model to evaluate the effects of the Oregon Health Plan (OHP) on beneficiary access.[17] Samples of adults aged 19 to 64 were selected from both the OHP and Food Stamp populations using Oregon State's 1998 eligibility files for both programs (1205 observations from OHP and 310 from Food Stamp). The results of the logistic regression model indicated that of the general adult population enrolled in OHP or a Food

[17] The access to health care services included usual source of care, physician visit in the past 3 months and 12 months, routine exams, blood pressure exam, specialist visit, emergency room visit in past 3 months, hospital admission, pap test, mammogram, dentist visit, prescription medicine, and mental health treatment.

Stamp program, those adults with health insurance, regardless of type, were significantly more likely than the uninsured to have seen a physician in the past 3 months (odds ratio = 3.66, $p < 0.01$) and 12 months (odds ratio = 3.59, $p < 0.01$).[18] In addition, those with health insurance were significantly more likely to have a primary care physician or other health care provider to seek routine health care services/advice (odds ratio = 3.4, $p < 0.01$).

Iezzoni, McCarthy, Davis, and Siebens (2000) explored the association between mobility constraints and utilization of screening and preventive services, controlling for demographic characteristics and access to health insurance and health care services.[19] The screening and preventive services considered for the purposes of the study were; Papanicolaou test, Mammogram, screen for tobacco use, and screen for alcohol use. The extent of mobility constraints was categorized as; (1) none (no difficulty with walking, climbing stairs, or standing, and no use of mobility aids), (2) minor (some difficulty with walking or climbing stairs or standing, or use of a cane or crutches), (3) moderate (a lot of difficulty with walking or climbing stairs or standing, or use of a walker), (4) major (inability to walk or climb stairs or stand, or use of a wheelchair or scooter). The results of the logistic regression suggested that females with health insurance were significantly more likely than those without insurance to report receiving screening and preventive services (adjusted odds ratio = 1.9, 95% confidence interval = 1.6 to 2.4 for the Papanicolaou test and 3.7, 95% confidence interval =2.5 to 5.4 for mammography). The findings were based on self-reported data of health care use and should therefore, be interpreted with the usual caution accorded to such data. Contradictory results were

[18] 95% confidence intervals were not reported.

[19] Demographic characteristics included age, gender, income, and race in this study. Access to care was measured in terms of whether respondents had a usual source of care.

reported by Arcury et al. (2005a), whose study found that having health insurance was not associated with an increase in health care visits for routine or chronic care. A follow-up study by Arcury et al. (2005b) confirmed that health insurance ownership had no significant effect on an individual's likelihood of accessing health care services for visits associated with routine, chronic, or acute care. In addition, the role of insurance as a predictor of health care utilization was examined by De Boer et al. (1997) who found that the majority of the analyses (14/18) did not find a positive association between health insurance and health care services utilization. One study reported that having insurance was associated with less frequent hospital visits while three other studies found that being insured led to more frequent hospital visits.

It follows then, from the literature review, that the effect of health insurance on health care services utilization is inconclusive. However, given that studies indicate that adults with health insurance, regardless of type of health insurance, were significantly more likely than the uninsured to access health care services (Mitchell, Haber, Khatutsky, & Donoghue, 2002; Iezzoni, McCarthy, Davis, & Siebens, 2000), this study will include a variable coding for "health insurance" in its model.

2.3.3 Usual Source of Care

Having a primary care physician is often believed to have a significant influence on an individual's health care services use. Researchers have traditionally defined usual source of care in terms of an individual having a public or private physician or clinic, a public hospital clinic, a walk-in clinic, or a private physician (Ettner, 1996; Mitchell, Haber, Khatutsky, & Donoghue, 2002).[20] The literature indicates having a primary or regular care provider tends to be a strong predictor for greater health care services use.

Sox, Swartz, Burstin, and Brennan (1998) compared the relative effects that having a primary care physician and health insurance had on access to health care services. The analysis of 1,952 adults of working age (18 to 64 years of age) examined at one of five teaching hospitals in Boston, Massachusetts, lead to the finding that absent a primary care physician, an individual was more likely to seek health care services.[21] After gender, race, insurance status, employment status, and education were controlled, the results of logistic regression showed that lack of a regular physician was a significant predictor of delay in seeking care (odds ratio = 1.6, 95% confidence interval = 1.2 to 2.1), absence of visits to the physician (odds ratio = 4.5%, 95% CI = 3.3 to 6.1), and absence of emergency department visits (odds ratio = 1.8, 95% CI = 1.4 to 2.4). The study discussed was a case study conducted at five university-affiliated urban hospitals in the Northeast of Boston, thereby restricting the generalizability of the findings to other populations.

The Iezzoni et al. (2000) study that explored the association between mobility constraints and use of screening and preventive services found that females having an usual source of care were significantly more likely to report receiving screening and preventive services (with adjusted odds ratio = 2.3, 95% confidence interval = 1.9 to 2.8 for the Papanicolaou test; and 5.0, 95% confidence interval =3.5 to 7.0 for mammography).

[20] Use of the emergency or the urgent care department is not typically considered a regular place of treatment.

[21] The subjects were who presented with 1 of 6 chief complaints (abdominal pain, asthma or chronic obstructive pulmonary disease, chest pain, hand laceration, head trauma, and vaginal bleeding).

In summary, the studies seem to suggest that usual source of care has a positive impact on health care services utilization behavior thereby necessitating the use of “usual source of care” in the mode. Also, the literature review leads us to hypothesize that usual source of care will be associated with increased health care services utilization by persons with disabilities (Sox, Swartz, Burstin, & Brennan, 1998; Iezzoni, McCarthy, Davis, & Siebens, 2000).

Table 2-2 Summary of Enabling Characteristics and Access to Health Care Literature

Authors	Sample	Method	Independent variables	Finding
Arcury, Gesler, Preisser, Sherman, Spencer and Perin 2005				Individuals with higher household income were more likely to use health care services for chronic care. Household income was not a significant predictor for routine checkups or acute care.
Coughlin, Long and Kendall 2002	840 (from New York City) and 957 (from Westchester County) working age, Medicaid population with disabilities	Logistic regression	Mental illness, MR/DD, age, gender, race, health status, mobility limitation, number of activity limitations	Household income was not a significant predictor of health care services utilization.
De Boer, Wijker, and De Haes 1997				Household income was not a significant predictor of hospital visits and physician visits.
Mitchell, Haber, Khatutsky and Donoghue 2002	Adults aged 19 to 64 were selected from both the OHP(1205) and Food Stamp (310)	Logistic regression	Gender, race, age, marriage, education, employment, geographical residence, health status, disabilities prevents working	Individuals with health insurance were more likely to have make physician visits.
Iezzoni, McCarthy, Davis, and Siebens 2000	77437 adults (over 18 years) of 1994 National Health Interview Survey (NHIS)	Logistic regression	Mobility constraints, age, race, education, household income, health insurance, usual source of care	Individuals with health insurance were more likely to use screening and preventive services.

Authors	Sample	Method	Independent variables	Finding
Arcury, Gesler, Preisser, Sherman, Spencer and Perin 2005				Individuals with health insurance were more likely to use acute care services. Health insurance was not a significant predictor for routine checkup visits and chronic care visits.
Arcury, Preisser, Gesler, and Powers 2005				Health insurance was not a significant predictor for routine checkup visits and chronic care visits.
De Boer, Wijker, and De Haes 1997				Health insurance was not a significant predictor for hospital visits.
Sox, Swartz, Burstin, and Brennan 1998	1,952 working age adults (18 to 64 years of age) who were seen at one of five teaching hospitals in the Boston and Massachusetts	Logistic regression	Gender, race, insurance status, employment status, education	Persons with usual source of care were more likely to have more frequent hospital visits.
Iezzoni, McCarthy, Davis, and Siebens 2000				Persons with usual source of care were more likely to have had Papanicolaou test and mammography.

2.4 Level of Disabilities and Access to Health Care

Persons with disabilities are more likely to experience greater difficulties with activities associated day-to-day living; it follows then that a variable coding for activity limitation should be accounted for in the model. In a review of studies on health care services use by the people with disabilities, De Boer (1997) identified only six studies that used limitation of daily activities as a predictor of frequency of physician visits. Of those studies, four found that limitation of daily activities had a statistically significant effect and resulted in more visits to the physician.

In their study, Diab and Johnston (2004) attempted to examine relationships between level of disabilities and receipt of certain preventive health services, controlling for age, sex, race, marital status, gender, income, education and employment status. Data from the 2000 and 1998 Behavioral Risk Factor Surveillance System (BRFSS) databases were analyzed (N = 59939).[22] Levels of disabilities were determined on an ordinal scale and included: (1) no disabilities or no limitation (no to all 3 questions about limitations); (2) mild disabilities (limited in some way but not enough to need help with "routine" or "personal" needs); (3) moderate disabilities (needs help with occasional routine activities but not with daily personal care needs); (4) severe disabilities (needs help with both routine and personal care needs). They hypothesized that persons with more severe disabilities would generally tend to receive fewer preventive services, such as mammograms, clinical breast examinations, Papanicolaou (Pap) tests, sigmoidoscopy or proctoscopy, and fecal occult blood testing than persons with lesser or no disabilities. The

[22] The BRFSS is an ongoing random-digit dialing monthly telephone surveillance system of "non-institutionalized civilian" adults, age 18 years and older. The goal of the BRFSS is "to collect uniform, state-based data on preventive health practices and risk behaviors that are linked to chronic diseases, injuries, and preventable infectious diseases in the US (Diab and Johnston, 2004, p. 750).

results from multiple logistic regression performed on the 1998 data demonstrated that persons with mild disabilities received influenza (odds ratio = 1.37)[23] and pneumonia vaccinations (odds ratio = 1.34) on a somewhat more frequent basis than persons without disabilities. In the 2000 data, females with mild disabilities received fewer clinical breast examinations (odds ratio = 0.93), while per the 1998 data females with severe disabilities received fewer mammograms than females with no disabilities (odds ratio = 0.84). However, there is a possibility of sampling bias affecting the results as the BRFSS does not conduct the surveys across states.

Iezzoni, McCarthy, Davis, and Siebens (2000) explored the association between mobility constraints and the use of screening and preventive services, controlling for demographic characteristics and access to insurance and health care services. The screening and preventive services included Pap smear, mammogram, screening for tobacco use, and screening for alcohol use. The resulting logistic regression showed that females with major mobility problems were significantly less likely than those without mobility problems to report receiving these services (adjusted odds ratio = 0.6; 95% confidence interval = 0.4 to 0.9 for the Pap smear and 0.7; 95% confidence interval =0.5 to 0.9 for mammography).

Using data from the 2001 California Health Interview Survey, Ramirez**,** Farmer, Grant, and Papachristou (2005) studied differences existing in preventive cancer screening behaviors among the people with disabilities and general adult population. A composite measure was generated for every respondent (n = 55,428) on the basis of self-reported responses to 11 items[24] to identify those presenting with generalized

[23] 95% confidential intervals were not given. The odds ratio showed in this paragraph are all significant.
[24] The 11 items were; poor health rating, assistive device needs, limitation in moderate activities, limitation

physical, mental, and/or combined health limitations that approximate disabilities. Respondents reporting poor health status, assistive device needs, and the presence of any health limitation in seven or more of nine adult-normative activities assessed were classified as persons with probable presence of disabilities. Compliance rates for cancer screening tests (mammography, Pap smear, prostate-specific antigen, sigmoidoscopy/colonoscopy, and fecal occult blood test) between the two groups were evaluated. The results of logistic regression showed that females with disabilities were 17% (Pap smear) and 13% (mammograms) more likely than females without disabilities to report noncompliance with cancer screening guidelines (odds ratio of Pap smear= 1.17, 95% confidence interval = 1.05 to 1.31; odds ratio of mammograms = 1.13, 95% confidence interval = 1.04 to 1.23). Males with disabilities were 19% more likely than males without disabilities to report having a prostate specific antigen test performed within the last 3 years (odds ratio = 1.19, 95% confidence interval = 1.06 to 1.43). However, CHIS 2001 data having been collected through a telephone survey of the non-institutionalized population, the sample excluded persons with hearing disabilities as well as those who were living in institutions such as nursing homes.

Long et al., (2002) carried out a telephone survey of 816 adults with disabilities in New York City between 1999—2000 to explore differences in access to and use of care among adults with physical disabilities, mental illness, and MR/DD. The results of their study indicated that the number of limitations in activities was not associated with

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in climbing stairs, did less than want (physical problems) past month, physical problems interfere kind of work and other activities past month, pain interfere with normal work past month, did less than want (emotional problems) past month, emotional problems interfere kind of work and other activities past month, physical/emotional problems interfere with social activities past month, arthritis problems ((Diab and Johnston, 2004, p. 2058).

frequency of visits to the physician among the population with disabilities.[25]

The literature review strongly suggests that limitations to carrying out day-to-day activities can be used as a proxy to measure level of disabilities. Also documented, is the association between presence and severity of disabilities and receipt of preventive services (Diab & Johnston, 2004; Iezzoni, McCarthy, Davis, & Siebens, 2000; Ramirez**,** Farmer, Grant, & Papachristou**,** 2005). Based on these findings, the current study will consider level of disabilities as a predictor.

[25] Level of disabilities was measured in terms of number of daily activities requiring assistance (bathing, dressing, eating, transferring, using the toilet, or getting around the home) and number of "instrumental activities of daily living" requiring assistance (meal preparation, shopping, finance, housework, using the telephone, or managing medications).

Table 2-3 Summary of Disabilities Level and Access to Health Care Literature

Authors	Sample	Method	Independent variables	Finding
De Boer, Wijker, and De Haes, 1997				Four studies found that limitation of daily activities has a statistically significant effect and resulted in more frequent physician visits.
Diab and Johnston, 2004	18 years and older during the years 2000 (N = 59939) and 1998 (N = 41106) from the Behavioral Risk Factor Surveillance System (BRFSS) in US	Logistic regression	Age, gender, education, income, ethnicity, and indicators of access to health care	Persons with mild disabilities were significantly more likely to receive influenza and pneumonia vaccinations. Females with mild disabilities were less likely to have clinical breast examination and mammograms.
Iezzoni et al., 2002				Females with major mobility problems were more likely to receive the Papanicolaou test and mammography.
Ramirez, Farmer, Grant, and Papachristou, 2005	55428 households in the 2001 California Health Interview Survey	Logistic regression	Age, race, education, income, marriage, language, usual source of care, insurance, cancer	Females with disabilities were more likely to have Papanicolaou tests and mammograms. Males with disabilities were more likely to have specific antigen test within the last 3 years.
Long, Coughlin and Kendall, 2002				Disabilities level was not a significant predictor of health care services use.

2.5 Access to Health Care Services and Health Status

In contrast to the wealth of literature on the association between access to health care services and health care services use, few studies have investigated the degree to which predisposing factors, enabling factors, and health care services utilization relate to health status based on Andersen's Health Behavioral Model. Gelberg et al. (2000) tested the Andersen Behavioral Model for Vulnerable Population in a study designed to determine predictors of the physical health status of homeless adults. Their model included predisposing factors, such as age, gender, race, education and enabling factors, such as regular source of care, insurance, income. The results of the multiple logistic regression analysis indicated that gender and regular source of care were associated with self-reported skin/leg/foot problems. Males and persons of both genders with a regular source of care were less likely to report having skin/leg/foot problem. However, age, gender, race, education, insurance, and income were not significantly related to health status. The subjects were all homeless persons, thus the results cannot be generalized to the general population at large.

Suzuki et al. (2007) examined the association between predisposing characteristics, enabling characteristics, and physical secondary conditions through health care practices and health care use in persons with spinal cord injuries. They employed a cross-sectional survey mailed to adults in portions of the northeastern and northwestern United States. Two hundred and seventy adults with spinal cord injury were recruited through three durable medical equipment supply companies in the states of Washington, New York, and Oregon. Participants were asked to rate how much each of the 18 physical secondary conditions[26] had been a source of trouble for them in the past year, using a scale of; 0 - not experienced, 1 - mild problem, 2 - moderate problem, and 3 - significant problem. The total of the scaled scores was calculated by multiplying the frequency by the degree to which the condition was a problem. Suzuki et al. (2007) were interested in the board determinants of health status as conceptualized by the Andersen Model such as, predisposing characteristics (age, gender, marital status, race, education), enabling characteristics (accessible fitness, layout of home, layout of community, insurance) and health care services use. The results of F Increment Tests showed that predisposing variables explained 12% of the variance [F (9, N = 270) = 5.99, $p < 0.05$] with additional 16% accounted for by enabling variables [F (10, N = 270) = 5.56, $p < 0.001$] and 13% accounted for by health care use [F (2, N = 270) = 27.32, $p < 0.05$]. Furthermore, the results of multiple regression analysis demonstrated that greater health care utilization was associated with having greater problems with secondary conditions (B = 0.46, $p < 0.05$). Age, gender, marital status, education, and personal health care practices were not a significant predictor of greater health care services utilization. The participants of this study represented a small convenience sample with bias, and were restricted to people with health insurance who had either purchased or requested repair of assistive equipment within the designated geographic areas.

Although few studies have examined the association of predisposing characteristics, enabling characteristics, health care services use and health status of persons with disabilities, the results of the Suzuki et al. (2007) study strongly suggests

[26] The conditions selected were too high or too low blood pressure, poor circulation, contractures, diabetes, fatigue, injuries, osteoporosis, pressure score, alcohol or other drug abuse, muscle spasm, urinary tract infection, yeast infections, pneumonia, repetitive motion pain, weight gain, chronic pain, stomach problems and constipation or bowel movement problems.

that predisposing characteristics, enabling characteristics and health care use are consistent with health status. In addition, the two studies cited indicate that variables coding for age, gender, race, education, marital status, income, insurance, regular source of care, and health care services use should be included when examining the association between health care services access and health status.

Table 2-4 Summary of Access to Health Care and Health Status Literature

Authors	Sample	Method	Independent variables	Finding
Gelberg, Ronald, Andersen, and Leake 2000				Males and persons with regular source of care were less likely to report having skin/leg/foot problems. Age, gender, race, education, insurance, and household income were not significantly related to health status.
Suzuki, Krahn, McCarthy, and Adams 2007	270 adults with spinal cord injuries were recruited through three durable medical equipment supply companies in the states of Washington, New York, and Oregon	*F* increment tests	Age, gender, marital status, race, education, accessibility, fitness, layout of home, layout of community, insurance. Personal health practices, health care services use	The study found that predisposing characteristics accounted for 12% of variance in secondary conditions, enabling characteristics accounted for 16%, and health practices and health care services use accounted for another 13%.

2.6 Spatial Accessibility, Health Care Services Utilization, and Health status

2.6.1 Measuring Spatial Accessibility

Most published measures of potential spatial accessibility to health care services can be classified into four categories (Talen, 2003; Guagliardo, 2004): (1) provider-to-population ratio, (2) distance to nearest provider, (3) average distance to a set of providers, (4) gravitational models, and (5) two-step floating catchment area method of provider influence.

Provider-to-population ratios are supply ratios which are computed for bordered areas, such as states, counties, census tracts or health care service areas. The numerator is the indicator of health service capacity, such as number of clinics, doctors or beds. The denominator is always the population size within a geographical area, which can be taken from the census data. The U.S. Department of Health and Human Services (DHHS) uses the population-to-physician ratio within a county as a basic indicator for identifying physician shortage areas (GAO, 1995; Lee, 1991). Provider-to-population ratios are good for gross comparison for rural areas and for large geographic areas. Unfortunately, provider-to-population ratios have significant limitations. First, they do not consider that people will cross geographical boundaries to seek health care services. This always occurs in small geographic areas such as urban postal code areas. Second, provider-to-population ratios cannot detect variation in supply within large bordered areas. In addition, such measures assume all people have equal access to health care services providers' independent of the location of residence. Thus they do not explicitly incorporate any measures of distance or travel impedance.

Travel impedance to nearest provider is typically measured from a personal residence or from a geometric centroid within a bordered area (states, counties, census tracts, zip code areas). Haynes, Lovett, and Gale (1999) used distance represented by a straight-line route to the nearest general practitioner and hospital to represent spatial accessibility. Travel impedance, sometimes referred to as travel cost, is often measured in units of distance travelled and time taken to travel along a road network (Brabyn & Skelly, 2002; Arcury et al., 2005). Travel impedance to nearest provider is also a good measure of spatial accessibility for rural areas, because provider choices are typically limited. However, there are usually a fair number of health care service provider options at similar distances from any resident point in congested urban areas.

Average travel impedance to provider is summed and averaged over the distance from the dispersed patient population points to all providers within a city or county. This method has only been used once for a health service study. Dutt, Dutta, Jaiswal, and Monroe (1986) measured accessibility to medical services by utilizing an average travel impedance index. The average travel impedance to provider index has two shortcomings. First, it over-weights the influence of health care service providers located near the periphery of the study area. In practice, for instance, people living near the western borders of a city may not go to health care service providers who are located in eastern areas. By including these health care service providers, the average distance gets inflated and the numerical value of the indicators of spatial accessibility for those residents in west areas is deflated. Moreover, average travel impedance measures do not tend to consider that people will cross geographical boundaries, if necessary, to seek health care services.

Gravity models attempt to represent the potential interaction between any population point and all service points within a reasonable distance, discounting the potential with increasing distance (Guagliardo, 2004, p. 5). The simplest formula of gravity-based accessibility is:

$$A_i = \sum_j \frac{S_j}{d_{ij}^{\beta}}$$

Where, *Ai* is geographical accessibility from point of population (*i*), and this point (*i*) can be a residence or the centroid of an area (states, counties, census tracts, zip code areas). *Sj* refers to service capacity at provider location. It is almost always measured as the number of professional employees at said location employed in health care services provision. *d* is the travel distance or time between points *i* and *j*. β represents the change in difficulty of travel as travel times or distance change, so it is a gravity decay coefficient. However, there are at least two problems with the simple gravity formulation. First, the geographical accessibility (*Ai*) value is so complicated that health care policy makers, who prefer to think of spatial accessibility in terms of provider-to-population ratios or simple distance, cannot typically comprehend its complexity. Second, it only models supply, and demand is not considered in the simple gravity formula. Therefore, Joseph and Bantock (1982) proposed a solution to this problem by adding a population demand adjustment factor, *Vj*, to the denominator.

$$V_j = \sum_k \frac{P_k}{d_{jk}^{\beta}}$$

Here, *Pk* is population size at the centroid of a census tract or block (point *k*). *d* is the geographical distance or travel time between point *k* and the health care service provider location *j*. The demand on provider location *j* is obtained by summing the gravity discounted influence of all population points within a reasonable distance (Guagliardo, 2004). The improved gravity model is thus:

$$A_i = \sum_j \frac{S_j}{d_{ij}^{\beta} V_j}$$

This gravity model attempts to consider the potential interaction between any population point and all health care service provider points within a reasonable distance, discounting the potential with increasing distances or travel times. However, the distance decay coefficient β is usually unknown. Therefore, empirical investigation is required to estimate β, and there is little in the primary care service literature to suggest probable values in the meantime.

A new spatial accessibility measurement method has been recently developed that provides an enhanced understanding of spatial accessibility to health care services provision. Radke and Mu (2000) developed the **two-step floating catchment area method;** a term coined by Luo and Wang (2003). This method is a special case of the improved gravity model and implemented in seven steps (Luo and Wang, 2003, p. 267):

(1) Use GIS street network analysis to compute the travel time between any pairs of physician location (taken as the Zip Code area centroid) and population location (taken as the census tract centroid).

(2) For each physician location, select population locations that are within a reasonable travel time (e.g., 30 minutes) of that physician location, thus defining an imaginary catchment area for physician location.

(3) Compute the physician-to-population ratio for catchment by dividing the number of physician(s) by the sum of population within catchment.

(4) Repeat (2) and (3) for all physician locations

(5) For each population location, search all physical locations that are within the reasonable travel time (e.g., 30 minutes), and sum up the physician-to-population ratios at these locations.

(6) Repeat step (5) for all population locations.

(7) Run a GIS query to identify all the census tracts with a ratio less than the DHHS standard (1:3500 for primary care) as the shortage areas.

The spatial accessibility values as derived by this method are in the familiar units of provider to population, while still accounting for geopolitical border cross. This is now widely considered to be the appropriate method of choice to calculate spatial accessibility when information of residence of patients and location of health care service providers is not sufficient.

In summary, the literature review indicates that the choice of measures selected to examine spatial accessibility has to be robust in order to represent the “real” estimates of spatial access. In particular, researchers have to be very aware that the location information of health care services providers and people that are available are not always of the quality required for studies of spatial accessibility. If the location information is inaccurate, potential spatial accessibility, such as coverage, gravity, catchment etc that are derived will not reflect the appropriate estimates of these attributes. In these instances, calculating real road distance or travel time as the measure of revealed spatial accessibility would be more pertinent as the accurate location information of health care services provider and people is known. This principle guides this study on the choice of appropriate measurements for spatial accessibility for the two data sets under analyses.

2.6.2 Spatial Accessibility and Health Care Utilization

The primary purpose of this study is to examine the association between spatial accessibility, health status, and health care services use. Of the few studies which explore the relationship between spatial accessibility and health care use based on Andersen's Health Behavioral Model, the analysis by Arcury et al. (2005) was one that attempted to integrate two domains of health geography into Andersen's Health Behavior Model: distance and transportation. Their analysis determined the importance of distance and transportation in rural health care services utilization. Distance to health care services providers was based on respondents' stating which hospital, clinic, or doctor they go to for routine medical care. Distance in kilometers from the respondents' place of residence to the location of medical care provider was calculated using GIS.[27] Transportation, an enabling factor for access to health care services is conceptually defined using the following attributes; possession of a driver's license, the number of days per week the respondent drives a vehicle, if any other person in the respondent's household has a driver's license, the number of vehicles owned by persons in the respondent's household, and if a member of the respondent's family used a ride provided by a relative or friend (Arcury et al., 2005). The results of logistic regression analysis showed that respondents with a driver's license had an estimated 1.58 times greater frequency of regular care visits (odds ratio = 1.58, 95% confidence interval = 1.10 to 2.26) and 2.3 times greater frequency of chronic care visits (odds ratio =2.3, 95% confidence interval = 1.41 to 3.76), than those who did not possess a driver's license. Distance to regular care was not a statistically significant predictor of the number of routine check-up visits. The study used

[27] The method employed in this study to calculate distance is not clear.

distance to represent spatial accessibility, but distance is often considered to be a less accurate measure as opposed to travel time.

In addition, Arcury et al. (2005) examined the association between individual transportation access characteristics and the number of health care service visits for chronic and routine care. Using the personal transportation measures (described earlier), public transportation measures and distance Arcury et al. (2005) conducted a logistics regression analysis. The results demonstrated that respondents who possessed a driver's license had 2.29 times more health care visits for chronic care (odds ratio = 2.29, 95% confidence interval = 1.19 to 4.39) and 1.92 times more visits for routine care than those who did not possess a driver's license (odds ratio = 1.92, 95% confidence interval = 1.32 to 2.79). Respondents who used a family-provided ride had 1.58 times more visits for chronic care than those who did not use a family-provided ride (odds ratio = 1.58, 95% confidence interval = 1.01 to 2.46). However, the study found that distance characteristics were not significantly associated with the number of health care services visits.

In addition, Coughlin et al. (2002) relied on Andersen's Behavioral Model to examine health care services access, use, and satisfaction within the working age Medicaid population with disabilities. Mathematica Policy Research, Inc. conducted the interviews by telephone in 1998, and obtained 1797 observations (840 from New York City and 957 from Westchester County). The results of logistic regression indicated that distance to the most proximate hospital was not significantly associated with the number of health care service visits, such as hospital stay in the past year or physicians visit in the past three months.

Grumbach, Vranizan, and Bindman (1997) used an analysis of survey data to determine whether patients' reports of access to health care services were associated with physician supply. The source of data on population characteristics was a 1993 telephone survey of a probability sample of 6,674 residents of the state of California ages 18—64 from 41 urban communities. They calculated the primary care physician to population ratio of the geographical units defined for the purposes of this study. The average size of the initial geographic units was 67 square miles. They used the traditional HPSA index (3,500 residents per primary care physician, or about 30 physicians per 100,000 residents) to define the lowest supply category, with the remaining categories consisting of residents in areas with 30—50, 50—100, and 100 or more primary care physicians per 100,000 population. After grouping survey respondents according to physician supply, they calculated the number of health care service visits during the past 3 months for each group. The results of multivariate regression, after controlling for respondents' age, sex, race/ethnicity, income, education, insurance status, and health status, showed that the primary care physician to population ratio was not significantly associated with health care visit rates. However, it should be noted that the results of this study cannot be generalized to other rural areas.

Review of some research employing the qualitative framework leads us to conclude that there exist some very pertinent barriers to health care services access for persons with disabilities. The studies suggest that inadequate access to certain primary preventive care services is likely a product of structural-environmental and process barriers. Per the findings, accessibility, financial burden, and health insurance were the key factors influencing access to health care services. Drainoni, Lee-Hood, Tobias, and Bachman (2006) conducted a series of focus group studies with persons with disabilities in different parts of Massachusetts in 2000, to gain an in-depth understanding of the barriers to health care access that they were confronted with. The study found that individuals in almost all of the focus groups cited transportation as a barrier to accessing health care services. Persons with disabilities living in the areas that lacked providers often had to travel great distances for treatment (Drainoni et al., 2006). Further, most of the focus group participants experienced limitations on the type of health-care providers, services, and devices that they were able to access due to restrictions imposed by their health insurance providers (Drainoni et al., 2006). Therefore, for most participants in this study accessibility and financial burden were significant impediments to seeking health care services.

Iezzoni, Killeen, and O'Day (2006) studied the health care services experiences of rural residents with disabilities in Massachusetts and Virginia. The goal of the study was to hear directly from persons with disabilities the experiences they confront in seeking and obtaining health care services (Iezzoni et al., 2006). To begin exploring this issue, they conducted four focus groups between the years 2000-2001 with working-age adults with disabilities living in rural areas. The results demonstrated that the persons with disabilities involved in this study had several concerns about enabling factors, such as accessibility and health insurance, in the course of health care services.

A review of these studies indicates that they employ distance to the most proximate health care services facility (Coughlin et al., 2002) or distance to the health care service providers that the respondents routinely go to for care (Arcury et al., 2005a; Arcury et al., 2005b) but do not include availability of health care services within an area. In their study, Grumbach, Vranizan, and Bindman (1997) found no association between health care services use and primary care physician to population ratio within the geographic unit. Overall, while the quantitative studies did not confirm the association between spatial accessibility and health care services utilization, qualitative researchers found that persons with disabilities had a concern about accessibility to health care services (Drainoni, Lee-Hood, Tobias, & Bachman, 2006; Iezzoni, Killeen, & O'Day, 2006). Based on these findings this study hypothesizes that spatial accessibility is a significant predictor of health care utilization by persons with disabilities.

Table 2-5 Summary of Spatial Accessibility and Access to Health Care Services Literature

Authors	Sample	Method	Independent variables	Finding
Arcury, Gesler, Preisser, Sherman, Spencer and Perin, 2005				Travel time and distance were not significant indicators of routine visits, chronic care visits and acute care visits.
Arcury, Preisser, Gesler, and Powers, 2005				Travel time was not significant in routine and chronic care visits.
Coughlin, Long and Kendall, 2002				Distance was not significant in health care services utilization.
Grumbach, Vranizan, and Bindman, 1997	6,674 California residents ages 18--64 from 41 of the urban communities	Multivariate regression	Age, sex, race/ethnicity, income, education, insurance status, health status, primary care physician to population ratio	Primary care physician to population ratio was not a significant predictor of health care services visits.
Drainoni, Lee-Hood, Tobias, and Bachman, 2006	87 persons with disabilities in Massachusetts	Focus groups		Many participants in their focus groups reported being confronted with the problem of accessibility and financial burden.
Iezzoni, Killeen, and O'Day, 2006	35 persons with disabilities in Massachusetts and Virginia.	Focus groups		They concluded that thoughtful solutions will require balancing notions of reasonable access, enabling factors (spatial accessibility, accessible transportation, health insurance), and the identified needs of persons with disabilities.

2.6.3 Spatial Accessibility and Health Status

There is a dearth of research that examine the association of spatial accessibility to health care services utilization and health status based on Andersen's Health Behavioral Model. Hence, this review examines studies that investigated the relationship between spatial accessibility and health outcome (death or illness) in a bid to better understand the potential effects that spatial accessibility has on health status. Jones, Bentham, and Harrison (1999) examined the relationships between asthma mortality[28] and access to primary and secondary services within the rural region of East Anglia, England. Two measures of health service accessibility were examined and they were; (1) the estimated mean travel time to the nearest main or branch general practitioner surgery and (2) the estimated mean travel time to the nearest large hospital for the residents of 536 electoral wards. After controlling for age, gender, socioeconomic index and indicator of social isolation, the results of a Poisson regression showed that there was a significant tendency for asthma-related mortality to increase with travel time to hospital, with a relative risk of 1.07 for each 10-minute increase in journey time ($p = 0.04$) (Jones et al., 1999). The results of this study supported the hypothesis that inaccessibility of acute hospital services may increase the risk of asthma mortality. However, that was no consistent trend for mortality to increase with travel time to general practitioner surgeries. This study did not consider, in its analyses, other measure of access to health services, such as the local physicians to population ratio.

Shi and Starfield (2000) used the 1996 Community Tracking Study household survey (N = 60,255) to examine whether primary care, measured at the state level,

[28] Information of asthma deaths was taken from the Regional Death System, and records were retrieved in which death had occurred between January 1985 and December 1995.

predicts individual morbidity as measured by self-rated health, while controlling for age, gender, race, education, paid work, employment type, hourly income, poverty level, health insurance, and tobacco consumption. The logistic regression model showed that primary care was significantly associated with individuals' self-rated health. Their study demonstrates that individuals living in states with a higher primary care physician to population ratio were more likely to report good health than those living in states with a lower ratio, after controlling for socioeconomic determinants of health status (odds ratio = 1.02, 95% confidence interval = 1.01 to 1.04). However, the state level primary care physician to population ratio was too broad a measure to represent individual's spatial accessibility to health care services.

The study by Luther, Studnicki, Kromery, and Lomando-Frakes (2003) attempted to identify geographical communities (84 zip code areas) with high and low access to primary care clinics that serve ethnic and racial minorities and develop a model to estimate number of lives saved by primary care clinics in Broward County, Florida. Proximity was used to measure high and low access, with zip codes containing or contiguous to a clinic classified as high access and all other zip codes as low access. Of the five models used to model chronic disease mortality health outcomes, only one (diabetes) did not show a significant difference for predicted rates. In terms of number of lives saved, the study estimated that more than 130 deaths would occur among African-Americans each year if African-Americans in the area of study had only low access to primary care programs.

Jones, Haynes, Sauerzapf, Crawford, Zhao, and Forman (2008) examined the effect of geographical accessibility on survival rates. Records of 117,097 cases of breast, colorectal, lung, ovary and prostate cancer diagnosed in Northern England between 1994 and 2002 were supplemented with estimates of travel times to the patients' general practitioners and hospitals attended. The result of logistic regression, adjusting for age, sex, whether the first hospital visited was a cancer center and distance from area of residence, showed that the risk of death was associated with straight-line distance to the nearest cancer center for prostate cancer (odds ratio = 1.003, 95% confidence interval = 1.002 to 1.004). Patients further from the nearest cancer center had a worse chance of survival. Although estimated travel time to the hospital of first referral was significantly associated with the risk of death for cancers of the breast (odds ratio = 0.995, 95% confidence interval = 0.993 to 0.997) and lung (odds ratio = 0.998, 95% confidence interval = 0.998 to 0.999), the relationship was in the opposite direction to that anticipated. In other words, patients further from a hospital had a better chance of survival. The limitations of this study were that they could not distinguish cancer-specific deaths, so the survival analysis could not avoid including some deaths due that occurred due to other causes. In addition, access to health services depends on a wider range of factors than those associated with distance (time), such as the local physician to population ratio.

In general, previous studies supported the notion that spatial accessibility is related to health outcome (Jones, Bentham, & Harrison, 1999; Shi and Starfield, 2000; Jones, Haynes, Sauerzapf, Crawford, Zhao, & Forman, 2008; Luther, Studnicki, Kromery, & Lomando-Frakes, 2003). However, Jones et al. (2008) found that patients further from a hospital had a better chance of survival.

These studies unlike the present study were interested in examining the association between spatial accessibility and death due to illness. The unit of their analyses was geographical or administrative. Few, if any, studies have investigated the degree to which spatial accessibility of health care services relate to personal health status of persons with disabilities. The current study will employ GIS to calculate spatial accessibility by tract level to provide a more accurate indicator. In addition, this study represents a new effort to examine the association between spatial accessibility and health status for the population with disabilities, and hypothesizes that persons with poor spatial accessibility to health care services will be associated with poor personal health status.

Table 2-6 Summary of Spatial Accessibility and Health Status Literature

Authors	Sample	Method	Independent variables	Finding
Jones, Bentham, and Harrison, 1999	536 electoral wards in East Anglia, England	Poisson regression GIS	Age, gender, socioeconomic status, travel time	Inaccessibility of acute health care services may increase the risk of asthma mortality. However, there was no consistent trend for mortality to increase with travel time to general practitioner surgeries.
Shi and Starfield, 2000	60255 individuals from the 1996 Community Tracking Study household survey	Logistic regression	Age, gender, race, education, paid work, employment type, hourly income, poverty level, health insurance, and tobacco use	Individuals living in states with a higher primary care physician to population ratio were more likely to report good health than those living in the states with a lower ratio.
Luther, Studnicki, Kromery, and Lomando-Frakes, 2003	84 zip code areas in Broward county of Florida	GIS	Zip code areas containing or contiguous to NBHD clinics targeted to serve ethnic and racial minorities (high access) and those Zip codes that are geographically more distant from the clinics (low access)	More than 130 deaths would occur among African-Americans each year if African-Americans in the area of study had only low access to primary care programs.
Jones, Haynes, Sauerzapf, Crawford, Zhao, and Forman, 2009	117,097 cases of breast, colorectal, lung, ovary and prostate cancer diagnosed in Northern England between 1994 and 2002	Logistic regression, GIS	Age, gender, if the first hospital visited was a cancer centre and distance from area of residence, estimates of travel times to the patients' general practitioners and hospitals attended , straight-line distance to the nearest cancer center for prostate cancer	Patients further from hospital had a better chance of survival.

2.7 Summary

This review finds that the Andersen behavioral model is a simple, inclusive, and useful model for studying access to health care services. On the basis of the Andersen Health Behavioral Model, the effects of predisposing variables, enabling variables and health behavioral variables are discussed. Most studies reviewed indicate that the effect of predisposing factors such as age, sex, education, race, and marital status on health care utilization is equivocal. Effects of the enabling factors income and insurance have been demonstrated to be unequivocal while having usual source of care has been shown to have a significant effect on health care services use. Although the effect of most variables is equivocal, each study which is based on the framework of Andersen Health Behavioral Model has been shown to include all these essential variables. Hence, the model employed in this study includes these variables.

Limitations in being able to carry out activities of daily life are often used as a measure of the level of disabilities in research about health care services use among persons with disabilities. The literature review demonstrates that severity of disabilities has an evident effect on health care services use.

Although few studies have examined the association of predisposing characteristics and enabling characteristics on health care services utilization and therefore the health status of persons with disabilities, the results of the study by Suzuki et al. (2007) confirmed that predisposing characteristics, enabling characteristics and health care use were associated with health status.

While the quantitative studies did not appear to support the notion that distance is always inversely related to rates of health care services utilization, some qualitative data have documented that accessibility to health care services are associated with health care services seeking behavior. Few studies have investigated the degree to which spatial accessibility to health care services relates to health status for persons with disabilities, and almost no research has been conducted on exploring the association between spatial accessibility and health status of persons with disabilities. Therefore, this study will explore that association.

CHAPTER III

RESEARCH DESIGN AND METHODS

This study seeks to ascertain the association between spatial accessibility, health care services utilization and health status for persons with disabilities based on a modified version of Andersen's Behavioral Model. In this chapter, a discussion of the conceptual model, data, analysis variable measures, and statistical analysis follow.

3.1 Conceptual Model and Hypotheses

Variations of Andersen's Behavioral model have been used successfully in health care services utilization studies of general populations (Arcury et al., 2005a; Arcury et al., 2005b; De Boer et al., 1997; Goodwin & Andersen, 2002; Green & Pope, 1999; Mayberry et al., 2000; Mitchell et al., 2002; Weitzman et al., 1997) as well as in vulnerable populations (Gelberg et al., 2000). Likewise, a few published studies that examine the use of health care services by the people with disabilities have also incorporated the Andersen Behavioral model as a theoretical framework (Coughlin et al., 2002; Long et al., 2002). The primary purpose of the present study is to assess the association of spatial accessibility of health care services with health care services utilization and health status for persons with disabilities. The conceptual model integrates spatial accessibility with the Andersen Behavioral Model, and focuses on persons with disabilities. Based on a “systems” perspective on the relationship between spatial accessibility, health care utilization and health status of persons with disabilities the framework posits that predisposing and enabling factors to health care services utilization influence health care utilization and health status. The model developed for this study not only acknowledges the importance of spatial accessibility in influencing access to health care services, but also integrates spatial accessibility variables. Spatial accessibility to health care services is regarded as an enabling characteristic.

In this model, health status is associated with predisposing factors, enabling factors, and health care utilization. Related measurable variables are listed under the constructs, and on the basis of the literature review presented in Chapter 2, all pertinent variables are considered for inclusion in the statistical analysis. The constructs applied in this framework are described in the following paragraphs.

“Predisposing characteristics” are defined as variables that exist before the onset of the illness and which describe the individual’s propensity to seek health care services. It is supposed that predisposing characteristics directly influence enabling characteristics, which in turn influence health care services use and health status. It is measured using demographic and social structural variables. Studies have demonstrated that; (1) health care services use among persons of advanced age is greater than among younger individuals (Goodwin & Andersen, 2002; Arcury et al., 2005a); (2) females are more likely than males to use health care services (Green & Pope, 1999; Arcury et al.,, 2005a);

(3) ethnic minority groups underutilized health care services when compared to Caucasians (Mayberry et al., 2000; Weitzman et al., 1997; Arcury et al., 2005b; Coughlin et al., 2002); (4) adults with lower levels of educational attainment underutilized health care services compared to people with higher levels of educational attainment (Arcury et al., 2005a); (5) Unmarried patients utilized health care services more frequently (De Boer et al., 1997); (6) tobacco consumption was associated with less health care services utilization (Arcury et al., 2005b). Therefore, included in the model are personal demographic factors, such as age and gender and tobacco use; and personal social structure factors such as race, education, and marital status. In addition, some studies have shed some light on the association between presence and severity of disabilities on receipt of preventive services (Diab & Johnston, 2004; Iezzoni et al., 2000; Ramirez et al., 2005) and therefore, level of disabilities is also considered in this study.

Enabling characteristics are aspects of an individual's ability to pay for health care services and the availability of such services in the area in which the individual lives, and includes such measures as income, insurance, usual source of health care service, and spatial accessibility. The review of the literature leads us to expect that household income, health insurance and usual source of care have significant effects on utilization of health care services. Also demonstrated are; (1) that a lower household income represents a significant barrier to obtaining health care services (Arcury et al., 2005b); (2) adults with health insurance, regardless of the type, are significantly more likely than the uninsured to have seen a physician (Mitchell et al., 2002; Iezzoni et al., 2000); and (3) individuals who have a usual source of care are more likely to use health care services than individuals without (Sox et al., 1998; Iezzoni et al., 2000). Based on these findings enabling characteristics applied in this model include income, health insurance, and usual source of health care service.

Spatial accessibility refers to factors such as travel impedance due to distance between patient location and health care service points, physician to population ratio, and having hospitals located within a 30-minute travel area. While the review of the quantitative literature indicated that there was insufficient evidence to infer significant association between distance, physician to population ratio and health care services utilization (Arcury et al., 2005a; 2005b) a review of the qualitative literature indicates that accessibility to health care services are associated with health care seeking behavior (Drainoni et al., 2006; Iezzoni et al., 2006). In particular, the studies found that the ratio of primary care physician to population is significantly associated with health status (Shi & Starfield, 2000).

As the present study is focused on exploring the association between spatial accessibility and health care services utilization and health status for persons with disabilities, spatial accessibility is included in the model as an enabling characteristic. The results of the study by Suzuki et al. (2007) confirm that predisposing characteristics, enabling characteristics, and health care services use are associated with health status. Therefore, this model assumes that the effects of predisposing and enabling characteristics are mediated by health care services utilization (e.g., health care visit, routine checkup visit) to predict health status.

As noted by Andersen (1995) the model does present some difficulties with circularity of need and health status, particularly for cross-sectional studies. The circularity issue can be understood by seeing how using current health conditions to explain the current health status can be self-reinforcing. To avoid this, the study elected to eliminate the variables of need from the analysis design, similar to other adaptations of the model (e.g., Gelberg et al., 2000; Suzuki et al., 2007).

The hypotheses that drive this study and derived from the conceptual model and the literature review are classified under six criterion groups and are as follows:

(1) Association between spatial accessibility of health care services provider and utilization of health care service visits in the past 12 months while controlling for predisposing characteristics and enabling characteristics;

$H1a_0$ = the travel time to the health care service provider is not associated with frequency of health care service visits while adjusting for predisposing and enabling characteristics.

$H1a_1$ = the travel time to the health care service provider is associated with frequency of health care service visits while adjusting for predisposing and enabling characteristics.

$H1b_0$ = the primary care physician to population ratio is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics.

$H1b_1$ = the primary care physician to population ratio is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics.

$H1c_0$ = having a hospital within the neighborhood is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics.

$H1c_1$ = having a hospital within the neighborhood is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics.

(2) Association between spatial accessibility to health care service providers and routine checkup visits made in the past 12 months while controlling for predisposing characteristics and enabling characteristics;

$H2a_0$ = the travel time to the health care service provider is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

$H2a_1$ = the travel time to the health care service provider is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

$H2b_0$ = the primary care physician to population ratio is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

$H2b_1$ = the primary care physician to population ratio is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

$H2c_0$ = having a hospital within the neighborhood is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

$H2c_1$ = having a hospital within the neighborhood is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics.

(3) Association between spatial accessibility to the health care services provider and health status while controlling for predisposing characteristics, enabling

characteristics, and health care services utilization;

$H3a_0$ = the travel time to the health care service provider is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

$H3a_1$ = the travel time to the health care service provider is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

$H3b_0$ = the primary care physician to population ratio is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

$H3b_1$ = the primary care physician to population ratio is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

$H3c_0$ = having a hospital within the neighborhood is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

$H3c_1$ = having a hospital within the neighborhood is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization.

(4) Association between spatial accessibility of health care service providers and health care services visits made in the past 12 months in both urban and rural areas while controlling for predisposing characteristics and enabling characteristics;

$H4a_0$ = travel time to the health care services provider is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4a_1$ = travel time to the health care services provider is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4b_0$ = the primary care physician to population ratio is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4b_1$ = the primary care physician to population ratio is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4c_0$ = having a hospital within the neighborhood is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4c_1$ = having a hospital within the neighborhood is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in urban areas.

$H4d_0$ = travel time to the health care services provider is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

$H4d_1$ = travel time to the health care services provider is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

$H4e_0$ = the primary care physician to population ratio is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

$H4e_1$ = the primary care physician to population ratio is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

$H4f_0$ = having a hospital within the neighborhood is not associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

$H4f_1$ = having a hospital within the neighborhood is associated with frequency of health care services visits while adjusting for predisposing and enabling characteristics in rural areas.

(5) Association between spatial accessibility to health care services and frequency of routine checkups in the past 12 months in both urban and rural areas while controlling for predisposing and enabling characteristics;

$H5a_0$ = travel time to health care services providers is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5a_1$ = travel time to health care services providers is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5b_0$ = the primary care physician to population ratio is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5b_1$ = the primary care physician to population ratio is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5c_0$ = having a hospital within the neighborhood is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5c_1$ = having a hospital within the neighborhood is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in urban areas.

$H5d_0$ = the travel time to the health care services provider is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

$H5d_1$ = the travel time to the health care services provider is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

$H5e_0$ = the primary care physician to population ratio is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

$H5e_1$ = the primary care physician to population ratio is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

$H5f_0$ = having a hospital within the neighborhood is not associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

$H5f_1$ = having a hospital within the neighborhood is associated with frequency of routine checkup visits while adjusting for predisposing and enabling characteristics in rural areas.

(6) Association between spatial accessibility of health care services and health status in both urban and rural areas while controlling for predisposing characteristics, enabling characteristics, and health care services utilization in both urban and rural areas;

$H6a_0$ = the travel time to health care services provider is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6a_1$ = the travel time to health care services provider is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6b_0$ = the primary care physician to population ratio is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6b_1$ = the primary care physician to population ratio is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6c_0$ = having a hospital within the neighborhood is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6c_1$ = having a hospital within the neighborhood is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in urban areas.

$H6d_0$ = the travel time to health care services provider is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

$H6d_1$ = the travel time to health care services provider is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

$H6d_0$ = the primary care physician to population ratio is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

$H6d_1$ = the primary care physician to population ratio is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

$H6d_0$ = having a hospital within the neighborhood is not associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

$H6d_1$ = having a hospital within the neighborhood is associated with health status while adjusting for predisposing characteristics, enabling characteristics, and health care services utilization in rural areas.

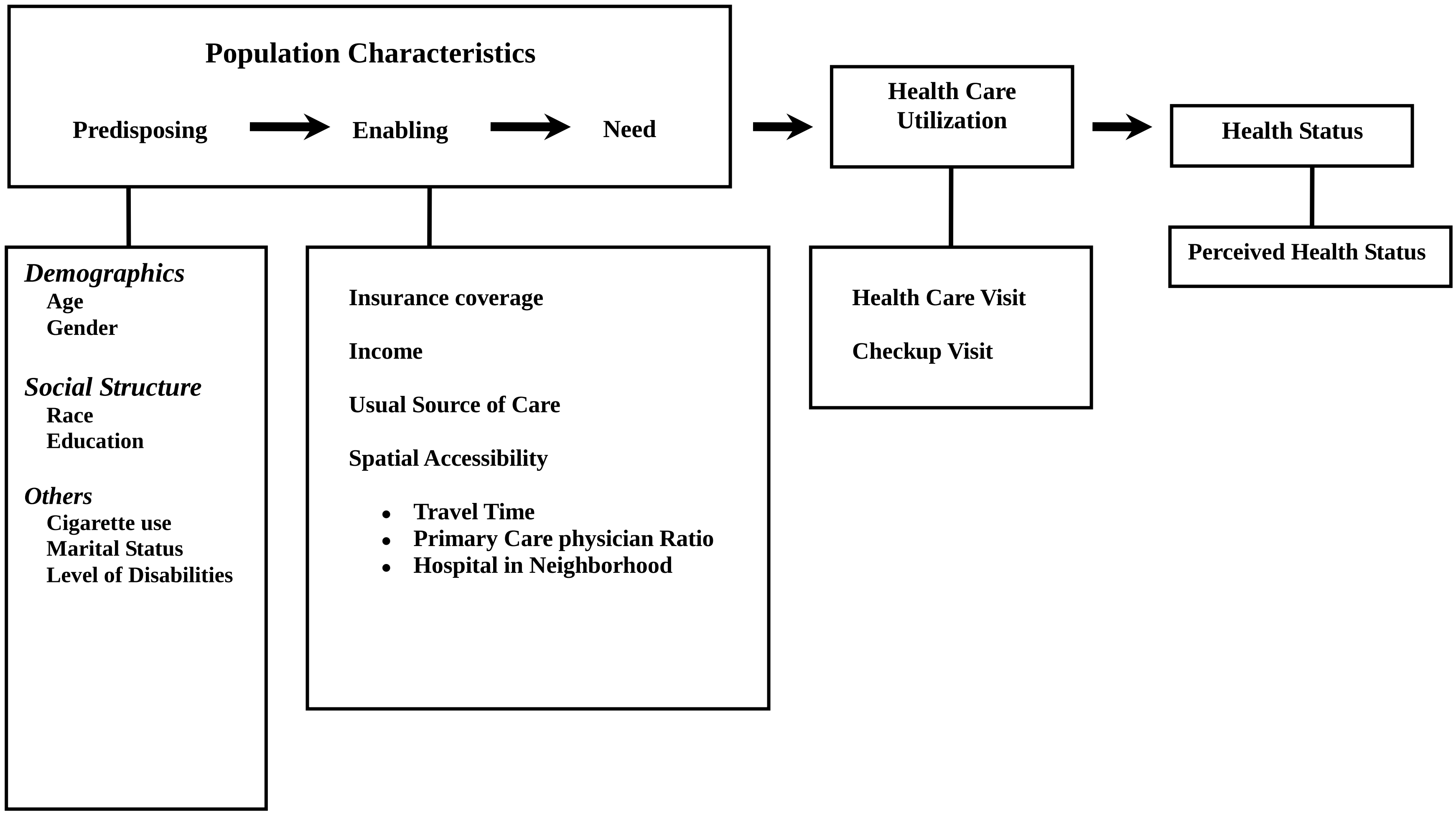

Figure 3-1 Model of Spatial Accessibility, Health Care Utilization, and Health Status for People with Disabilities

3.2 Datasets

The analysis in this study is performed on secondary data; datasets were selected based on the conformity to the principal components of the framework of this study. Only datasets that included the measures of demographic and socioeconomic characteristics, health insurance coverage, usual source of health care, limitations of activities, use of health care services, and health status which were associated with health behavioral model for persons with disabilities were selected. In addition, the information on residential location is essential to calculate spatial accessibility using *ArcGIS*; therefore datasets that did not include the zip code or census tract code of respondents, were removed from consideration. As inclusion of zip code or census tract of respondents renders the data confidential and requires permission to access original data sets from the holder of the original dataset. Two datasets that captured the residential location variable were procured with permission to access.

3.2.1 Access to Outpatient Medical Service in the Rural Southeast

Survey of Access to Outpatient Medical Service in the Rural Southeast (2002—2003) is from the Interuniversity Consortium for Political and Social Research (ICPSR) located within the University of Michigan. This dataset is a random digit dialing telephone survey conducted as part of an evaluation of the Southern Rural Access Program (SRAP), a Robert Wood Johnson Foundation initiative to improve access to basic medical care in targeted rural areas of eight southeastern states (AL, AR, GA, LA, MS, SC, TX, and WV). Within these states, 150 nonmetropolitan counties were selected for SRAP participation based on perceived local health needs, willingness of local organizations and providers to partner with the program's efforts, and prospects for long-term program viability. The 150 counties demonstrated greater socioeconomic need than other nonmetropolitan counties in the eight states: approximately 50% higher poverty rates, 30% higher unemployment, and 40% greater minority proportions.

The survey was fielded from November 2002 through July 2003 by Professional Research Consultants Inc. of Omaha, Nebraska (www.prconline.com) using accepted random digit dialing techniques. Low-population counties were oversampled. Up to 10 calls were attempted to randomly generated numbers within telephone exchanges and active number blocks in each county. A second-stage randomization scheme was used to identify one specific eligible adult to be surveyed from each household reached. Eligible adults were 18 years of age or older who had lived in the immediate area for at least 12 months and spoke either English or Spanish. The participation rate of households reached was 51%, with 4,879 total respondents and 4,682 refusals. Any telephone number that was reached (i.e., the call was picked up) was conservatively treated as eligible and counted as a refusal if the call was terminated before it could be determined whether an eligible adult lived in the household.

In this case, the 1,278 person sample consists of men and women who perceived themselves of having a limitation in usual activities. For the purposes of this study, excluded from the analyses were respondents who (1) provided inadequate geographic information on respondents' residence or town or city, or usual health care service provider location; or (2) were missing values for any of the outcome and explanatory variables used in this study. In all 196 respondents were excluded and analyses were conducted on the remaining 1082 subjects.

Topics covered by the Survey of Access to Outpatient Medical Service in the Rural Southeast (2002－2003) included health status, health insurance coverage, health care access challenges, confidence in and satisfaction with health care services received, and utilization of outpatient services including specific disease prevention services. Personal demographic characteristics collected by the survey include age, sex, race, Hispanic origin, primary language spoken at home, educational achievement, work status, household income, number of children at home, town or city where the place of health care where respondents usually get care is located, and the state, county, town, and ZIP code of residence. In general, the survey has variables which incorporate the principal components of the framework of this study, and provide a multi-states case to this study. In addition, variables of town or city where respondents usually get care are located, and the ZIP codes of residence provide the necessary information to calculate spatial accessibility to health care service provider. Boundary files containing township and zip code location in terms of latitude and longitude were downloaded from the United States Bureau of Census (Bureau of Census, 2008). These data are used in *ArcGIS* 9.2 to map and represent the location of people and outpatient medical services in the states; Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, West Virginia, and Texas. The travel time from respondent’s location (zip code) to health care location (town) is estimated based on 2006 ESRI road network shape file using Network Analyst in *ArcGIS* 9.2.

3.2.2 Ohio Family Health Survey

The data for 2008 Ohio Family Health Survey (OFHS) were procured from The

Center for Community Solution in Cleveland, Ohio. The data was collected through a statewide telephone survey conducted between August 2008 and January 2009, by the Ohio Department of Job and Family Services in collaboration with several other state agencies. The ORC Macro Corporation was responsible for the administration of the survey and the data analysis. The telephone surveys were of randomly selected adults and, if applicable, on behalf of a randomly selected child, in randomly selected, telephone-equipped Ohio households. Additionally, a sample of cell phone users were surveyed midway through the project to reach the increasing numbers of Ohioans who do not have landlines. The overall response rate was 34.6%. The OFHS final sample consisted of 50944 adults (over 18 years old). The survey questionnaire included three questions on the limitations of activities. Participants were asked whether they needed "(1) assistance with personal care, such as bathing, dressing, toilet, or feeding; (2) assistance with domestic activities, such as shopping, laundry, housekeeping, cooking, or transportation; (3) assistance with household maintenance, such as painting or yard work", and based on their responses to these three questions 8670 participants were determined to be "persons with disabilities". However, of the 8670 respondents 408 were missing values for one or more of the outcome variables and were therefore excluded from the analysis. The analyses were thus conducted on the remaining 8262 subjects.

Topics captured in the Ohio Family Health Survey (2008) were: health coverage status, employment characteristics, coverage for supplemental services (vision, dental, prescriptions, and mental health), health status, health care services utilization, unmet needs, access to health care services, health risk factors, and selected disease estimates. Personal demographic characteristics collected by the survey included age, sex, race, Hispanic origin, educational achievement, household income, number of children at home, and the state, county, town, tract, and ZIP code of residence. Similar to the Survey of Access to Outpatient Medical Service in the Rural Southeast (2002-2003), Ohio Family Health Survey (2008) had all of the control and outcome variables which are pertinent to the current study and provided a statewide case data. In addition, the region variable could be used to examine whether or not the association between spatial accessibility, health care services use, and health status were significant in both urban and rural areas. Tract ID could enable determination of spatial accessibility to health care services for each respondent in the survey through a process of "joining" [29] the two variables.

Boundary files containing tract and zip code location in terms of latitude and longitude were downloaded from the United States Bureau of Census (Bureau of Census, 2008). The hospital point shape file was obtained from the Environmental Systems Research Institute (ESRI) and the number of primary care physicians was obtained from the Ohio Medical Board. These data are used in *ArcGIS* 9.2 to calculate spatial accessibility to hospitals and primary care physicians by using the two-step floating catchment area (2SFCA) method (Luo & Wang, 2003; Luo et al., 2004; Yang et al., 2006; Wang et al., 2008). Detailed information on this method is fully discussed later.

3.3 Measurement of Variables

The dependent variable is self-rated health status. There are 11 independent variables, falling into four categories of spatial accessibility, predisposing characteristics, enabling characteristics, and health care services utilization characteristics. The predisposing variables are age, gender, race, education, marital status, tobacco use and limitation of daily activities. The enabling variables are household income, whether the respondent has another source of health insurance, and whether the respondent has a usual source of health care. Health care services utilization variables are whether the respondent has medical care visit and routine checkup visits in the past 12 months. Spatial accessibility includes travel time to health care services provider, primary care physician to population ratio, and hospital within respondents' neighborhood.

3.3.1 Access to Outpatient Medical Service in the Rural Southeast

Predisposing Factors. Predisposing variables in this analysis include sociodemographic, social structure and other variables. Age was determined using responses to the question, "*What is your age?*" It was collected as a continuous variable and is used as such in this analysis. Interviewers were instructed to record the respondent's gender or ask, "*Are you male or female?*" Responses include male (0) and female (1), with female being the reference category.

Measures of social structure are race and level of educational attainment. Respondent race was obtained through responses to the question, "*What is your race?*" Original response categories were the categories as traditionally defined by the Census Bureau: American Indian or Alaska Native (1), Asian or Asian American (2), Native Hawaiian or Other Pacific Islander (3), Black or African American (4), White (5), and Hispanic (6). For this analysis, race was recoded as a dummy variable: Whites (0) and Non-Whites (1) (which includes Native Americans or Alaska Natives, Asian or Pacific Islanders, Blacks, and Hispanic). Non-Whites is the reference category. The level of educational attainment variable was obtained through responses to the question, "*What is the highest grade of schooling that you have completed?*" The five original response categories—less than high school (1), high school or obtained GED (2), technical or trade school (3), some college (4), graduated from college (5), graduated from graduate or professional school (6)—were recoded to include three categories: less than high school (0), high school graduate (1), and some college or college graduate (2). Dummy variables were created for the first two categories. Some college or college graduate is the reference category.

Marital status was established through responses to the question, "*Which of the following best describes your present marital status?*" The response categories are married (1), separated (2), divorced (3), widowed (4), single, never been married (5), single, living as a couple (6). These categories were recoded to include two categories: single (separated, divorced, and widowed, never been married, and living as couple), and married. Single is the reference category. Moreover, tobacco use was determined through responses to "*Do you currently smoke cigarettes, cigars, pipes, or use any other tobacco product?*" Responses included yes (0) and no (1), and "No" is used as the reference category. Level of disabilities is measured using responses to the question, "*During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work or recreation?*" The number of days people cannot perform usual activities (self-care, work or recreation) in some level represents the level of disabilities. The more number of days people could not perform their usual activities, the more severe the level of disabilities. The number of days is a proxy for level of disabilities in the analysis.

Enabling Factors. Enabling variables include household income, the presence of other insurance, and the existence of a regular care source. Annual household income was collected as an ordinal variable and grouped into four categories (0-, less than $19,999; 1- $20,000 to $34,999; 2- $35,000 to $49,999; 3- more than 50,000), in response to the question "How much is your annual household income from all sources?" More than $50,000 is the reference category. Information on health insurance coverage was obtained through responses to the question, *"Do you have any kind of health care payment coverage, including health insurance, prepaid plans such as HMOs, or government plans such as Medicare?*" The response categories are yes (0) and no (1). "No" is the reference category. Usual source of care information was obtained from responses to the question, "*Is there one place that you usually go to when you are sick or need advice about your health?*" The variable was recoded to yes (0) and no (1), with "no" as the reference category.

Spatial accessibility. The Southern Rural Access Program Survey of Access to Outpatient Medical Service in the Rural Southeast (2002—2003) is a personal survey, and has accurate location information regarding the zip code of subjects and the township in which subjects obtain health care services. Travel time is a suitable measure of spatial accessibility for this analysis because accurate location information of health care services provider and subjects is known. Therefore, spatial accessibility will be represented by travel time, via road network to the health care services provider. Spatial accessibility to a health care service provider is defined as the driving time from the respondent's residence to the township of his or her health care services provider in the rural areas of Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, West

Virginia, and Texas. The coordinates of these places were entered into *ArcGIS* 9.2 and the travel time was calculated in minutes from the respondents' homes to each health care services provider's location. The questionnaire also had a question on perceived travel time. Spatial accessibility was represented on the basis of both calculated and perceived travel time. Detailed information on this method is fully introduced in Appendix A.

Primary care service areas (PCSA) were created as the aggregation of the contiguous zip codes (Goodman, Mick, Bott, Stukel, Chang, Marth, Poage, and Carretta, 2003) for a study examining people's health care services access. This dataset included the ratio of primary care physicians to population within PCSA, and this variable also would be a measure of spatial accessibility to health care service. Moreover, the variable which identified the PCSAs containing a federally qualified health care services center provided the other measure of spatial accessibility to health care services. The variable categories are thus: there is at least one federal qualified health center within respondents' PCSA (0), and there is none (1).

Health care services utilization. For this study, the number of medical visits that a person had made in the past 12 months was used to determine whether the respondent had utilized health care services. If a respondent reported one or more visits to a physician when asked, "*In the last 12 months, how many times did you go to a doctor office, clinic hospital to get care for yourself?*" the variable "health care visits" was coded as 0; if the respondent reported zero visits, the variable was coded as 1. Likewise, if a respondent reported having made a routine checkup visit in the past 12 months when asked, "*About how long has it been since you last visited any doctor or provider for a routine checkup?*" The variable "routine checkup visits" was coded 0; the variable was coded 1 if the respondent reported having had a routine checkup over 12 months ago (i.e., not without the designated time period) or reported never having been to a doctor for routine checkup.

Health status. The outcome variable is grouped into two categories from the original five to avoid having SPSS report an error "There are 80% cells without case in multi-logistic regression model, but binary logistic regression does not have any cells without case". The outcome variable was self-rated general health, and low self-reported health status was defined as poor or fair on a 5-point Likert scale. If a respondent reported excellent, very good, or good when asked, "*Would you say that, in general, your health is:*" the variable (excellent, very good, and good) was coded as 0; if the respondent reported fair and poor, the variable was coded as 1.

Table 3-1 Analytical Variable Measures of Survey of Access to Outpatient Medical Service in the Rural Southeast

	Variables	Characteristics	Recoding
Predisposing	Age	Continuous	18 to 94 years old
	Gender	Categorical	0 = Male 1 = Female
	Race	Categorical	0 = White 1 = Not a White (Asian, Native American, African American, Hispanic, Mixed, Italian, South American, Middle Eastern, Mexican)
	Education	Categorical	0 = Less than high school 1 = High school (technical or trade school) 2 = Some college or higher
	Limitation of activities	Continuous	Number of days not doing usual activities (self-care, work, recreation) during past 30 days
	Marital status	Categorical	0 = Single (divorced, widowed, separated, never married , and single, living as couple) 1 = Married
	Tobacco use	Categorical	0 = Yes (current smoker) 1 = No (non- smoker)
Enabling	Household Income	Categorical	0 = Under 19,999 (under 10,000; 10,000 to 14,999; 15,000 to 19,999) 1 = 20,000 to 34,999 (20,000 to 24,999; 25,000 to 34,999) 2 = 35,000 to 49,999 3 = Over 50,000 (50,000 to 74,999; 75,000 or more)

	Variables	Characteristics	Recoding
	Health insurance	Categorical	0 = Yes (insured) 1 = No (not insured)
	Usual source of care	Categorical	0 = Yes (having a usual source of care) 1 = No (not having)
Accessibility	Travel time	Continuous	Travel time in minutes from respondent's residence to their usual health care service provider. This variable included the time which was estimated by *ArcGIS* and perceived by respondents.
	Primary care	Continuous	Primary care physician-to-population ratios within respondents' PCSA (per thousand people)
	Hospital	Categorical	0 = There is at least a federally qualified hospital within respondents' PCSA 1 = There is not
Utilization	Visit for medical care	Categorical	0 = Yes (having made during the past year) 1 = No (not having made during the past year)
	Visit for regular checkup	Categorical	0 = Yes (having made during the past year) 1 = No (not having made during the past year)
Health	Self-rated health status	Categorical	0 = Good (good, very good, excellent) 1 = Poor (fair and poor)

3.3.2 Ohio Family Health Survey Data

Predisposing Factors. Predisposing variables in this analysis include socio-demographic, social structure, and other variables. Age was established through responses to the question, "*How old are you?*" It was collected as a continuous variable and is used as such in this analysis. Interviewers were instructed to record the respondent's gender or ask, "*Are you male or female?*" Responses include male (0) and female (1), with female being the reference category.

Race and levels of educational attainment are used as measures of social structure. Respondent race was obtained from responses to the question, "*Which one or more of the following would you say is your race?*" Original response categories were: White (1), Black or African American (2), Asian (3), Native American, American Indian, or Alaskan Native (4), Native Hawaiian or other Pacific Islander (5), Hispanic, Latino, Spanish (6), other (97). For this analysis, race was recoded into a dummy variable: Whites (1) and Non-Whites (0) (which includes Native Americans or Alaska Natives, Asian or Pacific Islanders, Blacks, Hispanic, and other). Non-White is the reference category. The education variable was created from responses to the question about the level of educational attainment. The five original response categories—up to high school but no diploma (1), high school and graduate or equivalent (2), some college (3), associate degree (4), 4 years college graduate (5), and advanced degree (6)—were recoded to include three categories: less than high school (up to high school but no diploma), high school graduate (high school and graduate or equivalent), and some college or college graduate (some college, associate degree, 4 years college graduate, advanced degree). Dummy variables were created for the latter two categories. Some college or college graduate is the reference category.

Marital status was determined based on the responses to the question, "*Which of the following best describes your present marital status?*" The response categories are married (1), divorced or separated (2), widowed (3), unmarried couple (4), never married (5). Never married is the reference category. Moreover, tobacco use was determined through responses to the question, "*Do you smoke cigarettes every day, some days, or not at all?*" Responses included everyday (1), some days (2), and not at all (3), and grouped to two values; yes (every day and some days) and no (not at all).

There are three questions pertaining to limitations on routine, everyday activities. Participants were asked whether they needed "personal care assistance; such as bathing, dressing, toileting, or feeding", "domestic assistance; such as shopping, laundry, housekeeping, cooking, or transportation", "help with household maintenance; such as painting or yard work." One variable was created to count the number of limitations of living activities and used as a proxy for level of disabilities in the analysis. This variable was coded into three categories to represent the number of limitations: three limitations (0), two limitations (1), and one limitation (2). One limitation is the reference category.

Spatial Accessibility. In general, the actual interaction between demand and supply is hard to obtain, thus potential spatial accessibility generally assumes that "given a reasonable range, people can obtain the service and every member of the population is then a potential user of the service". This study uses *ArcGIS* to determine potential spatial accessibility and unlike the previous dataset which focuses on real travel time, spatial accessibility in this instance focuses on availability of health care resources within a reasonable travel range.

Ohio Family Health Survey Data (2008) does not have accurate location information for health care services providers for each survey respondent. As there is no actual information on interaction between participants and health care service providers in this dataset, potential spatial accessibility will be the most appropriate measure. Primary care physicians or health care professionals affiliated with physicians' offices or clinics are typically the providers of health care services for persons with disabilities, thus the measures of spatial accessibility is configured to include potential spatial accessibility to hospitals and primary care. In addition, the US federal government uses the physical distance equivalent of half-hour travel time by road as a foundational component of the definition of "accessibility" (Luo, 2004). The potential spatial accessibility to a hospital will be represented by the number of hospitals within 30 minutes travel time for each zip code area in Ohio. The travel time is calculated based on 2006 ESRI road network shape file using Network Analyst in *ArcGIS* 9.2. Detailed information on this method is fully introduced in Appendix B.

Moreover, this study uses the two-step floating catchment area (2SFCA) method (Luo & Wang, 2003) to measure potential spatial accessibility to primary care physicians for residents of Ohio, utilizing data from primary care physicians registered with the Ohio Medical Board within the specialties of family practice, general practice, internal medicine, obstetrics and gynecology in 2008.[29] The data contains city, county, and zip codes in which the registered physicians are practicing. Based on number of primary care physicians practicing within each zip code area and the population within a census tract area, 2SFCA can help calculate the ratio of primary care physicians to population within

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[29] According to the research by Pathman, Ricketts III, and Konrad (2005), primary care physicians includes family practice, general practice, internal medicine, obstetrics and gynecology.

30-minute travel time zones (Appendix C).

Although the Ohio Family Health Survey cannot provide detailed information on the interaction between respondent and health care services provider, perceived travel time to health care service could be obtained from responses to the question, "*From the time you leave home, on average, about how long does it take to get to your main source for routine medical care*?".

Enabling Factors. Household income measures were developed by comparing federal poverty guidelines with 2008 OFHS data (which captured a survey respondent's annual gross income for calendar year 2007). Details of the 2007—2008 Federal Poverty Guidelines (FPL) are provided in the table (Table 3-2) that follows.[30] Annual household income was categorized according to federal poverty criteria based on household size: ≤100% federal poverty level, 101%-150%, 151%-200%, 201%-300%, 301% or more. 301% or more is the reference category. Information on whether the respondent has insurance was obtained through responses to the question, *"Are you covered by health insurance or some other type of health care plan?*" The response categories are yes (0) and no (1). "No" is maintained as the reference category. Usual source of care information was obtained from responses to the question, "*Is there a place that you usually go to when you are sick or you need advice about your health?*" The response categories are yes and no. The variable was recoded to yes (0) and no (1), with "no" being the reference category.

Health care services utilization. The variable health care services utilization was based on medical visits made by the respondent in the past 12 months. If a respondent

[30] See Federal Register, Vol. 73, No. 15, January 23, 2008, 3971-3972.

reported less than one year when asked, "*About how long has it been since you last saw a doctor or other health care professional about your/his/her own health?*" the variable (medical care visits) was coded 0; if the respondent reported more than 12 months or never, the variable was coded 1. Likewise, If a respondent reported having made a routine checkup visit in the past 12 months when asked, "*About how long has it been since you last visited a doctor for a routine checkup?*" the variable (routine medical care visits) was coded 0; if the respondent reported having a routine check-up over 12 months ago or never, the variable was coded 1.

Table 3-2 2008 Federal Poverty Guidelines

Persons in Family or Household	**48 Contiguous States and D.C.**	**Alaska**	**Hawaii**
1	$10,400	$13,000	$11,960
2	14,000	17,500	16,100
3	17,600	22,000	20,240
4	21,200	26,500	24,380
5	24,800	31,000	28,520
6	28,400	35,500	32,660
7	32,000	40,000	36,800
8	35,600	44,500	40,940
For each additional person, add	3,600	4,500	4,140

Health status. The dependent variable self-rated general health, and low self-reported health status was defined as poor or fair on a 5-point Likert scale. If a respondent reported excellent, very good, or good when asked, "*Would you say that, in general, your health is:*" a dichotomous general health variable was created by collapsing poor and fair into 1 category, and good, very good, and excellent into another.

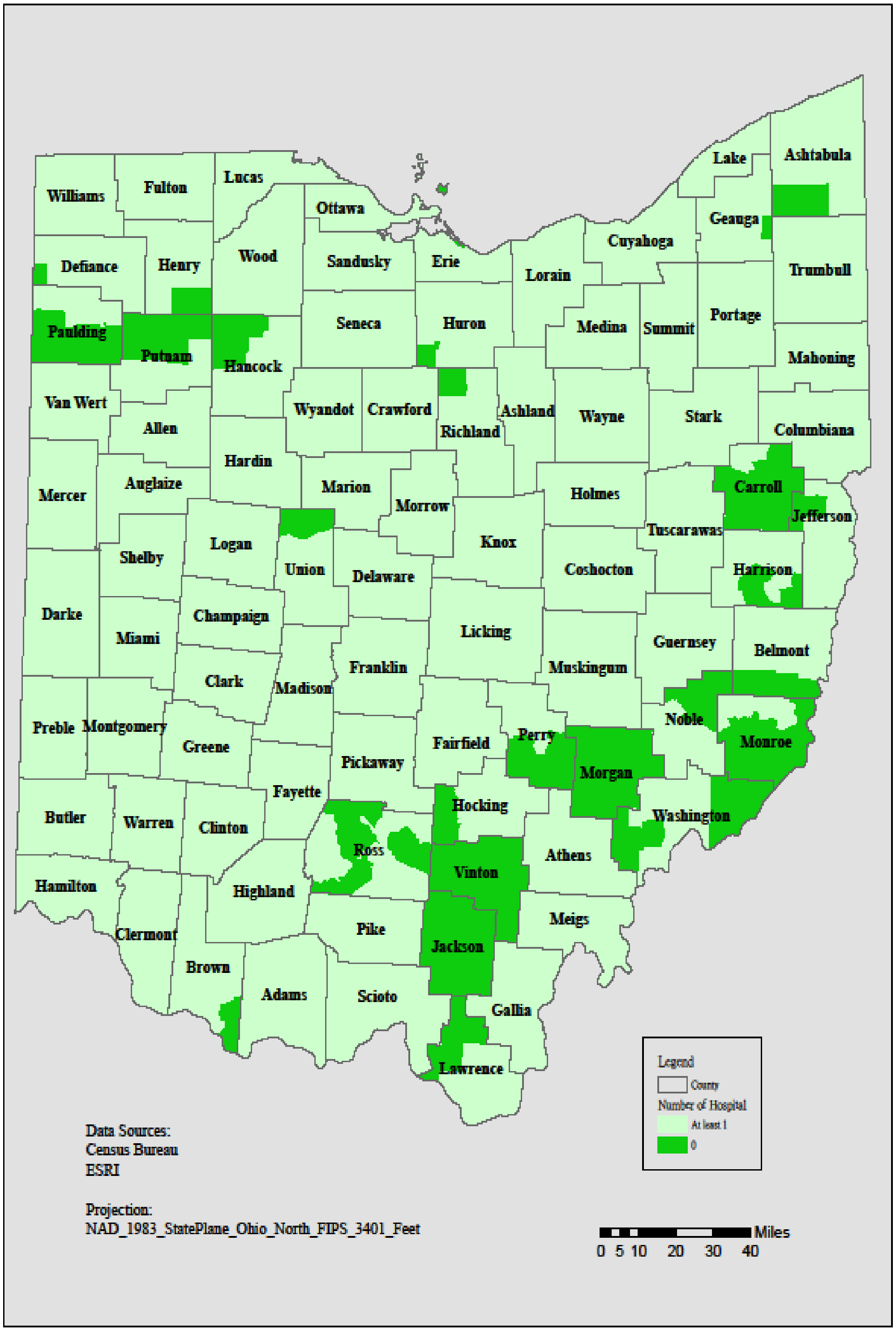

Figure 3-2 Number of Hospitals Located within 30-minute Driving Area

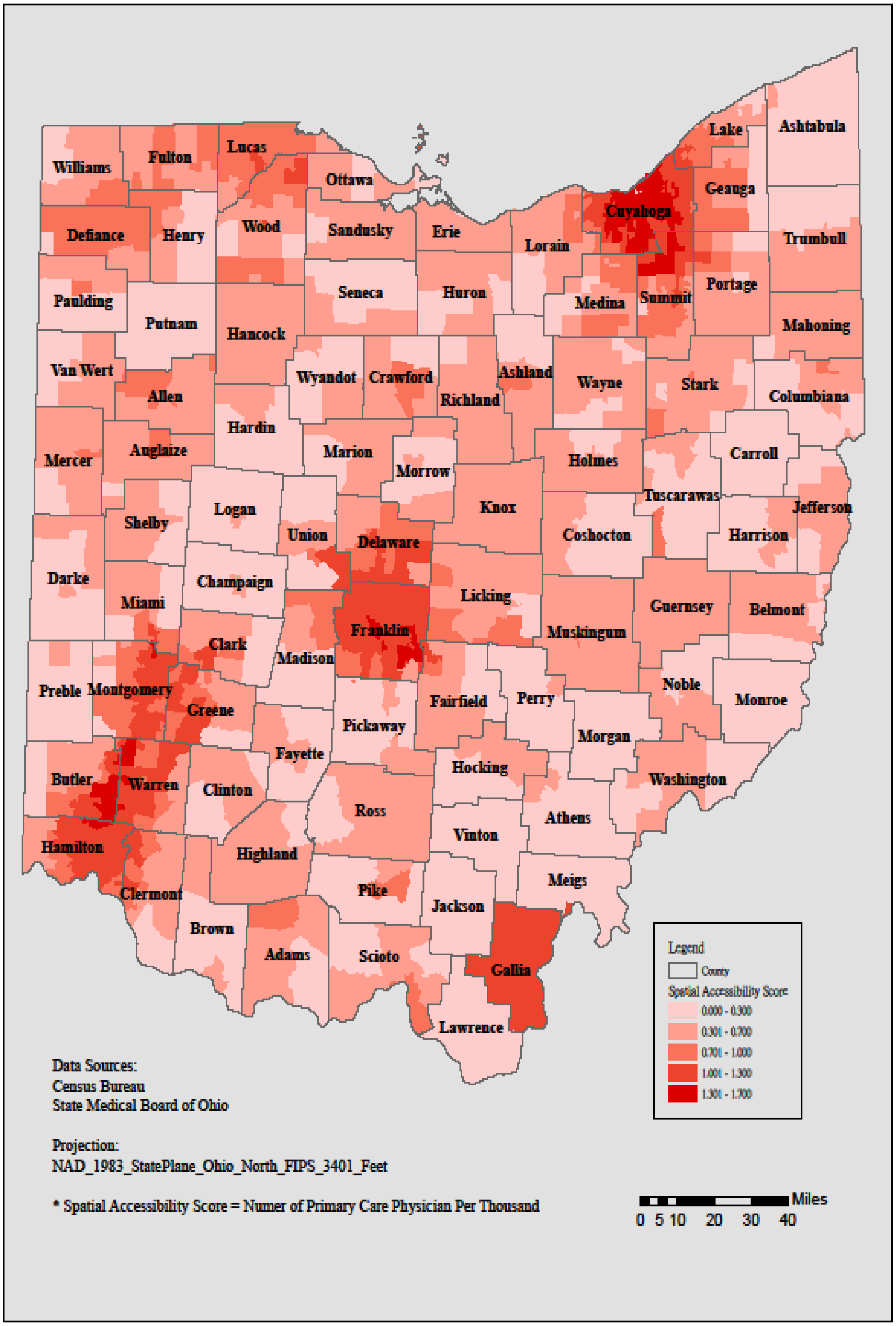

Figure 3-3 Primary Care Physician to Population Ratio within 30-minute Driving Areas (Per Thousand People)

Table 3-3 Analytical Variable Measures of Ohio Family Health Survey

	Variables	Characteristics	Recoding
Predisposing	Age	Continuous	18 to 109 years old
	Gender	Categorical	0 = Male 1 = Female
	Race	Categorical	0 = White 1 = Not a White (Native American or Alaska Natives, Asian or Pacific Islanders, Black, Hispanic, and other)
	Education	Categorical	0 = High school 1 = Less than high school 2 = Some college or higher (some college, associate degree, 4 years college graduate, advanced degree)
	Limitation of activity	Categorical	0 = Three limitations 1 = Tow limitations 2 = One limitation
	Marital status	Categorical	0 = Married 1 = Separated 2 = Widowed 3 = Unmarried couple 4 = Never married
	Tobacco use	Categorical	0 = Current smoker (some days and everyday) 1 = Non-smoker (not at all)

	Variables	Characteristics	Recoding
Enabling	Household Income	Categorical	0 = household income less than 100 % of poverty 1 = 101-150% 2 = 151-200% 3 = 201-300% 4 = 301% or more
	Health insurance	Categorical	0 = Having insurance 1 = No insurance
	Usual source of care	Categorical	0 = Having usual source 1 = No
Accessibility	Travel time	Continuous	Travel time in minutes from each respondent to their usual health care providers. This variable was perceived by respondents.
	Primary care	Continuous	Primary care physician-to-population ratios within 30-min areas (per thousand people)
	Hospital	Categorical	0 = There is at least a hospital within 30-min area 1 = There is not
Utilization	Visit for medical care	Categorical	0 = Having during last year 1 = Not having during last year
	Visit for regular checkup	Categorical	0 = Having during last year (1 to 12 months ago) 1 = Not having during last year (13 to 24, 25 to 60, 61 or more months, never)
Outcome	Health status	Categorical	0 = Good (good, very good, excellent) 1 = Poor (fair and poor)

3.4 Statistical Analysis

Multivariate modeling is an effective and efficient research method widely used in fields such as medicine, social science, epidemiology, and geography. Katz (1999) defines multivariate analysis as "a tool for determining the relative contribution of different causes to a single event" (p. 1). This method can help estimate independent health factor contributions to health care services utilization and health status. For multivariate models that utilize categorical dependent variables the analysis approach of choice is logistic and probit regression. While the results produced by both the models might be similar, probit coefficients are far more difficult for interpretation purposes as probit models do not have an equivalent to logistic regression model's odds ratios. For these reasons, logistic models are more frequently used.

This study examines the association of spatial accessibility to health care services utilization and health status. Health care utilization and health status are dichotomous variables in this study, thus this study uses logistic regression to compute the adjusted odds ratio to estimate the association between spatial accessibility to health care services and health outcome for persons with disabilities, statistically controlling for the other independent variables. Logistic regression does not require fulfilling of the restrictive assumptions that general linear regression mandates. It does not require normally distributed scores on the dependent variable, a linear relation between scores on dependent variable and scores on quantitative independent variables, or homogeneous variance of dependent variable across levels of independent variables. By contrast, the assumptions for logistic regression (Wright, 1995) are as follows:

(1) The dependent variable is categorically dichotomous.

(2) Scores on the dependent variable must be statistically independent of each other.

(3) The model must be correctly specified; that is, it should include all relevant independent variables, and it should not include any irrelevant independent variables.

(4) The categories on the dependent variable are assumed to be exhaustive and mutually exclusive; that is, each person in the study is known to be a member of one group or the other but not both.

Even though there are fewer assumptions in logistic regression, preliminary data screening is still useful and important. One of the most important issues that should be addressed in a preliminary data screen is the distribution of scores on the dependent variable. In this study, there will be two possible values of the dependent variable. If the total number of cases is very small, the number of cases in the smaller outcome group may simply be too small to obtain meaningful results. In this study, there are several categorical variables. It is useful to set up a table to show the cell frequencies for any pair of categorical variables. Logistic regression may not produce valid results when there are one or more cells that have expected cell frequencies < 5. If there are more than 20% of the cells which have expected value < 5, this situation should be carefully manipulated. The variables in such a scenario can be manipulated by either combining the groups or excluding the variables from the analysis.

If the sample size is too small, the reliability of the estimates tends to be low. However, it is difficult to decide whether the sample size has adequate statistical power in logistic regression. Peduzzi, Concato, Kemper, Holford, and Feinstein (1996) have suggested that as a rule of thumb, a minimum total number of observations in the sample should at least be 10 times the number of independent variables in the regression. A larger number of observations may be required to have acceptable statistical power.

Data from the surveys were converted to SPSS version 15 for data management and analysis. The strategy for dealing with missing data followed in this study was to estimate the value of missing cases (Agresti & Finlay, 1999). The advantage of this method is that no observations will be lost. However, the drawback to using this technique is that one can inadvertently introduce bias into the results that can be difficult to predict. An example of a method for estimating missing values for cross sectional studies includes assigning the sample mean or modeling the value of missing data by using the other covariates in the analysis (e.g. simple imputation; Katz, 1999; Cohen, 1988).

Data analysis began with a descriptive examination of the variables including frequency distribution, means, standard deviations, and ranges. Bivariate analysis for each dependent variable included Chi-square tests and *t*-tests of association. Logistic regression was then performed to examine the effects of spatial accessibility on the odds of having health care services visits, having routine checkup visits, and being poor in health status, controlling for all other factors. Both the odds ratios and their 95 percent confidence intervals (C.I.) are presented. A significance level of $p \leq .05$ was used to conduct all tests.

Multicollinearity can affect the parameters of a regression model. Logistic regression is equally as prone to the bias effect of collinearity and it is essential to test for collinearity following a logistic regression analysis. Menard notes in *Applied Logistic*

Regression Analysis (2002), that much of the diagnostic information for multicollinearity (e.g., VIFs) can be obtained by calculating an OLS regression model using the same dependent and independent variables used in the logistic regression model (Menard, 2002). Menard suggests that a tolerance value less than 0.1 almost certainly indicates a serious collinearity problem (Menard, 2002), and Myers also suggests that a VIF value greater than 10 is cause for concern (Myers, 1990). Allison indicates that a VIF over 2.5 is cause for concern as is a tolerance less than 0.40 (Allison, 1999). The analyses conducted for the purposes of this dissertation adapt Allison's criteria for assessing collinearity.

The model is evaluated using -2 log likelihood, Hosmer-Lemeshow test, Cox & Snell's R Square, and Nagelkerke R Square. When results of the test of -2 log likelihood test is statistically significant ($p < 0.05$), this indicates that the logistic model is more effective than the null model. Nonsignificance on the H-L goodness-of-fit test implies the model's estimates fit the data at an acceptable level ($p > 0.05$). Cox and Snell's R Square and Nagelkerke R Square are variations of the R Square for linear regression model. However, these two R Square indices do not mean what R-squared means in OLS regression (the proportion of variance explained by the predictors). These two are treated as supplementary to the goodness-of-fit test statistic (Long, 1997; Menard, 2000).

3.5 Summary

This cross-sectional study uses two survey datasets; (1) Survey of Access to Outpatient Medical Service in the Rural Southeast (2002—2003), and (2) Ohio Family Health Survey (2008) to test the relationship of spatial accessibility to health care services utilization and health status in persons with disabilities. Binary logistic models will be used to identify the association of spatial accessibility and health care utilization, and the association of spatial accessibility and health status while adjusting for the effects of other factors. The models were evaluated using both the goodness of fit test and Hosmer-Lemeshow version.

CHAPTER IV

RESULTS

The purpose of the cross-sectional analysis conducted was to explore the association between spatial accessibility to health care services, health care services utilization and the health status of adult (over 18 years old) persons with disabilities. The sample data utilized in the analysis for this study were derived from two survey datasets: Survey of Access to Outpatient Medical Service in the Rural Southeast and Ohio Family Health Survey. Variables included were predisposing variables—age, gender, levels of educational attainment, race, level of disabilities, marital status, and tobacco use and enabling variables—income, insurance, and usual source of care. The variables coding for spatial accessibility in the Survey of Access to Outpatient Medical Service in the Rural Southeast were calculated based on the perceived travel time to the health care services provider. Ohio Family Health Survey included perceived travel time to the health care services provider, number of hospitals located within a thirty minute commute, and the ratio of primary care physician to population within a 30-minute commute.

Data management and logistic regression analyses were conducted in *SPSS* version 15. The significant levels for all statistical tests were set at 0.05. The results of the analyses (of data from both datasets) are reported in this chapter in three sections; section one describes the frequency distributions for all the variables included in the analytic models for the sample, section two examines the statistical differences between the data of the two groups using a chi-square test or a *t*-test of differences ($p < 0.05$), and section three provides results of the logistic regression analyses.

4.1 Survey of Access to Outpatient Medical Service in the Rural Southeast

4.1.1 Descriptive statistics

The general characteristics of the study sample are depicted in Table 4.1. The study sample includes 997 (92.1%) persons who had made a medical visit in the past 12 months and 85 (7.9%) persons who had not. Among them 950 (87.8%) persons had undergone a routine check-up in the past 12 months and 132 (12.2%) had not. Of those, 503 (46.5%) perceived themselves to be in good health and 517 (53.5%) perceived themselves to be in poor health. The mean age of the participants was 51.25 years (*SD* = 15.9), and the majority of participants were female (72.6%, *n* = 785). The racial composition of more than half the sample was White (*n* = 716) and four out of five respondents had at least a high school level of educational attainment (*n* = 810). Of the total sample, 31.7% (*n* = 343) were married. Tobacco use was indicated by 318 (29.4%) respondents. The mean of the reported number of days that respondents had been unable to perform daily activities in the past 30 days was 13.2 (*SD* = 11.274). Of the total participants 770 (71.2%) reported an annual household income less than $34,999 and 826 (76.3%) participants reported having some kind of health insurance coverage. An usual source of health care was reported as being available to them by 550 (50.8%) of the respondents as opposed to the 532 (49.2%) who did not.

The mean travel time as calculated by *ArcGIS* 9.2 was 30.74 minutes (*SD* = 30.146) while that reported by the participants themselves was 26.52 minutes (*SD* = 26.874). The mean of the ratio of primary care physician to population (per thousand people) within PCSA was 0.5283 (*SD* = 0.25655). Only 40.7% (*n* = 440) of the respondents had a federal qualified health clinic (FHQC) within their Primary Care Shortage Area (PCSA).

Table 4-1 Characteristics of Sample from the Access to Outpatient Medical Service in the Rural Southeast Survey

Variables	N	Mean	S.D.	%	Range
Total = 1082					
Predisposing Characteristics					
Age		51.25	15.9		18-94
Gender					
Female	785			72.6	
Male	297			27.4	
Race					
White	716			66.2	
Non-White	366			33.8	
Education					
Less than high school	272			25.1	
High School	435			40.2	
College	375			34.7	
Marital status					
Single	739			68.3	
Married	343			31.7	
Tobacco use					
Yes	318			29.4	
No	764			70.6	
Limited activity days		13.2	11.274		1-30
Enabling Characteristics					
Income					
Less than 19,999	512			47.3	
20,000 to 34,999	258			23.8	
35,000 to 49,999	127			11.7	
More than 50,000	185			17.1	

Variables	N	Mean	S.D.	%	Range
Insurance					
Yes	745			68.9	
No	337			31.1	
Usual source of care					
Yes	550			50.8	
No	532			49.2	
Spatial Accessibility					
Calculated time (minutes)		30.74	30.146		1-266
Perceived time (minutes)		26.53	26.874		1-207
Ratio of PCP to population within PCSA		0.5283	0.25655		0-2.22018
FQHC within PCSA					
Yes	440			40.7	
No	642			59.3	
Health Care Utilization					
Medical visit last year					
Yes	997			92.1	
No	85			7.9	
Routine checkup last year					
Yes	950			87.8	
No	132			12.2	
Health Status					
General health status					
Excellent/very good/good	503			46.5	
Fair/poor	579			53.5	

4.1.2 Bivariate Analysis

(1) Health care visit

None of the spatial accessibility measures are significantly associated with frequency of visits paid for health care services. Calculated travel time (p = 0.622), perceived travel time (p = 0.759), ratio of primary care physician to population within PCSA (p = 0.061), and federal qualified clinic within PCSA (p = 0.430) were not found to be significant.

Several predisposing and enabling characteristics were found to be associated with frequency of health care services visits (Table 4-2). Older individuals, Whites, those with a higher level of educational attainment, those with a higher household income, and those with health insurance were more likely to have a greater frequency of health care services visits. Individuals 51.73 years and older made more health care services visits compared to those 45.58 years. A greater proportion of Whites (93.6) had more frequent health care services visits than others (89.3%). Individuals with an earned college degree were more likely (95%) to have made health care services visits than those with a high school degree (91.3%) and those with a less than high school education (89.3%). Individuals with an annual household income greater than $50,000 (94.6%) made more frequent visits than those with an annual household income of less than $19,999 (89.5%). The insured (95%) had greater health care services visits compared to the uninsured (85.5%).

(2) Routine checkup visit

None of the spatial accessibility measures were significantly associated with visits for routine checkups; calculated travel time (p = 0.243), perceived travel time (p =

0.051), ratio of primary care physician to population within PCSA (p = 0.122), and federal qualified clinic within PCSA (p = 0.376) were all insignificant predictors of frequency of health care visits for routine checkups.

Several predisposing and enabling characteristics wee however, associated with routine checkup visits (Table 4-2); older individuals, non-Whites, the insured and those with more number of days marked by limited activity were more likely to have routine checkups. Frequency of routine check-up visits was greater for older individuals (52.2 years) than for younger (44.95) and for non-Whites (92.3%) than Whites (85.5%). Significant differences were also found between having regular checkup and not having in number of days with limitations of daily activities (13.53 days compared with 10.82 days). Ninety-two percent of those insured made routine checkup visits compared to 78.9% of the uninsured.

(3) Health status

Calculated travel time (p = 0.023), and perceived travel time (p = 0.000) were both found to be significantly associated with health status. Individuals with a greater commute time to their health care services provider were more likely to perceive themselves to be in poor health. However, ratio of primary care physician to population within PCSA (p = 0.185), and location of federally qualified clinic within the PCSA (p = 0.752) were not found to be significant predictors of perceived health status (Table 4-3).

Individuals who perceived themselves to be of poor health status were; older (55.32 years of age compared to 46.56), single, had a lower level of educational attainment, lower household income, no usual source of care, greater number of days with limited activity , and had paid a routine checkup visit in the past year. Seventy-five percent of individuals with less than high school level educational attainment perceived themselves to be in poor health compared to 54.3% of individuals who had earned a high school degree and 38.1% of individuals who had earned a college degree. Individuals with an annual household income less than $19,999 were more likely (69.1%) to report being of poor health status than individuals with an annual household income greater than $50,000 (28.1%). Of those insured only 51% perceived themselves to be in poor health compared to 59.1% of the uninsured. Of those individuals who had usual source of care 49.6% perceived their health status as being poor while of those who had no usual source of care 57.5% believed themselves to be in poor health. Those who had routine health check-ups were more likely (55.2%) to report being in poor health than those who did not (41.7%).

(4) Summary

Bivariate analyses revealed that calculated travel time and perceived travel time were significantly associated with perceived health status. Older individuals and Whites, those with greater educational attainment, those with higher annual household income, and those with health insurance were more likely to have greater frequency of health care services visits. Individuals who were older, non-White, insured, and experienced more days with limited activity were more likely to undergo routine checkups. With regard to perceived health status older, single, individuals with lower levels of educational attainment, lower annual household income, no usual source of care, greater number of days with limited activity, and greater number of routine checkups in the past year were more likely to perceive themselves to be in poor health status.

Table 4-2 Bivariate Analyese for the Access to Outpatient Medical Service in the Rural Southeast Data Set (Health Care Services Utilization)

	Health Care Services Visit			**Routine Checkup**		
	Yes (*N* =997)	**No (*N* = 85)**	***P***	**Yes (*N* =950)**	**No (*N* = 132)**	***P***
Calculated travel time	30.61 (SD = 30.084)	32.29 (SD = 31.010)	0.622	31.14 (SD = 30.75)	27.87 (SD = 25.299)	0.243
Perceived travel time	26.44 (SD = 26.868)	27.38 (SD = 27.095)	0.759	27.71 (SD = 27.383)	22.23 (SD = 22.51)	0.051
PCP to population within PCSA	0.524 (SD = 0.2545)	0.579 (SD = 0.2765)	0.061	0.524 (SD = 0.2530)	0.561 (SD = 0.2797)	0.122
FQHC within PCSA			0.430			0.376
Yes	402 (92.7%)	38 (7.3%)		391 (88.9%)	49 (11.1%)	
No	595 (91.4%)	47 (8.6%)		559 (87.1%)	83 (12.9%)	
Age	51.73 (SD = 15.820)	45.58 (SD = 15.829)	0.001*	52.12 (SD = 15.906)	44.95 (SD = 14.420)	0.000*
Gender			0.091			0.23
Female	730 (93%)	55 (7%)		695 (88.5%)	90 (11.5%)	
Male	267 (89.9%)	30 (10.1 %)		255 (85.9%)	42 (14.1 %)	
Race			0.014*			0.001*
White	670 (93.6%)	46 (6.4%)		612 (85.5%)	104 (14.5%)	
Non-White	327 (89.3%)	39 (10.7%)		338 (92.3%)	28 (7.7%)	
Education			0.016*			0.435
Less than High school	243 (89.3%)	29 (10.7%)		243 (89.3%)	29 (10.7%)	
High School	397 (91.3%)	38 (8.7%)		384 (88.3%)	51 (11.7%)	
College	357 (95.2%)	18 (4.8%)		323 (86.1%)	52 (13.9%)	
Marital status			0.818			0.975
Single	680 (92.0%)	59 (8.0%)		649 (87.8%)	90 (12.2%)	
Married	317 (92.4%)	26 (7.6%)		301 (87.8%)	42 (12.2%)	
Tobacco use			0.213			0.439
Yes	288 (90.6%)	30 (9.4%)		283 (89%)	35 (11%)	
No	709 (92.8%)	55 (7.2%)		667 (87.3%)	97 (12.7%)	
Limited activity days	13.03 (SD = 11.206)	15.24 (SD = 11.920)	0.083	13.53 (SD = 11.344)	10.82 (SD = 10.488)	0.009*
Income			0.011*			0.742
Less than 19,999	458 (89.5%)	54 (10.5%)		455 (88.9%)	57 (11.1%)	
20,000 to 34,999	241 (93.4%)	17 (6.6%)		224 (86.8%)	34 (13.2%)	
35,000 to 49,999	123 (96.9%)	4 (3.1%)		109 (85.8%)	18 (14.2%)	
More than 50,000	175 (94.6%)	10 (5.4%)		162 (87.6%)	23 (12.4%)	

	Health Care Services Visit			Routine Checkup		
	Yes (*N* =997)	**No (*N* = 85)**	***P***	**Yes (*N* =950)**	**No (*N* = 132)**	***P***
Insurance			0.000*			0.000*
Yes	709 (95.2%)	36 (4.8%)		684 (91.8%)	61 (8.2%)	
No	288 (85.5%)	49 (14.5%)		266 (78.9%)	71 (21.1%)	
Usual source of care			0.469			0.867
Yes	510 (92.7%)	40 (7.3%)		482 (87.6%)	68 (12.4%)	
No	487 (91.5%)	45 (8.5%)		468 (88%)	64 (12%)	

* $p < 0.05$

Table 4-3 Bivariate Analyses for the Access to Outpatient Medical Service in the Rural Southeast Data Set (Health Status)

	Health status		
	Good (*N* = 503)	**Poor (*N* = 579)**	***P***
Calculated travel time	28.51 (SD = 27.254)	32.69 (SD = 32.349)	0.023*
Perceived travel time	22.77 (SD = 23.355)	29.77 (SD = 29.227)	0.000*
PCP to population within PCSA	0.5393 (SD = 0.2641)	0.5186 (SD = 0.2497)	0.185
FQHC within PCSA			0.752
Yes	202 (45.9%)	238 (54.1%)	
No	301 (46.9%)	341 (53.1%)	
Age	46.56 (SD = 16.062)	55.32 (SD = 14.595)	0.000*
Gender			0.884
Female	366 (46.6%)	160 (53.4%)	
Male	137 (46.1%)	419 (53.9 %)	
Race			0.151
White	344 (48%)	372 (52%)	
Non-White	159 (43.4%)	207 (56.6%)	
Education			0.000*
Less than High school	72 (26.5%)	200 (73.5%)	
High School	199 (45.7%)	236 (54.3%)	
College	232 (61.9%)	143 (38.1%)	
Marital status			0.839 *
Single	342 (50.2%)	397 (49.8%)	
Married	161 (42.6%)	182 (57.4%)	
Tobacco use			0.772
Yes	150 (47.2%)	168 (52.8%)	
No	353 (46.2%)	411 (53.8%)	
Limited activity days	8.46 (SD = 9.637)	17.32 (SD = 10.978)	0.000*
Income			0.000*
Less than 19,999	158 (30.9%)	354 (69.1%)	
20,000 to 34,999	136 (52.7%)	122 (47.3%)	
35,000 to 49,999	76 (59.8%)	51 (40.2%)	
More than 50,000	133 (71.9%)	52 (28.1%)	
Insurance			0.014*
Yes	365 (49%)	380 (51%)	
No	138 (40.9%)	199 (59.1%)	
Usual source of care			0.009*
Yes	277 (50.4%)	273 (49.6%)	
No	226 (42.5%)	306 (57.5%)	

	Health status		
	Good (*N* = 503)	**Poor (*N* = 579)**	***P***
Medical care visit			0.212
Yes	469 (47%)	528 (53%)	
No	34 (40%)	51 (60%)	
Routine checkup			0.004*
Yes	426 (44.8%)	524 (55.2%)	
No	77 (58.3%)	55 (41.7%)	

* $p < 0.05$

4.1.3 Logistic Regression

(1) The association between spatial accessibility and health care services visit, controlling for other predictors;

The model-predicted odds ratios for the health care services visits are reported in Table 4-4. Three spatial accessibility predictors--calculated travel time, perceived travel time, and having federal qualified health care center within respondents' PCSA--were not significant predictors of the likelihood of a person with disabilities making a health care services visit. Within the parameters of the same model, the association of ratio of primary care physician to population within participants' PCSA to health care services visit was found to be significant (Exp(B) =.403, 95% C.I. = .175-.928). Individuals in locations that have a higher primary physician to population ratio are less likely to have made a health care services visit within the past year. Areas with higher ratios of primary care physicians to population had, in general, a much lower total health care cost than did other areas, partly because of better preventive care.

When adjusted for other factors, the analyses demonstrated that several of the predisposing and enabling characteristics had significant associations with health care services visits. The odds ratios of health care services visits are positively related to age. In other words, older adults were more likely than younger adults to have had health care services use in the previous year. The insured were more likely to have had a health care service visit as opposed to the uninsured. The overall fit of these models were significant (p < 0.00). Results of the Hosmer-Lemeshow test suggest that these four models were adequate at predicting the data (p > 0.05). The tolerance and VIF value indicate that there are no issues potentially arising from the presence of collinearity (Table 4-7).

(2) The association between spatial accessibility and routine checkup visits, controlling for other predictors;

The model-predicted odds ratios from the logistic regression models for having routine checkup visits are reported in Table 4-5. None of the spatial accessibility predictors were found to be significant predictors of routine checkup visits made in the past year. Several predisposing and enabling characteristics were, however, associated with routine checkup visits when adjusted for other characteristics. Older adults were more likely than younger adults to have had a routine checkup in the previous year. White adults were less likely to have had a routine checkup visit within the past 12 months compared to Non-White adults. This can be partly explained by the observation that White adults, on average, perceived themselves to be in good health. The insured were more likely to have had a routine checkup visit in the past year. The overall fit of these models was significant (p < 0.00). The Hosmer-Lemeshow test suggests that these four models are predicting the data sufficiently well (p > 0.05) and the tolerance and VIF values indicate no collinearity (Table 4-7).

(3) The association between spatial accessibility and poor health status, controlling for other predictors;

The model-predicted odds ratios for health status from the logistic models are reported in Table 4-6. Modeled using the same assumptions and parameters, perceived travel time was estimated to be positively associated with poor health status (Exp(B) =1.008, 95% C.I. = 1.002-1.013). In other words, adults who had a longer drive time to the health care services provider were more likely to perceive of themselves to be in poor health.

Several predisposing and enabling characteristics were associated with routine checkup visits, while controlling for other characteristics. Older adults were more likely than younger adults to report being in poor health. Persons with disabilities with less than high school education are more likely to perceive of themselves as being in poor health status compared to persons with disabilities with a college education. The odd ratios of perceived poor health status are positively related to number of days of limited activity. Individuals with a greater number of limited activity days (in the past month) were more likely to report poor health. Adults with an annual household income of less than $49,999 were more likely to consider themselves to be in poor health compared to adults with an annual household income of at least $50,000. The insured were less likely to perceive themselves to be in poor health compared to the uninsured. The overall fit of these models were significant ($p < 0.00$). The results of the Hosmer-Lemeshow test suggest that models 2 and 4 predict the data well ($p > 0.05$) and the tolerance and VIF values indicate no collinearity problems (Table 4-8).

Table 4-4 Predicted Odds Ratios for Having Health Care Services Visit in the Past Year

	Model 1			Model 2			Model 3			Model 4		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.029**	**1.012**	**1.046**	**1.029**	**1.012**	**1.047**	**1.028**	**1.011**	**1.045**	**1.028**	**1.011**	**1.045**
Gender (reference = female)	.657	.401	1.077	.655	.400	1.072	.646	.396	1.055	.640	.393	1.044
Race (reference = non-White)	1.337	.821	2.177	1.338	.821	2.179	1.390	.851	2.272	1.321	.812	2.152
Education (reference = college)												
Less than high school	.562	.279	1.133	.565	.281	1.136	.596	.297	1.198	.577	.287	1.159
High School	.590	.319	1.092	.587	.317	1.087	.594	.321	1.099	.596	.322	1.103
Marital Status (reference = single)	1.082	.653	1.793	1.083	.653	1.793	1.062	.641	1.762	1.082	.653	1.792
Tobacco Use (reference = no)	.826	.510	1.338	.825	.510	1.337	.829	.510	1.345	.828	.511	1.341
Limited Activity Days	.981	.960	1.003	.981	.960	1.003	.981	.960	1.003	.981	.960	1.002
Income (reference = more than 50,000)												
Less than 19,999	.800	.346	1.853	.807	.349	1.868	.756	.326	1.755	.803	.346	1.861
20,000 to 34,999	1.173	.497	2.768	1.182	.501	2.791	1.162	.492	2.741	1.167	.495	2.753
35,000 to 49,999	2.226	.663	7.474	2.239	.667	7.515	2.240	.669	7.504	2.278	.679	7.644
Insurance (reference = no)	**2.306**	**1.404**	**3.786**	**2.309**	**1.407**	**3.791**	**2.339**	**1.423**	**3.845**	**2.310**	**1.407**	**3.792**
Usual Source of Care (reference = no)	1.106	.675	1.811	1.107	.676	1.813	1.191	.723	1.962	1.113	.680	1.822
GIS Travel Time (minutes)	.997	.990	1.005									

	Model 1			Model 2			Model 3			Model 4		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Perceived Travel Time (minutes)				.997	.989	1.005						
Primary Care Physicians to Population within PCSA							**.403**	**.175**	**.928**			
Federal Qualified Health Care Center within PCSA (reference =no)										.891	.562	1.414
Constant	3.770			3.669			5.559			3.741		
Model Chi-Square	55.399 (.000)			55.322 (.000)			59.247 (.000)			55.084 (.000)		
H &L Test	.432			.635			.923			.676		
Cox & Snell R Square	.050			.050			.053			.050		
Nagelkerke R Square	.118			.118			.126			.117		

Table 4-5 Predicted Odds Ratios for Having Routine Checkup Visits in the Previous Year

	Model 1			Model 2			Model 3			Model 4		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.021**	**1.007**	**1.035**	**1.020**	**1.006**	**1.034**	**1.021**	**1.007**	**1.035**	**1.021**	**1.007**	**1.035**
Gender (reference = female)	.709	.466	1.080	.701	.461	1.067	.728	.479	1.105	.725	.478	1.101
Race (reference = non-White)	**.352**	**.218**	**.568**	**.351**	**.217**	**.567**	**.356**	**.221**	**.575**	**.354**	**.219**	**.572**
Education (reference = college)												
Less than high school	1.242	.703	2.193	1.239	.701	2.191	1.266	.717	2.237	1.220	.691	2.155
High School	1.208	.770	1.895	1.215	.774	1.907	1.209	.770	1.897	1.203	.767	1.888
Marital Status (reference = single)	1.080	.716	1.628	1.075	.713	1.622	1.062	.704	1.601	1.079	.715	1.627
Tobacco Use (reference = no)	1.378	.894	2.125	1.381	.896	2.131	1.395	.904	2.153	1.382	.897	2.129
Limited Activity Days	1.017	.997	1.037	1.017	.997	1.036	1.018	.999	1.038	1.017	.998	1.037
Income (reference = more than 50,000)												
Less than 19,999	.931	.489	1.775	.919	.482	1.752	.904	.473	1.725	.927	.487	1.765
20,000 to 34,999	.919	.495	1.706	.907	.488	1.685	.924	.497	1.719	.920	.495	1.709
35,000 to 49,999	.849	.423	1.701	.853	.426	1.709	.836	.417	1.675	.840	.419	1.683
Insurance (reference = no)	**3.217**	**2.111**	**4.902**	**3.206**	**2.102**	**4.888**	**3.267**	**2.142**	**4.982**	**3.230**	**2.119**	**4.924**
Usual Source of Care (reference = no)	.845	.559	1.277	.849	.561	1.284	.868	.573	1.317	.847	.560	1.281

	Model 1			Model 2			Model 3			Model 4		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
GIS Travel Time (minutes)	1.003	.995	1.010									
Perceived Travel Time (minutes)				1.006	.997	1.014						
Primary Care Physicians to Population within PCSA							.551	.272	1.116			
Federal Qualified Health Care Center within PCSA (reference =no)										1.131	.763	1.676
Constant	2.150			2.132			3.042			2.151		
Model Chi-Square	77.862 (.000)			79.107 (.000)			79.964 (.000)			77.666 (.000)		
H &L Test	.804			.288			.435			.966		
Cox & Snell R Square	.069			.071			.071			.069		
Nagelkerke R Square	.133			.135			.136			.132		

Table 4-6 Predicted Odds Ratios for Poor Health Status

	Model 1			**Model 2**			**Model 3**			**Model 4**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.025**	**1.015**	**1.035**	**1.024**	**1.014**	**1.034**	**1.026**	**1.016**	**1.036**	**1.025**	**1.015**	**1.035**
Gender (reference = female)	.910	.663	1.250	.895	.651	1.230	.936	.684	1.283	.936	.683	1.282
Race (reference = non-White)	1.028	.751	1.408	1.025	.747	1.405	1.033	.754	1.415	1.021	.745	1.401
Education (reference = college)												
Less than high school	**2.124**	**1.411**	**3.197**	**2.138**	**1.419**	**3.221**	**2.127**	**1.412**	**3.202**	**2.095**	**1.392**	**3.153**
High School	**1.393**	**1.005**	**1.930**	**1.424**	**1.026**	**1.977**	**1.388**	**1.001**	**1.923**	**1.394**	**1.006**	**1.932**
Marital Status (reference = single)	1.082	.803	1.458	1.081	.802	1.459	1.069	.793	1.440	1.078	.800	1.452
Tobacco Use (reference = no)	.968	.715	1.311	.962	.709	1.304	.981	.724	1.329	.975	.720	1.320
Limited Activity Days	**1.064**	**1.050**	**1.078**	**1.063**	**1.049**	**1.078**	**1.065**	**1.050**	**1.079**	**1.064**	**1.050**	**1.079**
Income (reference = more than 50,000)												
Less than 19,999	**2.780**	**1.722**	**4.487**	**2.746**	**1.699**	**4.438**	**2.708**	**1.675**	**4.377**	**2.762**	**1.712**	**4.458**
20,000 to 34,999	1.514	.954	2.401	1.491	.938	2.369	1.510	.951	2.395	1.506	.950	2.388
35,000 to 49,999	1.443	.848	2.454	1.469	.863	2.502	1.394	.819	2.374	1.403	.826	2.386
Insurance (reference = no)	**.679**	**.488**	**.946**	**.677**	**.486**	**.944**	**.690**	**.495**	**.962**	**.685**	**.492**	**.954**
Usual Source of Care (reference = no)	.765	.561	1.042	.763	.560	1.041	.771	.565	1.051	.754	.553	1.027

	Model 1			Model 2			Model 3			Model 4		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Health Care Services Visit (reference = no)	.899	.532	1.518	.895	.529	1.514	.869	.514	1.468	.893	.530	1.505
Routine Checkup Visit (reference = no)	1.464	.945	2.268	1.440	.928	2.233	1.451	.937	2.247	1.475	.953	2.285
GIS Travel Time (minutes)	1.004	.999	1.009									
Perceived Travel Time (minutes)				**1.008**	**1.002**	**1.013**						
Primary Care Physicians to Population within PCSA							.646	.373	1.121			
Federal Qualified Health Care Center within PCSA (reference =no)										.951	.716	1.264
Constant	.061			.061			.086			.069		
Model Chi-Square	293.167 (.000)			298.128 (.000)			293.081 (.000)			290.779 (.000)		
H &L Test	.040			.062			.032			.112		
Cox & Snell R Square	.237			.241			.237			.236		
Nagelkerke R Square	.317			.322			.317			.315		

Table 4-7 Collinearity Diagnostics for Models in Table 4-4 and Table 4-5

	Model 1		Model 2		Model 3		Model 4	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.801	1.248	.797	1.255	.805	1.243	.804	1.244
Gender	.963	1.039	.965	1.036	.976	1.025	.976	1.025
Race	.885	1.131	.885	1.131	.883	1.132	.878	1.139
Education	.774	1.292	.774	1.291	.774	1.293	.774	1.292

	Model 1 Tolerance	Model 1 VIF	Model 2 Tolerance	Model 2 VIF	Model 3 Tolerance	Model 3 VIF	Model 4 Tolerance	Model 4 VIF
Marital Status	.984	1.016	.984	1.016	.984	1.016	.984	1.016
Tobacco Use	.988	1.012	.988	1.012	.989	1.012	.989	1.011
Limited Activity Days	.856	1.168	.856	1.169	.859	1.165	.858	1.165
Income	.624	1.604	.622	1.607	.623	1.606	.624	1.604
Insurance	.849	1.177	.849	1.178	.849	1.177	.849	1.177
Usual Source of Care	.829	1.207	.830	1.205	.826	1.210	.827	1.209
GIS Travel Time	.968	1.033						
Perceived Travel Time			.961	1.040				
Primary Care Physicians to Population within PCSA					.989	1.011		
Federal Qualified Health Care Center within PCSA							.984	1.016

Table 4-8 Collinearity Diagnostics for Models in Table 4-6

	Model 1		**Model 2**		**Model 3**		**Model 4**	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.788	1.270	.784	1.276	.791	1.265	.790	1.266
Gender	.959	1.043	.961	1.041	.971	1.029	.971	1.030
Race	.866	1.155	.866	1.155	.865	1.156	.860	1.163
Education	.771	1.296	.772	1.295	.772	1.296	.772	1.295

Marital Status	.984	1.017	.984	1.016	.984	1.016	.984	1.016
Tobacco Use	.986	1.014	.986	1.014	.986	1.014	.986	1.014
Limited Activity Days	.851	1.175	.851	1.176	.853	1.172	.853	1.172
Income	.623	1.606	.621	1.609	.622	1.608	.623	1.606
Insurance	.815	1.228	.814	1.228	.814	1.229	.815	1.227
Usual Source of Care	.828	1.208	.829	1.207	.825	1.211	.827	1.210
Medical Care Visit	.951	1.052	.951	1.052	.948	1.055	.951	1.052
Routine Checkup Visit	.927	1.078	.927	1.079	.926	1.080	.928	1.078
GIS Travel Time	.967	1.034						
Perceived Travel Time			.960	1.042				
Primary Care Physicians to Population within PCSA					.983	1.017		
Federal Qualified Health Care Center within PCSA							.984	1.017

4.2 Ohio Family Health Survey

4.2.1 Descriptive statistics

The general characteristics of the study sample are summarized in Table 4-16. The sample consists of 7973 (96.5%) individuals who had paid a medical visit in the past 12 months and 289 (3.5%) who had not. Of those individuals included in the sample, 6527 (79%) had undergone a routine check-up in the past 12 months and 1735 (21%) had not. The individuals who reported being in good health were 3496 (42.3%) while 4766 (57.7%) reported being in poor health. The mean age of the participants was 62.61 years (SD = 15.587), and a majority of the participants were female (73.6%). More than four out five individuals in the sample were White and had earned at least a high school education. Close to a third (n = 2671, 32.3%) were still married and a forth reported being current smokers (n = 2178, 26.4%). Within the sample, 787 participants (9.5%) reported experiencing at least three limitations in performing living activities, 2734 (33.1%) reported having at least two limitations, and 4741(57.4%) reported having at least one limitation. An annual household income less than the federal poverty level was reported by 2419 (29.3%) while a majority were insured (n = 7633, 92.4%). Most (n = 8049, 97.4%) had usual source of care, while a small fraction of the sample (n = 213, 2.6%) did not.

Moreover, the mean travel time as reported by the participants themselves was 25.80 minutes (SD = 34.816) while the mean of primary care physician-to-population ratio was 0.7481 per thousand people (SD = 0.41128). Only 5.5% respondents did not have a hospital within a 30-minute commute radius (n =453).

Table 4-9 Characteristics of Sample in Ohio Family Health Survey Data Set

Variables	**N**	**Mean**	**S.D.**	**%**	**Range**
Total = 8262					
Predisposing Characteristics					
Age		62.61	15.587		18-109
Gender					
Female	6083			73.6	
Male	2179			26.4	
Race					
White	6745			81.6	
Non-White	1517			18.4	
Education					
Less than high school	1382			16.7	
High School	3433			41.6	
College	3447			41.7	
Marital status					
Married	2671			32.3	
Separated	2074			25.1	
Widowed	2397			29.0	
Unmarried Couple	126			1.5	
Never Married	994			12.0	
Tobacco use					
Yes	2178			26.4	
No	6084			73.6	
Limitation of activity					
3 limitations	787			9.5	
2 limitations	2734			33.1	
1 limitation	4741			57.4	
Enabling Characteristics					
Income					
100% or less	2419			29.3	
101%-150%	1494			18.1	
151%-200%	965			11.7	
201%-300%	1521			18.4	
301% or more	1863			22.5	

Variables	**N**	**Mean**	**S.D.**	**%**	**Range**
Insurance					
Yes	7633			92.4	
No	629			7.6	
Usual source of care					
Yes	8049			97.4	
No	213			2.6	
Spatial Accessibility					
Perceived time (minutes)		25.80	34.816		1-800
PCP to population within 30-min		0.7481	0.41128		0-1.7
Hospital within 30-min					
Yes	7809			94.5	
No	453			5.5	
Health Care Services Utilization					
Medical visit in the past year					
Yes	7973			96.5	
No	289			3.5	
Routine checkup in the past year					
Yes	6527			79	
No	1735			21	
Health Status					
General health status					
Excellent/very good/good	3496			42.3	
Fair/poor	4766			57.7	
Region					
Urban	4658			56.4	
Rural	3604			43.6	

4.2.2 Bivariate Analysis

(1) Health care services visit

The analyses indicated that the ratio of primary care physicians to population was significantly associated with health care services visit (p = .024). Individuals who lived within the areas of higher primary care physician to population ratio were less likely to have paid a health care services visit in the past year. This could be partly explained by the access to preventive care at the primary care services provider rendering acute visits for health care services unlikely. However, the variables perceived travel time (p = 0.392), and location of hospital within a 30-minute commute radius (p = 0.124) were not found significant predictors (Table-4-17).

Several predisposing and enabling characteristics were found to be associated with health care services visit. Older, White, married, individuals, those with a higher annual household income, the insured, those with regular source of care, and women were more likely to have made a health care services visit in the past year. Individuals who were 62.93 years of age were more likely to have made a health care services visit than individuals who were 53.77 years old. In the past year, 96.8% of the women participants had made a health care visit services and a greater proportion of White (96.8%) participants had made a health care services visit compared to the Non-White (95.3%) participants. Married individuals (97%) were more likely to have visited health care services than those single (93.7%). A majority of the individuals (98%) with an annual household income greater than 300% the federal poverty level visited health care services, compared to 96.6% of people with an annual income less than federal poverty level. Of the insured, 97.7% percent had made a health care services visit compared to

81.4 % of the uninsured. Among those participants with a usual source of care 97.1% had made a health care services visit, while 73.7% of those who did not have a usual source of care did so.

(2) Routine checkup visit

The analyses revealed that none of the spatial accessibility measures were significantly associated with routine checkup visit; perceived travel time (p = 0.965), ratio of primary care physician to population within 30-min areas (p = 0. 568), and hospital within 30-min areas (p = 0.624) were not significant predictors.

Several predisposing and enabling characteristics were however, associated with routine checkup visits. The older, insured, married, with less limitations of activity, and with regular source of care were more likely to have made routine checkup visit. Participants 63.85 years of age were more likely to make health care services visits for routine checkup than participants who were 57.59 years of age. Of those married, 77.7% made routine checkup visits as opposed to 67.5% of those who were single. Among the insured 92% had made routine checkup visits compared to 48 % of the uninsured participants. Of those who reported having an usual source of care, 79.9% had made routine checkup visits, compared to the 46.5% of those who did not have an usual source of care.

(3) Health status

Perceived travel time (p = 0.000), ratio of primary care physicians to population (p = 0.000), and presence of a hospital within a 30-minute commute radius (p = 0.000) were found to be significantly associated with perceived health status. Those participants who were faced with a longer travel time to their health care service provider were more likely to perceive themselves to be in poor health. Participants who lived in areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Also associated with perceived poor health was the absence of a hospital within a 30-minute travel time.

The younger, male, non-White, separated or single, with lower level of educational attainment, with greater limitations of activities, lower household income, and the uninsured were more likely to perceive themselves to be of poor health status. The survey responders who considered themselves to be in good health were likely to be slightly younger than those who considered themselves to be in poor health (60.58 years as opposed to 65.38 years). Of the females in the survey, 56% perceived themselves to be in poor health while 62.9% of the males answered similarly. Of the White respondents 56.2% perceived themselves to be in poor health compared to 64.1% of the non-White respondents. Single (64.3%) and separated (65.3%) respondents reported being in poor health compared to 59.3% of the married respondents. Respondents with three limitations of activity were more likely to report poor health (76.4%) than those with one limitation (48.4%). A greater number of the participants who earned an annual household income less than the federal poverty level (72.1%) considered themselves in poor health than the participants with an annual household income greater than 300% of federal poverty level (42.2%). Of the insured 56.8%perceived themselves to be in poor health compared to 68.5% of the uninsured.

(4) Summary

The results of the bivariate analyses reveal that ratio of primary care physicians to population is associated with health care services visit while perceived travel time, ratio of primary care physicians to population, and location of a hospital within a 30-minute commute radius are associated with perceived health status. Older individuals and women, Whites, married individuals, those with higher income, the insured, and those with a regular source of care were more likely to have made health care services visits. Older, married individuals, those with less limitations of activity, the insured, and those with a regular source of care were more likely to have routine checkup visits. Those who were younger, single or separated, non-White, males, with lower levels of educational attainment, with more limitations of activities, less annual household income, and the uninsured were more likely to report being in poor health.

Table 4-10 Bivariate Analyses for Ohio Family Health Survey Data Set (Health Care Services Utilization)

	Health Care Services Visit			**Routine Checkup**		
	Yes (*N* =7973)	**No (*N* = 289)**	***p***	**Yes (*N* =6527)**	**No (*N* = 1735)**	***P***
Perceived travel time	25.73 (SD = 35.033)	27.52 (SD = 28.166)	0.392	25.80 (SD = 34.907)	25.76 (SD = 34.479)	0.965
PCP to population within 30min	0.7461 (SD = 0.41076)	0.8017 (SD = 0.42266)	0.024*	0.7467 (SD = 0.41204)	0.7531 (SD = 0.40849)	0.568
Hospital within 30min			0.124			0.624
Yes	7530 (96.4%)	279 (3.6%)		6165 (78.9%)	1644 (21.1%)	
No	443 (97.8%)	10 (2.2%)		362 (79.9%)	91 (20.1%)	
Age	62.93 (SD = 15.436)	53.77 (SD = 17.084)	0.000*	63.85 (SD = 15.134)	57.59 (SD = 16.370)	0.000*
Gender			0.011*			0.484
Female	5889 (96.8%)	194 (3.2%)		4817 (79.2%)	1266 (20.8%)	
Male	2084 (95.6%)	95 (4.4 %)		1710 (78.5%)	469 (21.5 %)	
Race			0.0003*			0.277
White	6528 (96.8%)	217 (3.2%)		5313 (78.8%)	1432 (21.2%)	
Non-White	1445 (95.3%)	72 (4.7%)		1214 (80%)	303 (20%)	
Education			0.468			0.783
Less than High school	1338 (96.8%)	44 (3.2%)		1101 (79.7%)	281 (20.3%)	
High School	3303 (96.2%)	130 (3.8%)		2711 (79%)	722 (21%)	
College	3332 (96.7%)	115 (3.3%)		2715 (78.8%)	732 (21.2%)	
Marital status			0.000*			0.000*
Married	2588 (96.9%)	83 (3.1%)		2075 (77.7%)	596 (22.3%)	
Separated	1987 (95.8%)	87 (4.2%)		1617 (78%)	457 (22%)	
Widowed	2344 (97.8%)	53 (2.2%)		2007 (83.7%)	390 (16.3%)	
Unmarried Couple	118 (93.7%)	8 (6.3%)		85 (67.5%)	41 (32.5%)	
Never Married	936 (94.2%)	58 (5.8%)		743 (74.7%)	251 (25.3%)	
Tobacco use			0.354			0.060
Yes	2095 (96.2%)	83 (3.8%)		1690 (77.6%)	488 (22.4%)	
No	5878 (96.6%)	206 (3.4%)		4837 (79.5%)	1247(20.5%)	

	Health Care Services Visit			Routine Checkup		
	Yes (*N* =7973)	**No (*N* = 289)**	***P***	**Yes (*N* =6527)**	**No (*N* = 1735)**	***p***
Limitation of activity			0.363			0.002*
3 limitations	22 (2.8%)	765 (97.2%)		127 (16.1%)	660 (83.9%)	
2 limitations	91 (3.3%)	2643 (96.7%)		593 (21.7%)	2141 (78.3%)	
1 limitation	176 (3.7%)	4565 (96.3%)		1015 (21.4%)	3726 (78.6%)	
Income			0.000*			0.356
100% or less	2309 (96.6%)	110 (4.5%)		1919 (79.3%)	500 (20.7%)	
101%-150%	1434 (96%)	60 (4.0%)		1163 (77.8%)	331 (22.2%)	
151%-200%	937 (97.1%)	28 (2.9%)		759 (78.7%)	206 (21.3%)	
201%-300%	1468 (96.5%)	53 (3.5%)		1188 (78.1%)	333 (21.9%)	
301% or more	1825 (98.0%)	38 (2.0%)		1498 (80.4%)	365 (19.6%)	
Insurance			0.000*			0.000*
Yes	7461 (97.7%)	512 (2.3%)		6225(81.6%)	1408 (18.4%)	
No	172 (81.4%)	117 (18.6%)		302 (48%)	327 (52%)	
Usual source of care			0.000*			0.000*
Yes	7816 (97.1%)	233 (2.9%)		6428 (79.9%)	1621 (20.1%)	
No	157 (73.7%)	56 (26.3%)		99 (46.5%)	114 (53.5%)	

* $p < 0.05$

Table 4-11 Bivariate Analyses for Ohio Family Health Survey Data Set (Health Status)

	Health status		
	Good (*N* = 3496)	**Poor (*N* = 4766)**	***P***
Perceived travel time	21.80 (SD = 24.625)	28.73 (SD = 40.452)	0.000*
PCP to population within 30min	0.7703 (SD = 0.40507)	0.7318 (SD = 0.41507)	0.000*
Hospital within 30min			0.000*
Yes	3350 (42.9%)	4459 (57.1%)	
No	146 (32.2%)	307 (67.8%)	
Age	65.38 (SD = 16.451)	60.58 (SD = 14.593)	0.000*
Gender			0.000*
Female	2688 (44.2%)	3395 (55.8%)	
Male	808 (37.1%)	1371 (62.9 %)	
Race			0.000*
White	2951 (43.8%)	3794 (56.2%)	
Non-White	545 (35.9%)	972 (64.1%)	
Education			0.006*
Less than High school	599 (43.3%)	782 (56.7%)	
High School	1382 (40.3%)	2051 (59.7%)	
College	1515 (44%)	1932 (56%)	
Marital status			0.000*
Married	1088 (40.7%)	1583 (59.3%)	
Separated	720 (34.7%)	1354 (65.3%)	
Widowed	1234 (41.5%)	1163 (48.5%)	
Never Married	409 (41.1%)	585 (58.9%)	
Unmarried Couple	45 (35.7%)	81 (64.3%)	
Tobacco use			0.531
Yes	934 (42.9%)	1244 (57.1%)	
No	2562 (42.1%)	3522 (57.9%)	
Limitation of activity			
3 limitations	186 (23.6%)	601 (76.4%)	0.000*
2 limitations	866 (31.7%)	1868 (68.3%)	
1 limitation	2444 (51.6%)	2297 (48.4%)	
Income			0.000*
100% or less	675 (27.9%)	1744 (72.1%)	
101%-150%	562 (37.6%)	932 (62.8%)	
151%-200%	411 (42.6%)	554 (57.4%)	
201%-300%	771 (50.7%)	750 (49.3%)	
301% or more	1077 (57.8%)	786 (42.2%)	

	Health status		
	Good (*N* = 3496)	**Poor (*N* = 4766)**	***P***
Insurance			0.000*
Yes	3298 (43.2%)	4335 (56.8%)	
No	198 (31.5%)	431 (68.5%)	
Usual source of care			0.687
Yes	3403 (42.3%)	4646 (57.7%)	
No	93 (43.7%)	120 (56.3%)	
Health care services visit			0.742
Yes	3371 (42.3%)	4602 (57.7%)	
No	125 (43.3%)	164 (56.7%)	
Routine checkup			0.386
Yes	2746 (42.1%)	3781 (57.9%)	
No	750 (43.2%)	985 (56.8%)	

* $p < 0.05$

4.2.3 Logistic Regression

(1) The association between spatial accessibility and utilization of health care services, controlling for other factors;

The odds ratios for the health care visit for the final model are reported in table 4-12. The analyses indicated that none of the spatial accessibility variables were significant predictors of health care services visit. Several predisposing and enabling characteristics were however, associated with health care services visits, when adjusted for other factors. The odd ratios of health care services visit was determined to be positively related to age, i.e., older adults were found to be more likely to have utilized health care services compared to younger adults. The insured were more likely to have paid a health care services visit in last year compared to the uninsured as were those who had a usual source of care compared to those who did not. The overall fit of these models were significant ($p < 0.00$) and the Hosmer-Lemeshow test suggested that models 1 and 2 predicted the data well ($p > 0.05$). The tolerance and VIF value indicate no a lack of potential collinearity problems (Table 4-15).

(2) The association between spatial accessibility and routine checkup visits, controlling for other factors;

The odds ratios for routine checkup visit for the final model are reported in table 4-13. The spatial accessibility factors were insignificant predictors of routine health care services visits. Several predisposing and enabling characteristics were however, associated with routine checkup visits, when controlled for other factors. The odd ratios of routine checkup visits were found to be positively related to age, i.e., older adults were more likely to have routine checkup visits than younger adults. Of the respondents White respondents were less likely than non-White respondents to have had a routine checkup in the past year. Those reporting only one limitation to performing living activities as well as those reporting two were less likely to have had a routine checkup than those reporting three limitations. The insured were more likely to have had a routine checkup visit in the past year compared to the uninsured. Those with a usual source of care were more likely to have a routine checkup visit compared to those who did not. The overall fit of these models are significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that the four specified models are not predicting the data well ($p <.005$). The tolerance and VIF value indicate no collinearity problems (Table 4-15).

(3) The association between spatial accessibility and health status, controlling for other factors;

The odds ratios for poor health status for the final model are also reported in table 4-14. The results indicated that travel time was associated with perceived poor health status [Exp(B) = 1.005, 95% C.I. = 1.004-1.007]. Adults who had to drive further or longer to access health care services were therefore more likely to perceive themselves to be in poor health compared to adults who had a shorter drive to their health care services provider. The odds ratios of the variable "poor health status" was negatively associated with the variable "ratio of primary care physician to population within 30 minute area" [Exp(B) =.763, 95% C.I. = .674-.864]. Participants who resided in areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Further, respondents who resided within a 30-minute commute to the hospital were 76.4% less likely to consider themselves to be in poor health in comparison to respondents who resided in areas that did not have a hospital within a 30-minute commute (95% C.I. =.6-.961).

The analyses demonstrated that given the same conditions, several predisposing and enabling characteristics were associated with health care visits. The odds ratio of "poor health status" was found to be negatively associated with age. Thus, per model 2 older adults were less likely to perceive themselves to be in poor health status compared to younger adults. Males were more likely to perceive themselves to be in poor health than females and White respondents were less likely (85.1%) than the non-White respondents to perceive themselves to be in poor health (95% C.I. =.743-.976). Participants with a lower level of educational attainment were more likely to perceive themselves to be in poor health compared to participants with a higher level of educational attainment. Respondents who were married, separated, or widowed were more likely to report being in poor health than those who were never married. A possible explanation could be that individuals who were married, separated, or widowed were more likely to be older and therefore more likely to have age-related illnesses. Individuals with fewer limitations to performing living activities were less likely to perceive themselves to be in poor health compared to those with greater number of limitations. The participants whose annual household income placed them below the federal poverty level were more likely than those 300% above the federal poverty level to report being in poor health. The insured were less likely to be in poor health status compared to the uninsured. Individuals who had undergone a routine checkup in the past year were more likely to report being in poor health than those who had not. The overall fit of these model were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that models 2 and 3 are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-16).

Table 4-12 Predicted Odds Ratios for Having Health Care Visit in the Previous Year

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.018**	**1.008**	**1.028**	**1.018**	**1.008**	**1.029**	**1.018**	**1.008**	**1.028**
Gender (reference = female)	.797	.606	1.047	.792	.603	1.041	.787	.599	1.034
Race (reference = non-White)	1.127	.833	1.525	1.025	.737	1.425	1.097	.810	1.486
Education (reference = college)									
Less than high school	1.012	.699	1.463	1.020	.705	1.475	1.018	.704	1.472
High School	.909	.693	1.192	.911	.694	1.194	.914	.697	1.199
Marital Status (reference = Never married)									
Married	1.123	.753	1.677	1.078	.719	1.616	1.103	.738	1.648
Separated	1.105	.754	1.619	1.081	.736	1.587	1.096	.747	1.607
Widowed	1.050	.645	1.708	1.018	.625	1.659	1.028	.632	1.674
Unmarried couple	1.254	.555	2.832	1.246	.552	2.813	1.253	.554	2.833
Tobacco Use (reference = no)	.835	.635	1.099	.830	.631	1.093	.830	.631	1.092
Limitation of Activity (reference = 3 limitations)									
1 limitation	.762	.474	1.224	.769	.479	1.236	.763	.475	1.226
2 limitations	.924	.562	1.520	.933	.568	1.533	.925	.563	1.519

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	.685	.453	1.037	.668	.441	1.014	.673	.444	1.019
101%-150%	.687	.444	1.065	.670	.432	1.040	.682	.440	1.057
151%-200%	.870	.516	1.467	.850	.503	1.436	.855	.507	1.443
201%-300%	.671	.431	1.044	.659	.423	1.027	.667	.428	1.039
Insurance (reference = no)	**5.796**	**4.351**	**7.719**	**5.778**	**4.337**	**7.698**	**5.823**	**4.369**	**7.760**
Usual Source of Care (reference = no)	**6.443**	**4.433**	**9.364**	**6.453**	**4.437**	**9.385**	**6.564**	**4.512**	**9.550**
Perceived Travel Time (minutes)	1.000	.996	1.003						
Primary Care Physicians to Population within 30-min				.787	.565	1.096			
Hospital within 30-min (reference =no)							.552	.281	1.087
Constant	.822			1.080			1.496		
Model Chi-Square	375.465 (.000)			377.464 (.000)			378.900 (.000)		
H &L Test	.131			.200			.012		
Cox & Snell R Square	.044			.045			.045		
Nagelkerke R Square	.170			.171			.171		

Table 4-13 Predicted Odds Ratios for Having Routine Checkup Visit in the Previous Year

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.021**	**1.016**	**1.025**	**1.021**	**1.016**	**1.025**	**1.020**	**1.016**	**1.025**
Gender (reference = female)	1.047	.921	1.189	1.049	.924	1.192	1.050	.925	1.193
Race (reference = non-White)	**.803**	**.690**	**.933**	**.771**	**.655**	**.906**	**.799**	**.686**	**.929**
Education (reference = college)									
Less than high school	1.039	.886	1.220	1.040	.886	1.220	1.039	.885	1.219
High School	1.026	.910	1.158	1.027	.910	1.158	1.026	.910	1.157
Marital Status (reference = Never married)									
Married	.926	.764	1.122	.912	.751	1.106	.922	.761	1.117
Separated	1.006	.832	1.218	.999	.825	1.210	1.006	.831	1.217
Widowed	.982	.786	1.227	.971	.777	1.213	.979	.784	1.223
Unmarried couple	.908	.593	1.390	.910	.594	1.393	.908	.593	1.391
Tobacco Use (reference = no)	**.871**	**.770**	**.985**	**.871**	**.770**	**.985**	**.871**	**.770**	**.985**
Limitation of Activity (reference = 3 limitations)									
1 limitation	**.736**	**.596**	**.909**	**.736**	**.596**	**.908**	**.734**	**.595**	**.906**
2 limitations	**.741**	**.595**	**.922**	**.740**	**.595**	**.921**	**.739**	**.594**	**.919**

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	1.150	.970	1.362	1.141	.963	1.353	1.150	.970	1.362
101%-150%	.937	.785	1.120	.929	.777	1.111	.936	.783	1.118
151%-200%	.904	.740	1.104	.897	.734	1.097	.903	.739	1.104
201%-300%	.875	.736	1.040	.869	.731	1.034	.874	.735	1.039
Insurance (reference = no)	**3.488**	**2.916**	**4.173**	**3.483**	**2.912**	**4.167**	**3.486**	**2.914**	**4.170**
Usual Source of Care (reference = no)	**3.177**	**2.360**	**4.275**	**3.186**	**2.367**	**4.289**	**3.193**	**2.372**	**4.299**
Perceived Travel Time (minutes)	1.001	.999	1.002						
Primary Care Physicians to Population within 30-min				.903	.780	1.046			
Hospital within 30-min (reference =no)							.899	.702	1.151
Constant	.171			.198			.195		
Model Chi-Square	519.775 (.000)			520.861 (.000)			519.742 (.000)		
H &L Test	.020			.026			.042		
Cox & Snell R Square	.061			.061			.061		
Nagelkerke R Square	.095			.095			.095		

Table 4-14 Predicted Odds Ratios for Poor Health Status in the Previous Year

	Model 1			**Model 2**			**Model 3**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**.986**	**.983**	**.990**	**.986**	**.982**	**.990**	**.986**	**.982**	**.990**
Gender (reference = female)	**1.333**	**1.193**	**1.489**	**1.364**	**1.222**	**1.523**	**1.367**	**1.225**	**1.527**
Race (reference = non-White)	.931	.820	1.057	**.836**	**.730**	**.958**	.914	.805	1.037
Education (reference = college)									
Less than high school	1.020	.892	1.167	1.018	.890	1.164	1.012	.884	1.157
High School	**1.166**	**1.052**	**1.291**	**1.166**	**1.053**	**1.291**	**1.163**	**1.050**	**1.288**
Marital Status (reference =Never married)									
Married	**1.896**	**1.597**	**2.251**	**1.813**	**1.527**	**2.154**	**1.855**	**1.562**	**2.202**
Separated	**1.668**	**1.407**	**1.978**	**1.635**	**1.379**	**1.938**	**1.660**	**1.401**	**1.968**
Widowed	**1.285**	**1.064**	**1.553**	**1.243**	**1.029**	**1.501**	**1.266**	**1.048**	**1.528**
Unmarried couple	1.270	.843	1.913	1.288	.854	1.942	1.281	.850	1.932
Tobacco Use (reference = no)	.979	.881	1.089	.983	.884	1.092	.981	.883	1.091
Limitation of Activity (reference = 3 limitations)									
1 limitation	**.341**	**.285**	**.409**	**.339**	**.283**	**.406**	**.337**	**.281**	**.404**
2 limitations	**.748**	**.619**	**.906**	**.746**	**.616**	**.902**	**.743**	**.614**	**.898**

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	**3.308**	**2.866**	**3.817**	**3.295**	**2.855**	**3.803**	**3.339**	**2.894**	**3.853**
101%-150%	**2.441**	**2.102**	**2.834**	**2.405**	**2.071**	**2.793**	**2.433**	**2.096**	**2.826**
151%-200%	**2.100**	**1.779**	**2.480**	**2.074**	**1.756**	**2.448**	**2.101**	**1.780**	**2.480**
201%-300%	**1.438**	**1.247**	**1.659**	**1.417**	**1.228**	**1.635**	**1.431**	**1.240**	**1.650**
Insurance (reference = no)	**.764**	**.626**	**.931**	**.758**	**.622**	**.923**	**.761**	**.625**	**.927**
Usual Source of Care (reference = no)	1.318	.974	1.783	1.330	.981	1.802	1.345	.992	1.823
Health Care Visit	1.264	.958	1.670	1.253	.949	1.655	1.250	.947	1.649
Routine Checkup Visit	**1.134**	**1.003**	**1.283**	**1.135**	**1.003**	**1.283**	**1.138**	**1.006**	**1.286**
Perceived Travel Time (minutes)	**1.005**	**1.004**	**1.007**						
Primary Care Physicians to Population within 30-min				**.763**	**.674**	**.864**			
Hospital within 30-min (reference =no)							**.654**	**.528**	**.811**
Constant	1.705			2.790			3.101		
Model Chi-Square	1079.961 (.000)			1055.820 (.000)			1052.994 (.000)		
H &L Test	.024			.110			.139		
Cox & Snell R Square	.123			.120			.120		
Nagelkerke R Square	.165			.161			.161		

Table 4-15 Collinearity Diagnostics for Models in Table 4-13 and Table 4-14

	Model 1		**Model 2**		**Model 3**	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.893	1.120	.895	1.117	.895	1.117
Gender	.969	1.032	.976	1.025	.976	1.024
Race	.942	1.061	.802	1.247	.934	1.071
Education	.999	1.001	.999	1.001	.999	1.001
Marital Status	.929	1.076	.921	1.086	.928	1.078
Tobacco Use	.999	1.001	.999	1.001	.999	1.001
Limitation of Activity	.975	1.026	.976	1.025	.976	1.025
Income	.875	1.143	.870	1.150	.875	1.142
Insurance	.908	1.102	.908	1.101	.908	1.101
Usual Source of Care	.970	1.031	.970	1.031	.969	1.032
Perceived Travel Time	.981	1.019				
Primary Care Physicians to Population within 30-min			.835	1.198		
Hospital within 30-min					.986	1.015

Table 4-16 Collinearity Diagnostics for Models in Table 4-15

	Model 1		Model 2		Model 3	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.882	1.134	.884	1.131	.884	1.132
Gender	.969	1.032	.975	1.025	.975	1.025
Race	.941	1.063	.801	1.249	.932	1.073
Education	.999	1.001	.999	1.001	.999	1.001
Marital Status	.929	1.076	.921	1.086	.928	1.078
Tobacco Use	.998	1.002	.998	1.002	.998	1.002
Limitation of Activity	.974	1.026	.975	1.026	.975	1.025
Income	.874	1.144	.869	1.151	.874	1.144
Insurance	.861	1.161	.861	1.161	.861	1.161
Usual Source of Care	.940	1.064	.940	1.064	.939	1.064
Health Care Visit	.846	1.182	.846	1.182	.846	1.182
Routine Checkup Visit	.861	1.162	.861	1.162	.861	1.162
Perceived Travel Time	.981	1.019				
Primary Care Physicians to Population within 30-min			.834	1.198		
Hospital within 30-min					.985	1.015

4.2.4 Urban and Rural Areas

The Ohio Family Health Survey 2008 categorizes counties within the four primary regions (Appalachian, Rural non-Appalachian, Suburban, and Metropolitan) based on similarities in demographic characteristics. The county groups within each region are listed in Table 4-17.

Table 4-17 Four Primary Regions in Ohio Family Health Survey 2008

Region	**Counties**
Metropolitan	Allen, Butler, Cuyahoga, Franklin, Hamilton, Lorain, Lucas, Mahoning, Montgomery, Richland, Summit, Stark
Suburban	Auglaize, Clark, Delaware, Fairfield, Fulton, Geauga, Greene, Madison, Medina, Miami, Lake, Licking, Pickaway, Portage, Trumbull, Union, Wood
Rural Non-Appalachian	Ashland, Ashtabula, Champaign, Clinton, Crawford, Darke, Defiance, Erie, Fayette, Hancock, Hardin, Henry, Huron, Knox, Logan, Marion, Mercer, Morrow, Ottawa, Paulding, Preble, Putnam, Sandusky, Seneca, Shelby, Van Wert, Warren, Wayne, Williams, Wyandot
Rural Appalachian	Adams, Athens, Brown, Belmont, Carroll, Clermont, Columbiana, Coshocton, Gallia, Guernsey, Harrison, Highland, Hocking, Holmes, Jackson, Jefferson, Lawrence, Meigs, Monroe, Morgan, Muskingum, Noble, Perry, Pike, Ross, Scioto, Tuscarawas, Vinton, Washington

For the purposes of this study, metropolitan and suburban counties are grouped under urban areas and rural Non-Appalachian and Appalachian counties are grouped under rural areas. Based on this categorization, the results of logistic regression are summarized.

(1) The association between spatial accessibility and health care services visit, controlling for other factors in urban areas;

The logistic regression model-predicted odds ratios for the health care services visit in urban areas are reported in Table 4-18. The analyses revealed that of all the spatial accessibility predictors none were significantly related to health care services visits. Given the same conditions, however, several predisposing and enabling characteristics were found to be associated with health care services visits. The odds ratio of health care services visit was positively related to age; older adults were thus more likely to have utilized health care services compared to younger adults. The insured were more likely to have made a health care services visit in the past year as opposed to the uninsured. Participants who had a usual source of care were more likely than those who did to have made a health care services visit. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that these models are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-21).

(2) The association between spatial accessibility and routine checkup visit, controlling for other factors in urban areas;

The logistic regression model-predicted odds ratios for the health care services visits in urban areas are reported in Table 4-19. None of the spatial accessibility predictors are revealed to be significant predictors of health care services visits in urban areas. Several predisposing and enabling characteristics were however, associated with routine checkup visits when adjusted for other factors. The odds ratio of routine checkup visits was positively related to age; older adults were more likely than younger adults to have made routine checkup visits. White respondents were less likely than non-White respondents to have made a routine checkup visit in the past year. Participants who had two limitations from performing living activities were less likely to have made a routine checkup visit compared to those with three limitations. The insured were more likely than the uninsured to have had a routine checkup visit in the past year. Respondents with a usual source of care were more likely to have had a routine checkup visit compared to those who did not. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that these models are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-21).

(3) The association between spatial accessibility and health status, controlling for other factors in urban areas;

The logistic regression model-predicted odds ratios for the health status in urban areas are reported in Table 4-20. Results indicated that travel time was associated with perceived poor health status [Exp(B) = 1.002, 95% C.I. = 1.001-1.004]; adults who had to drive further an longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who had a shorter or quicker drive. The variables primary care physician to population within 30-minute area ratio and location of a hospital within 30-minute commute were not significantly associated with perceived health status.

Several predisposing and enabling characteristics were revealed to be associated with perceived health status when adjusted for other factors. The odds ratio of poor health was negatively related to age; older adults were less likely to report being in poor health compared to younger adults. Given the same conditions, males were more likely to perceive themselves to be in poor health than females while White respondents were less likely than non-White respondents to report being in poor health. Participants with a high school degree were more likely to perceive themselves to be in poor health compared to participants who had a college degree. Married and separated adults were more likely to report being in poor health than adults who had never been married. As speculated in the previous section this observation could be because married and separated are typically older than those how have never been married and could therefore be more likely to have age-related illnesses. Individuals who reported having greater limitations of living activity were more likely to perceive themselves to be in poor health. Participants whose annual household income was below the federal poverty level and those who were uninsured were more likely to report being in poor health. Individuals who had a regular source of care were more likely to report being in poor health than those who did not have a regular source of care. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that these models are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-22).

(4) The association between spatial accessibility and health care services visit, controlling for other factors in rural areas;

The odds ratio for health care services visits is negatively associated with the primary care physician to population within 30 minute area ratio [Exp(B) =.530, 95% C.I. = .289-.972]. Participants who reside in an area with a higher primary care physician to population ratio were less likely to have made a health care services visit (Table 4-23).Several predisposing and enabling characteristics were also associated with health care services visit when adjusted for other factors. Older adults were more likely than younger adults to have utilized health care services. The insured were more likely to have made a health care services visit in the past year compared to the uninsured as were those who had a usual source of care. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that these models are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-26).

(5) The association between spatial accessibility and routine checkup visit, controlling for other factors in rural areas;

The logistic regression model-predicted odds ratios for the routine checkup visits in rural areas are reported in Table 4-24. The results indicate that spatial accessibility variables are insignificant predictors of routine checkup visits in rural areas. Several predisposing and enabling characteristics were however, associated with routine checkup visits when adjusted for other factors. Older adults were more likely than younger adults to have routine checkup visits. Participants reporting two limitations to their living activities were less likely to have had a routine checkup visit compared to those with three limitations. The insured were more likely than the uninsured to have had a routine checkup visit in the past year as had individuals with a usual source of care. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that these models are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-26).

(6) The association between spatial accessibility and health status, controlling for other factors in rural area;

The logistic regression model-predicted odds ratio for the association of spatial accessibility and health status in rural areas are reported in Table 4-25. The results showed that perceived travel time was associated with poor health status [Exp(B) = 1.008, 95% C.I. = 1.006-1.011]; adults who had a longer drive to their health care service provider were more likely to report being in poor health compared to adults faced with a shorter drive. The odds ratio for poor health status was negatively associated with the ratio of primary care physician to population within a 30-minute area [Exp(B) =.659, 95% C.I. = .514-.846]. Respondents who resided in areas that had a higher primary care physician to population ratio were less likely to report being in poor health. Further, respondents who had a hospital within a 30-minute commute were less likely to think themselves to be in poor health compared to those who did not have a hospital within the 30-minute commute [Exp(B) =.705, 95% C.I. = .561-.888].

Given the same conditions, several predisposing and enabling characteristics were found to be associated with perceived health status. The odds ratio of poor health was estimated to be negatively associated with age; older adults were less likely to perceive themselves to be in poor health compared to younger adults. This may well be a function of the higher expectations that younger people adults have for their health; thus, their criteria for what constitutes poor health may be broader and more inclusive than those who are older. Males were more likely to perceive themselves to be in poor health than females. Participants who are married or separated were more likely to report being in poor health than those who were never married. Those who reported fewer limitations to their living activities were less likely to perceive themselves to be in poor health compared to those with greater limitations. Individuals whose annual household income placed them below the federal poverty level were more likely than those placed 300% above the federal poverty level to report being in poor health. Participants who had undergone a routine checkup in the past year were more likely to report being in poor health than those who had not. The overall fit of these models were significant ($p < 0.00$) and the results of the Hosmer-Lemeshow test suggest that models 1 and 2 are predicting the data well ($p > 0.05$). The tolerance and VIF values indicate no collinearity problems (Table 4-27).

Table 4-18 Predicted Odds Ratios for Having Health Care Services Visit in the Previous Year (Urban Areas)

	Model 1			**Model 2**			**Model 3**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.020**	**1.006**	**1.034**	**1.020**	**1.007**	**1.034**	**1.020**	**1.006**	**1.034**
Gender (reference = female)	.708	.493	1.019	.713	.497	1.024	.710	.495	1.019
Race (reference = non-White)	1.101	.768	1.579	1.046	.719	1.521	1.100	.768	1.575
Education (reference = college)									
Less than high school	1.067	.656	1.737	1.072	.658	1.744	1.066	.655	1.735
High School	.969	.674	1.393	.971	.675	1.396	.971	.675	1.396
Marital Status (reference =Never married)									
Married	1.277	.750	2.172	1.247	.732	2.125	1.279	.752	2.175
Separated	1.079	.673	1.730	1.072	.669	1.720	1.079	.673	1.731
Widowed	.938	.504	1.746	.927	.498	1.725	.936	.503	1.742
Unmarried couple	1.170	.447	3.067	1.177	.450	3.081	1.167	.445	3.056
Tobacco Use (reference = no)	.742	.517	1.064	.739	.515	1.060	.743	.518	1.065
Limitation of Activity (reference = 3 limitations)									
1 limitation	1.038	.573	1.882	1.057	.583	1.916	1.039	.573	1.884
2 limitations	1.058	.569	1.968	1.073	.577	1.995	1.058	.569	1.968

	Model 1			Model 2			Model 3		
	OR	95% C.I.		OR	95% C.I.		OR	95% C.I.	
Income (reference = 301% or more of federal poverty level)									
100% or less	.689	.400	1.188	.685	.397	1.181	.691	.402	1.191
101%-150%	.837	.460	1.525	.825	.452	1.504	.845	.463	1.542
151%-200%	.800	.395	1.620	.798	.393	1.618	.803	.396	1.626
201%-300%	.752	.413	1.370	.743	.407	1.354	.754	.414	1.374
Insurance (reference = no)	**6.621**	**4.539**	**9.657**	**6.585**	**4.515**	**9.605**	**6.613**	**4.534**	**9.644**
Usual Source of Care (reference = no)	**6.362**	**3.881**	**10.427**	**6.350**	**3.872**	**10.414**	**6.386**	**3.896**	**10.470**
Perceived Travel Time (minutes)	1.000	.995	1.006						
Primary Care Physicians to Population within 30-min ratio				.780	.455	1.337			
Hospital within 30-min (reference =no)							1.725	.216	13.776
Constant	.521			.695			.301		
Model Chi-Square	250.177 (.000)			377.464 (.000)			250.390 (.000)		
H &L Test	.292			.467			.133		
Cox & Snell R Square	.052			.052			.052		
Nagelkerke R Square	.197			.198			.198		

Table 4-19 Predicted Odds Ratios for Having Routine Checkup Visit in the Previous Year (Urban Areas)

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.018**	**1.012**	**1.024**	**1.018**	**1.012**	**1.024**	**1.018**	**1.012**	**1.024**
Gender (reference = female)	1.094	.921	1.301	1.090	.917	1.295	1.090	.917	1.295
Race (reference = non-White)	.761	.640	.905	.752	.628	.901	.763	.642	.908
Education (reference = college)									
Less than high school	1.026	.833	1.264	1.028	.834	1.266	1.027	.833	1.265
High School	1.161	.989	1.364	1.161	.989	1.363	1.161	.988	1.363
Marital Status (reference =Never married)									
Married	.938	.735	1.197	.937	.734	1.196	.943	.739	1.202
Separated	1.056	.834	1.337	1.056	.834	1.337	1.058	.835	1.339
Widowed	.932	.705	1.232	.932	.705	1.232	.935	.707	1.235
Unmarried couple	1.038	.611	1.764	1.042	.613	1.772	1.039	.611	1.766
Tobacco Use (reference = no)	.858	.729	1.009	.857	.729	1.008	.858	.729	1.009
Limitation of Activity (reference = 3 limitations)									
1 limitation	.758	.571	1.007	.761	.573	1.010	.760	.573	1.009
2 limitations	.740	.551	.992	.741	.553	.994	.741	.552	.994

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	1.091	.873	1.364	1.084	.867	1.355	1.087	.870	1.359
101%-150%	.947	.746	1.201	.943	.743	1.197	.948	.747	1.203
151%-200%	.872	.665	1.145	.869	.662	1.141	.873	.665	1.146
201%-300%	.892	.710	1.120	.891	.709	1.119	.894	.712	1.123
Insurance (reference = no)	**3.633**	**2.863**	**4.610**	**3.634**	**2.864**	**4.611**	**3.636**	**2.865**	**4.614**
Usual Source of Care (reference = no)	**2.789**	**1.882**	**4.134**	**2.787**	**1.880**	**4.131**	**2.790**	**1.882**	**4.135**
Perceived Travel Time (minutes)	.999	.997	1.001						
Primary Care Physicians to Population within 30-min ratio				.935	.744	1.175			
Hospital within 30-min (reference =no)							1.145	.407	3.222
Constant	.242			.255			.205		
Model Chi-Square	277.178 (.000)			279.809 (.000)			276.543 (.000)		
H &L Test	.187			.249			.171		
Cox & Snell R Square	.058			.058			.058		
Nagelkerke R Square	.090			.090			.090		

Table 4-20 Predicted Odds Ratios for Poor Health Status in the Previous Year (Urban Areas)

	Model 1			Model 2			Model 3		
	OR	95% C.I.		OR	95% C.I.		OR	95% C.I.	
Age	**.990**	**.985**	**.995**	**.990**	**.985**	**.995**	**.990**	**.985**	**.995**
Gender (reference = female)	**1.302**	**1.124**	**1.508**	**1.316**	**1.137**	**1.524**	**1.312**	**1.134**	**1.520**
Race (reference = non-White)	**.819**	**.709**	**.946**	**.790**	**.680**	**.918**	**.813**	**.704**	**.940**
Education (reference = college)									
Less than high school	.976	.817	1.165	.979	.820	1.169	.975	.817	1.164
High School	**1.187**	**1.037**	**1.358**	**1.189**	**1.039**	**1.361**	**1.186**	**1.036**	**1.357**
Marital Status (reference =Never married)									
Married	**1.672**	**1.351**	**2.070**	**1.636**	**1.322**	**2.026**	**1.648**	**1.332**	**2.040**
Separated	**1.625**	**1.321**	**1.998**	**1.612**	**1.311**	**1.981**	**1.617**	**1.315**	**1.988**
Widowed	1.185	.937	1.498	1.168	.924	1.477	1.175	.929	1.485
Unmarried couple	.923	.569	1.499	.924	.568	1.501	.921	.567	1.497
Tobacco Use (reference = no)	1.059	.922	1.216	1.057	.920	1.214	1.058	.921	1.215
Limitation of Activity (reference = 3 limitations)									
1 limitation	**.333**	**.262**	**.422**	**.331**	**.261**	**.420**	**.331**	**.261**	**.420**
2 limitations	**.759**	**.591**	**.974**	**.756**	**.589**	**.971**	**.756**	**.589**	**.970**

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	**2.700**	**2.241**	**3.252**	**2.706**	**2.247**	**3.260**	**2.717**	**2.256**	**3.272**
101%-150%	**2.315**	**1.898**	**2.824**	**2.303**	**1.887**	**2.809**	**2.303**	**1.888**	**2.810**
151%-200%	**2.052**	**1.636**	**2.573**	**2.046**	**1.632**	**2.566**	**2.044**	**1.630**	**2.563**
201%-300%	**1.357**	**1.125**	**1.637**	**1.346**	**1.115**	**1.624**	**1.348**	**1.117**	**1.627**
Insurance (reference = no)	**.740**	**.571**	**.958**	**.736**	**.569**	**.953**	**.739**	**.571**	**.956**
Usual Source of Care (reference = no)	**1.562**	**1.048**	**2.326**	**1.560**	**1.046**	**2.326**	**1.555**	**1.044**	**2.318**
Health Care Services Visit	1.317	.912	1.900	1.319	.914	1.904	1.325	.918	1.911
Routine Checkup Visit	1.021	.870	1.200	1.018	.867	1.196	1.019	.867	1.197
Perceived Travel Time (minutes)	**1.002**	**1.001**	**1.004**						
Primary Care Physicians to Population within 30-min ratio				.876	.723	1.061			
Hospital within 30-min (reference =no)							.536	.202	1.422
Constant	1.174			1.483			2.365		
Model Chi-Square	542.369			539.534			539.379		
H &L Test	.138			.260			.114		
Cox & Snell R Square	.110			.109			.109		
Nagelkerke R Square	.147			.147			.146		

Table 4-21 Collinearity Diagnostics for Models in Table 4-19 and Table 4-20

	Model 1		**Model 2**		**Model 3**	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.876	1.142	.877	1.140	.877	1.140
Gender	.976	1.025	.981	1.019	.981	1.020
Race	.898	1.113	.821	1.218	.900	1.111
Education	.998	1.002	.998	1.002	.998	1.002
Marital Status	.919	1.088	.917	1.091	.920	1.087
Tobacco Use	.999	1.001	.999	1.001	.999	1.001
Limitation of Activity	.978	1.023	.978	1.023	.978	1.022
Income	.834	1.199	.835	1.198	.836	1.195
Insurance	.895	1.118	.895	1.118	.895	1.118
Usual Source of Care	.962	1.039	.962	1.039	.962	1.039
Perceived Travel Time	.979	1.021				
Primary Care Physicians to Population within 30-min ratio			.899	1.112		
Hospital within 30-min					.998	1.002

Table 4-22 Collinearity Diagnostics for Models in Table 4-21

	Model 1		**Model 2**		**Model 3**	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.868	1.153	.869	1.151	.868	1.152
Gender	.975	1.026	.979	1.021	.979	1.021
Race	.895	1.117	.819	1.222	.897	1.115
Education	.998	1.002	.998	1.002	.998	1.002
Marital Status	.919	1.088	.916	1.092	.920	1.087
Tobacco Use	.998	1.002	.998	1.002	.998	1.002
Limitation of Activity	.977	1.023	.978	1.023	.978	1.023
Income	.834	1.199	.834	1.198	.836	1.196
Insurance	.842	1.188	.842	1.188	.842	1.188
Usual Source of Care	.932	1.073	.932	1.073	.932	1.073
Health Care Services Visit	.837	1.194	.837	1.194	.837	1.194
Routine Checkup Visit	.871	1.148	.871	1.148	.871	1.148
Perceived Travel Time	.979	1.021				
Primary Care Physicians to Population within 30-min ratio			.899	1.112		
Hospital within 30-min					.998	1.002

Table 4-23 Predicted Odds Ratios for Having Health Care Services Visit in the Previous Year (Rural Areas)

	Model 1			**Model 2**			**Model 3**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.016**	**1.001**	**1.032**	**1.016**	**1.001**	**1.032**	**1.016**	**1.000**	**1.031**
Gender (reference = female)	.940	.618	1.432	.912	.599	1.387	.916	.602	1.394
Race (reference = non-White)	1.217	.509	2.907	1.113	.463	2.676	1.178	.493	2.816
Education (reference = college)									
Less than high school	.972	.549	1.721	.971	.548	1.720	.978	.552	1.731
High School	.871	.577	1.315	.872	.577	1.316	.884	.585	1.335
Marital Status (reference =Never married)									
Married	.982	.492	1.957	.931	.465	1.866	.959	.480	1.916
Separated	1.066	.530	2.147	1.033	.511	2.089	1.061	.526	2.142
Widowed	1.169	.510	2.679	1.108	.481	2.553	1.127	.490	2.591
Unmarried couple	1.555	.319	7.587	1.493	.306	7.291	1.567	.320	7.683
Tobacco Use (reference = no)	.970	.631	1.490	.957	.622	1.472	.957	.623	1.472
Limitation of Activity (reference = 3 limitations)									
1 limitation	.488	.217	1.094	.487	.217	1.092	.492	.220	1.100
2 limitations	.741	.318	1.730	.751	.322	1.752	.746	.320	1.735

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	.700	.365	1.345	.677	.352	1.301	.681	.355	1.308
101%-150%	.574	.297	1.107	.565	.292	1.091	.575	.298	1.113
151%-200%	.927	.421	2.040	.906	.412	1.991	.915	.416	2.010
201%-300%	.601	.308	1.171	.597	.306	1.163	.600	.308	1.170
Insurance (reference = no)	**4.805**	**3.063**	**7.539**	**4.844**	**3.083**	**7.611**	**4.865**	**3.091**	**7.655**
Usual Source of Care (reference = no)	**6.492**	**3.622**	**11.634**	**6.679**	**3.721**	**11.990**	**6.828**	**3.797**	**12.279**
Perceived Travel Time (minutes)	1.000	.995	1.004						
Primary Care Physicians to Population within 30-min ratio				**.530**	**.289**	**.972**			
Hospital within 30-min (reference =no)							.502	.244	1.033
Constant	1.697			2.446			3.240		
Model Chi-Square	135.657 (.000)			139.632 (.000)			139.760 (.000)		
H &L Test	.265			.644			.360		
Cox & Snell R Square	.037			.038			.038		
Nagelkerke R Square	.144			.148			.148		

Table 4-24 Predicted Odds Ratios for Having Routine Checkup Visit in the Previous Year (Rural Areas)

	Model 1			**Model 2**			**Model 3**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**1.023**	**1.017**	**1.030**	**1.023**	**1.016**	**1.030**	**1.023**	**1.016**	**1.030**
Gender (reference = female)	.992	.819	1.202	1.009	.833	1.221	1.011	.835	1.223
Race (reference = non-White)	.950	.615	1.468	.952	.615	1.473	.961	.622	1.484
Education (reference = college)									
Less than high school	1.054	.820	1.355	1.048	.816	1.347	1.049	.816	1.348
High School	.879	.732	1.057	.877	.730	1.053	.876	.730	1.053
Marital Status (reference =Never married)									
Married	.888	.639	1.234	.890	.641	1.237	.893	.643	1.240
Separated	.925	.662	1.292	.931	.666	1.301	.933	.668	1.304
Widowed	1.024	.700	1.497	1.029	.704	1.504	1.031	.705	1.506
Unmarried couple	.687	.331	1.427	.699	.338	1.447	.699	.337	1.448
Tobacco Use (reference = no)	.888	.734	1.073	.893	.739	1.079	.893	.738	1.079
Limitation of Activity (reference = 3 limitations)									
1 limitation	**.723**	**.526**	**.994**	**.716**	**.522**	**.984**	**.716**	**.521**	**.983**
2 limitations	.751	.541	1.044	.746	.537	1.037	.745	.537	1.035

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	1.209	.927	1.576	1.216	.932	1.586	1.219	.935	1.589
101%-150%	.906	.690	1.191	.909	.692	1.195	.912	.694	1.198
151%-200%	.896	.663	1.211	.899	.665	1.216	.902	.667	1.219
201%-300%	.833	.637	1.089	.837	.640	1.094	.839	.642	1.097
Insurance (reference = no)	**3.393**	**2.578**	**4.465**	**3.380**	**2.569**	**4.447**	**3.376**	**2.566**	**4.442**
Usual Source of Care (reference = no)	**3.762**	**2.379**	**5.949**	**3.825**	**2.420**	**6.047**	**3.836**	**2.425**	**6.066**
Perceived Travel Time (minutes)	1.002	1.000	1.005						
Primary Care Physicians to Population within 30-min ratio				.887	.664	1.184			
Hospital within 30-min (reference =no)							.919	.706	1.197
Constant	.090			.103			.103		
Model Chi-Square	263.454 (.000)			260.492 (.000)			260.230 (.000)		
H &L Test	.979			.978			.870		
Cox & Snell R Square	.070			.070			.070		
Nagelkerke R Square	.110			.109			.109		

Table 4-25 Predicted Odds Ratios for Poor Health Status in the Previous Year (Rural Areas)

	Model 1			**Model 2**			**Model 3**		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Age	**.982**	**.976**	**.988**	**.981**	**.975**	**.987**	**.981**	**.975**	**.986**
Gender (reference = female)	**1.382**	**1.165**	**1.640**	**1.447**	**1.221**	**1.714**	**1.458**	**1.231**	**1.727**
Race (reference = non-White)	1.021	.698	1.495	1.012	.690	1.484	1.045	.714	1.530
Education (reference = college)									
Less than high school	1.101	.893	1.358	1.072	.870	1.320	1.069	.868	1.316
High School	1.143	.975	1.340	1.137	.971	1.332	1.134	.968	1.328
Marital Status (reference =Never married)									
Married	**2.050**	**1.513**	**2.776**	**2.051**	**1.515**	**2.775**	**2.061**	**1.523**	**2.790**
Separated	**1.571**	**1.154**	**2.139**	**1.588**	**1.168**	**2.160**	**1.597**	**1.174**	**2.173**
Widowed	1.336	.960	1.861	1.352	.972	1.881	1.356	.974	1.887
Unmarried couple	**2.562**	**1.095**	**5.996**	**2.718**	**1.162**	**6.360**	**2.696**	**1.152**	**6.307**
Tobacco Use (reference = no)	.883	.748	1.041	.897	.761	1.057	.894	.758	1.053
Limitation of Activity (reference = 3 limitations)									
1 limitation	**.353**	**.266**	**.469**	**.350**	**.264**	**.464**	**.347**	**.262**	**.460**
2 limitations	**.725**	**.538**	**.976**	**.727**	**.541**	**.978**	**.722**	**.537**	**.970**

	Model 1			Model 2			Model 3		
	OR	**95% C.I.**		**OR**	**95% C.I.**		**OR**	**95% C.I.**	
Income (reference = 301% or more of federal poverty level)									
100% or less	**4.342**	**3.449**	**5.466**	**4.386**	**3.488**	**5.516**	**4.403**	**3.502**	**5.536**
101%-150%	**2.558**	**2.030**	**3.222**	**2.564**	**2.037**	**3.227**	**2.578**	**2.048**	**3.244**
151%-200%	**2.130**	**1.658**	**2.735**	**2.142**	**1.670**	**2.747**	**2.152**	**1.679**	**2.760**
201%-300%	**1.527**	**1.221**	**1.909**	**1.531**	**1.227**	**1.912**	**1.538**	**1.232**	**1.920**
Insurance (reference = no)	.773	.565	1.057	.771	.565	1.053	.770	.564	1.051
Usual Source of Care (reference = no)	1.033	.642	1.662	1.079	.670	1.739	1.090	.675	1.760
Health Care Services Visit	1.195	.777	1.838	1.139	.742	1.750	1.141	.743	1.751
Routine Checkup Visit	**1.312**	**1.082**	**1.592**	**1.335**	**1.102**	**1.618**	**1.340**	**1.105**	**1.623**
Perceived Travel Time (minutes)	**1.008**	**1.006**	**1.011**						
Primary Care Physicians to Population within 30-min ratio				**.659**	**.514**	**.846**			
Hospital within 30-min (reference =no)							**.705**	**.561**	**.888**
Constant	4.329			7.394			8.002		
Model Chi-Square	579.539 (.000)			545.470 (.000)			543.781 (.000)		
H &L Test	.133			.142			.049		
Cox & Snell R Square	.149			.140			.140		
Nagelkerke R Square	.201			.190			.189		

Table 4-26 Collinearity Diagnostics for Models in Table-4-24 and Table 4-25

	Model 1		Model 2		Model 3	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.910	1.099	.913	1.096	.912	1.096
Gender	.959	1.042	.968	1.034	.969	1.032
Race	.993	1.007	.990	1.010	.994	1.006
Education	.996	1.004	.997	1.003	.997	1.003
Marital Status	.936	1.068	.935	1.070	.936	1.069
Tobacco Use	.997	1.003	.998	1.002	.998	1.002
Limitation of Activity	.968	1.033	.969	1.032	.969	1.032
Income	.908	1.101	.908	1.101	.909	1.100
Insurance	.922	1.085	.922	1.085	.922	1.084
Usual Source of Care	.976	1.024	.977	1.024	.976	1.025
Perceived Travel Time	.975	1.026				
Primary Care Physicians to Population within 30-min ratio			.988	1.012		
Hospital within 30-min					.993	1.007

Table 4-27 Collinearity Diagnostics for Models in Table 4-26

	Model 1		Model 2		Model 3	
	Tolerance	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Age	.894	1.119	.897	1.115	.896	1.116
Gender	.959	1.042	.967	1.034	.969	1.032
Race	.993	1.007	.990	1.010	.994	1.006
Education	.996	1.004	.997	1.003	.997	1.003
Marital Status	.936	1.068	.934	1.070	.936	1.069
Tobacco Use	.996	1.004	.998	1.002	.997	1.003
Limitation of Activity	.966	1.035	.967	1.034	.967	1.034
Income	.907	1.103	.907	1.103	.908	1.102
Insurance	.883	1.132	.883	1.132	.883	1.132
Usual Source of Care	.948	1.055	.948	1.055	.947	1.056
Health Care Services Visit	.854	1.171	.853	1.172	.853	1.172
Routine Checkup Visit	.843	1.186	.844	1.185	.844	1.185
Perceived Travel Time	.974	1.027				
Primary Care Physicians to Population within 30-min ratio			.987	1.013		
Hospital within 30-min					.992	1.008

4.3 Summary of Results

The multivariate analyses of "Survey of Access to Outpatient Medical Service in the Rural Southeast" dataset revealed that the ratio of primary care physician to population within a PCSA had a significant association with health care services visits when predisposing and enabling characteristics were controlled. Of the respondents, those residing within an area that had a higher primary physician to population ratio were less likely to have made a health care services visit in the past year. This may imply that that better access to primary care can prevent the need for acute health care, because the primary care physicians practice preventive medicine in treating diseases before irreversible end-organ damage has occurred (Chobanianet al., 2003; Murphy et al., 2004).

Of the spatial accessibility variables none were significant predictors of a routine checkup visit having been made in the past 12 months. Perceived travel time was significantly associated with poor health status; adults who had to drive longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who were faced with a shorter drive. This may imply that that travel distance can be the potential barrier to management of health for people with disabilities.

The analyses of the "Ohio Family Health Survey" dataset indicate that of the spatial accessibility factors considered none were significant predictors of health care services visit or routine checkup visits. However, the ratio of primary care physician to population within a 30-minute area, and not having a hospital within a 30-minute commute were significant predictors of poor health status. Participants of the survey who resided within areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Likewise, those residing in areas that had a hospital located within a 30-minute commute were also less likely to report being in poor health. These analyses find some limited evidence of a positive health effect from having more primary care services and hospitals close to home for people with disabilities.

Further analyses of the Ohio Family Health Survey dataset, which is comprised of data collected from urban and rural areas, revealed that perceived travel time was significantly associated with poor health status per the multivariate model of the urban area data. Adults who had to drive longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who were faced with a shorter drive in urban area. This may imply that that travel distance can be the potential barrier to management of health for people with disabilities in urban, too.

The model of rural areas revealed that the ratio of primary care physician to population within a 30-min area had a significant association with health care services visits when predisposing and enabling characteristics were controlled. Of the respondents in rural, those residing within an area that had a higher primary physician to population ratio were less likely to have made a health care services visit in the past year. This result is consistent with the finding in analysis of “Survey of Access to Outpatient Medical Service in the Rural Southeast”.

The model of rural areas also revealed that perceived travel time, ratio of primary care physician to population within 30 minute area, and having a hospital within a 30-minute commute were all significantly associated with poor health status. Adults who had to drive longer time to get health care service were more likely to perceive themselves to be in poor health compared to adults who had a shorter drive. Participants who lived within areas that had a higher primary care physician to population ratio were less likely to perceive themselves to be in poor health. Those having hospital within a 30-minute commute were less likely to report being in poor health. This implies that spatial accessibility can be the potential barrier to management of health for people with disabilities in rural areas.

Table 4-28 Summary of Significant Predictors in the Final Models

Outcome	**Significant Spatial Accessibility Predictors**	**Other Significant Characteristics**
Southeast Rural		
Health Care Visit	Primary care physician to population ratio (-)	Age (+), Insurance (+)
Checkup Visit	None	Age (+), White (-), Insurance (+)
Poor Health Status	Perceived travel time (+)	Age (+), Education (-), Limited activity days (+), Income (-), Insurance (-)
Ohio Family Health Survey		
Health Care Visit	None	Age (+), Insurance (+), Usual Source (+)
Checkup Visit	None	Age (+), White (-), Cigarette use (-), Limitations of activity (+), Insurance (+), Usual Source (+)
Poor Health Status	Perceived travel time (+)*, Primary care physician to population within 30-min (-), Hospital within 30-min (-)	Age (-), Male (+), White (-), Education (-), Limitations of activity (+), Income (-), Insurance (-)
Ohio Family Health Survey (Urban Areas)		
Health Care Visit	None	Age (+), Insurance (+), Usual Source (+)
Checkup Visit	None	Age (+), White (-), Limitations of activity (+), Insurance (+), Usual Source (+)
Poor Health Status	Perceived travel time (+)	Age (-), Male (+), White (-),Education (-), Married (+), Separated (+), Limitations of activity (+), Income (-), Insurance (-), usual source (+)
Ohio Family Health Survey (Rural Areas)		
Health Care Visit	Primary care physician to population within 30-min (-)	Age (+), Insurance (+), Usual Source (+)
Checkup Visit	None	Age (+), Limitations of activity (+), Insurance (+), Usual Source (+)
Poor Health Status	Perceived travel time (+), Primary care physician to population within 30-min (-), Having hospital within 30-min (-)*	Age (-), Male (+), Never married (-), Limitations of activity (+), Income (-), Insurance (-)

+: positive association; -: negative association; * *p*-value Hosmer-Lemeshow test for the model < 0.05

CHAPTER V

DISCUSSION AND CONCLUSION

This chapter includes a discussion of the findings and a description of the inherent limitations of the study. Implications for research and health policy are presented along with recommendations for future research.

5.1 Discussion

(1) Survey of Access to Outpatient Medical Services in the Rural Southeast

The objective of this study was to estimate the importance of spatial accessibility in health care services utilization and the health status of persons with disabilities, controlling for other factors. A distance decay effect in health care access behavior has been documented in the literature (Girt, 1973; Gesler and Cromartie, 1985; Bronstein and Morissey, 1990), and travel time to access health care services has been cited as an important variable in several health care services utilization studies (Arcury et al., 2005a; 2005b). In keeping with findings of previous research (Arcury et al., 2005a; 2005b), the analyses of the Survey of Access to Outpatient Medical Service in the Rural Southeast (2002—2003) revealed that travel time is not significant in determining the use of health care services and routine checkup visits. The study by Arcury et al. (2005a) found two transportation characteristics that had significant associations with health care services utilization: having a driver's license and being able to avail a ride from relatives or friends regularly. These factors may indicate an ability to traverse distance and may be more important in determining utilization of health care services or routine checkup visits than travel time.

Spatial accessibility as measured by the primary care physician to population ratios within PCSA was found to be a significant predictor of health care services visits. Respondents who resided in areas with a higher primary physician to population ratio were less likely to have made a health care services visit in the past year. This result reiterates findings of previous studies (Kravet et al., 2008) and suggests that better access to primary care can prevent the need for acute health care. Through their preventive focus, primary care physicians can positively impact persons with disabilities.

The present study was unique in its inclusion of the association between spatial accessibility and health status of persons with disabilities. Perceived travel time was a statistically significant predictor of health status whereas calculated travel time was not. In southern rural areas, adults with disabilities who had a longer drive to their health care service provider were more likely to perceive themselves to be in poor health compared to adults who had to travel a shorter distance. The health status of persons with disabilities in southern rural areas was thus, associated with driving distance to the service provider. This may imply that that travel distance can be the potential barrier to management of health for people with disabilities. Travel distance has a negative effect on health behavior. People with disabilities are likely to become the more sensitive to the development of disease the farther they live from usual source of health care.

Consistent with the findings of other studies, several of the predisposing and enabling characteristics examined were associated with health care services utilization or health status. Older individuals and the insured were more likely to have made a health care services visit. The respondents who were older, White and insured were more likely to have had a routine checkup visit. Older individuals, those with a lower level of educational attainment, those with more limited activity days, those with a lower household income, and the uninsured were more likely to report being in poor health. Given that these factors, as well as spatial accessibility are significant predictors of health care utilization behavior, it is pertinent for them to be addressed in the policy process.

(2) Ohio Family Health Survey

The multivariate analyses of the Ohio Family Health Survey dataset indicated that the time involved in travelling to the health care services provider's location was not a significant predictor of health care services visits or routine checkup visits. Thus, spatial accessibility of health care services as measured by the physician to population ratios was not an important deciding factor in obtaining health care services or regular checkup visits among persons with disabilities in Ohio. Having a hospital located within a 30-minute travel time, a measure that has not been studied previously was also determined to not be related to utilization of health care services or regular checkup visits. The results therefore suggest that proximity to a health care services provider is not a significant predictor of health care services utilization (Cromley & McLafferty, 2003, p. 235).

This study's contribution to the literature of the field is in particular its examination of the association between spatial accessibility and health status of persons with disabilities. The results indicate that among the people with disabilities, adults who had to drive longer to obtain health care services were more likely to perceive themselves to be in poor health compared to adults who had a shorter drive. Respondents who resided in areas with physician scarcities were more likely to perceive themselves to be in poor health. Having a hospital located within a 30-minute commute was a factor also significantly associated with perceived health status; individuals who resided in areas that had a hospital located within a 30-minute commute were less likely to report being in poor health. These findings indicate that spatial accessibility factors such as travel time, the primary care physician to population ratio, and having a hospital located within a 30-minute drive are associated with the perceived health status of the population with disabilities. People far from usual source of care and living in health care shortage area can result the poorer health status for people with disabilities disabilities.

The analyses of the survey data from the urban areas of Ohio revealed that spatial accessibility factors were not predictors of health care services utilization or perceived health status. These findings may be thought to imply that spatial accessibility concerns are less relevant in urban areas. However, the multivariate model revealed: adults who had to drive longer to access health care services were more likely to perceive themselves to be in poor health compared to adults who were faced with a shorter drive in urban area. This may imply that that travel distance can be the potential barrier to management of health for people with disabilities in urban, too.

Contrary to findings of the urban survey data, for respondents in the rural area survey, the physician to population ratio within a 30-minute travel time area was significantly associated with health care services visits. Participants living in areas with a higher primary care physician to population ratio were less likely to have made a health care services visit; this may imply that that better access to primary care can prevent the need for acute health care. This finding is consistent with conclusions reached in a previous study (Kravet et al., 2008). Having a hospital located within a 30-minute travel time, a measure not used previously, is also not related to health care services visits or routine checkup visits in rural areas of Ohio.

In rural areas, adults with disabilities who drive a longer time to access health care services are more likely to perceive themselves to be in poor health compared to adults who face a shorter drive. Respondents residing in areas with physician scarcities are more likely to perceive themselves to be in poor health. These findings may imply that people far from usual source of care and living in health care shortage area can result the poorer health status for people with disabilities.

Of the factors analyzed, several predisposing and enabling characteristics were determined to be associated with health care services utilization or health status, and these findings are in keeping with findings of previous studies in the field. Older individuals, the insured, and those with a regular source of care are more likely to have made a health care services visit in the past year. The older, insured, non-White, non-smoking respondents, with greater limitations to daily activities, and with a regular source of care were more likely to have made a routine checkup visit. Younger, non-White, married, separated, or widowed, uninsured, males, with lower levels of educational attainment, greater limitations of daily activities, and lower annual household income are more likely to be in poor health.

The aforementioned predisposing and enabling factors were significant predictors of health care services seeking behavior be it in urban or rural regions of Ohio. The variable tobacco use was not however, significant in predicting routine checkup visits made by persons with disabilities in rural or urban regions of Ohio in the past year. Race was not a determinant of routine checkup visits made by respondents of rural Ohio. Education and race were both insufficient predictors of health status for the respondents residing in rural Ohio.

5.2 Implications

(1) Survey of Access to Outpatient Medical Service in the Rural Southeast

It is evident that poor access to health care services leads to a lesser than optimal utilization and also delays health care seeking behavior. Better access to health care services can therefore promote early preventive care, thereby decreasing the need for acute health care. The analyses of the data from the rural Southeast indicate that travel time to health care services provider is an important predictor of health status among persons with disabilities. Policies to address health care access and health status improvement for persons with disabilities should address spatial accessibility factors. For instance, provision of door-to-door transportation services for persons with disabilities from point of residence to the health care services provider might be an appropriate intervention in all regions and local areas where there is sufficient evidence that longer travel time is associated with poor health among persons with disabilities.

(2) Ohio Family Health Survey

Evidence of the importance of a source of primary care, sometimes known as the "medical home," is rapidly accumulating (Starfield & Shi, 2004). In the United States, the concept of a medical home has recently gained some traction as an approach toward improving the quality of general health care and the management of chronic illness. The resources of primary care are the base for a medical home to provide accessible, comprehensive, ongoing, and integrated care (Daniels, Adams, Carroll & Beinecke, 2009).

The analyses of the Ohio Family Health Survey dataset indicate that spatial accessibility to the primary source of care is an important determinant of health status among persons with disabilities in Ohio. This suggests that medical homes should address spatial accessibility issues. The Department of Health and Human Services has identified areas that suffer from a shortage of health professionals using a specified threshold of population-to-physician ratio set at 3500:1 (Ricketts et al., 2007). Based on this rule, the primary care shortage areas in Ohio are depicted in Figure 5-1. Areas that earned a lower accessibility to primary care physician score are mostly rural (such as Carroll, Hardin, Hocking, Jackson, Lawrence, Meigs, Monroe, Morgan, Paulding, Perry, Preble, Putnam, and Vinton). For medical home policy to be implemented effectively these should be the first target areas that receive more primary care physicians.

Moreover, spatial cluster analysis can detect the spatial pattern of distribution. Area-based spatial cluster analysis can be employed to examine whether objects in proximity or adjacency are related (similar or dissimilar) to each other. In GeoDa, the Spatial Autocorrelation Tool can be utilized to create cluster maps the analysis of which can enable detection of cluster areas with low spatial accessibility to primary care, high number of low income families with persons with disabilities, and high incidence of persons with disabilities belonging to the low-income group. The locations of significant Local Moran's I statistics ($p < 0.05$), classified by type of spatial association are depicted in Figures 5-2, 5-3 and 5-4.[31] The dark red and dark blue locations are indications of spatial clusters (respectively, high surrounded by high, and low surrounded by low). In contrast, the light red and light blue colored locations are indications of spatial outliers (respectively, high surrounded by low, and low surrounded by high).

These figures reveal that some clusters with low spatial accessibility to primary care, higher incidence of persons with disabilities, and high percentage of people with disabilities are located in the southern part of the state. These clusters warrant greater attention and should be the focus of further research, particularly as the state government attempts to launch the medical home program for persons with disabilities.

[31] This study use Geoda to create a rook-based contiguity spatial weights matrix. A rook weights matrix defines a location's neighbors as those areas with shared borders (in contrast to a queen weights matrix, which also includes the vertices). For instance, on a regular grid, neighbors according to the rook criterion would be cells to the North-South and West-East of a cell but not the Northwest, Southeast, etc. Rook matrices are contiguity-based matrices with .gal extensions in GeoDa.

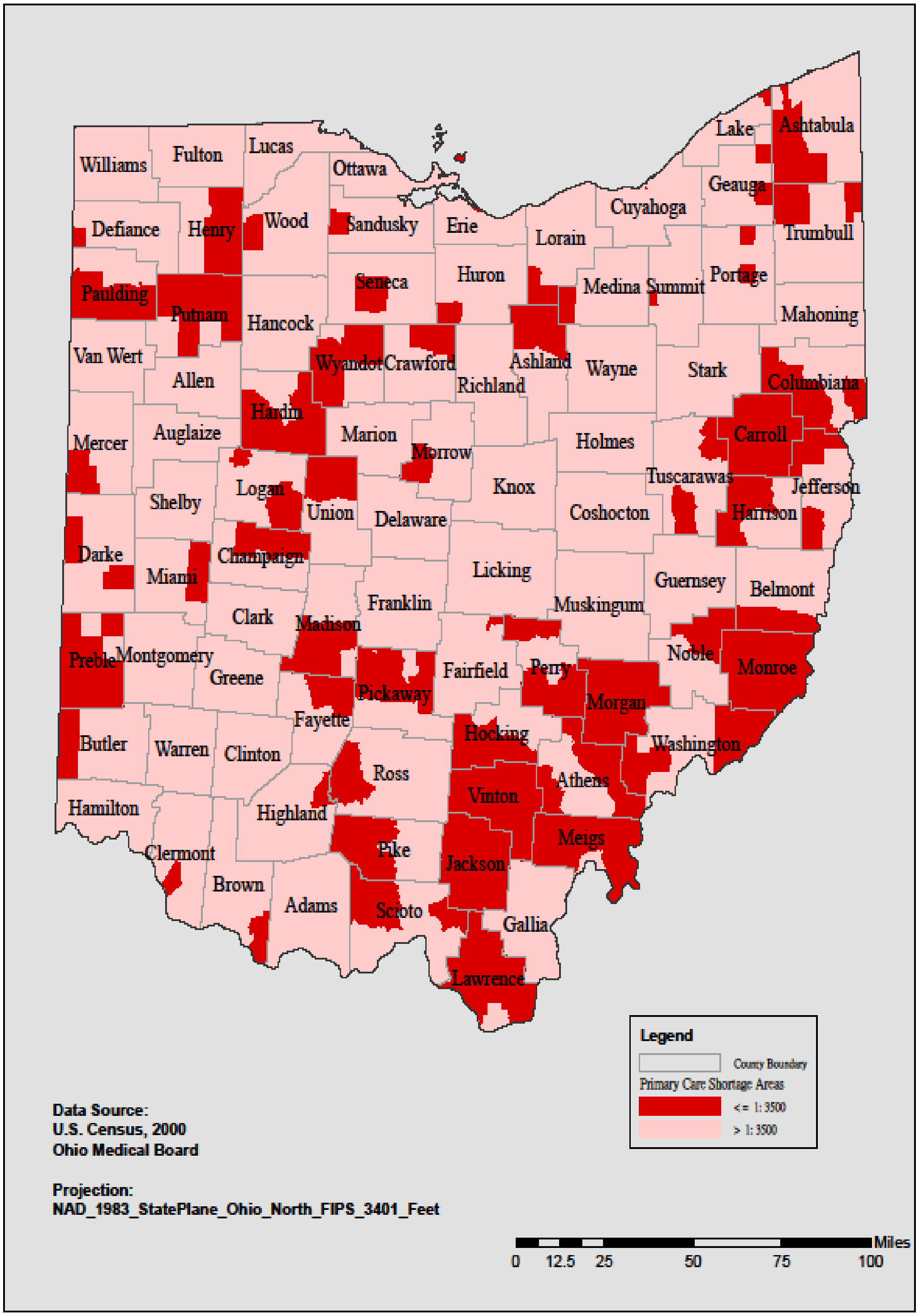

Figure 5-1 Primary Care Physician Shortage Areas in Ohio

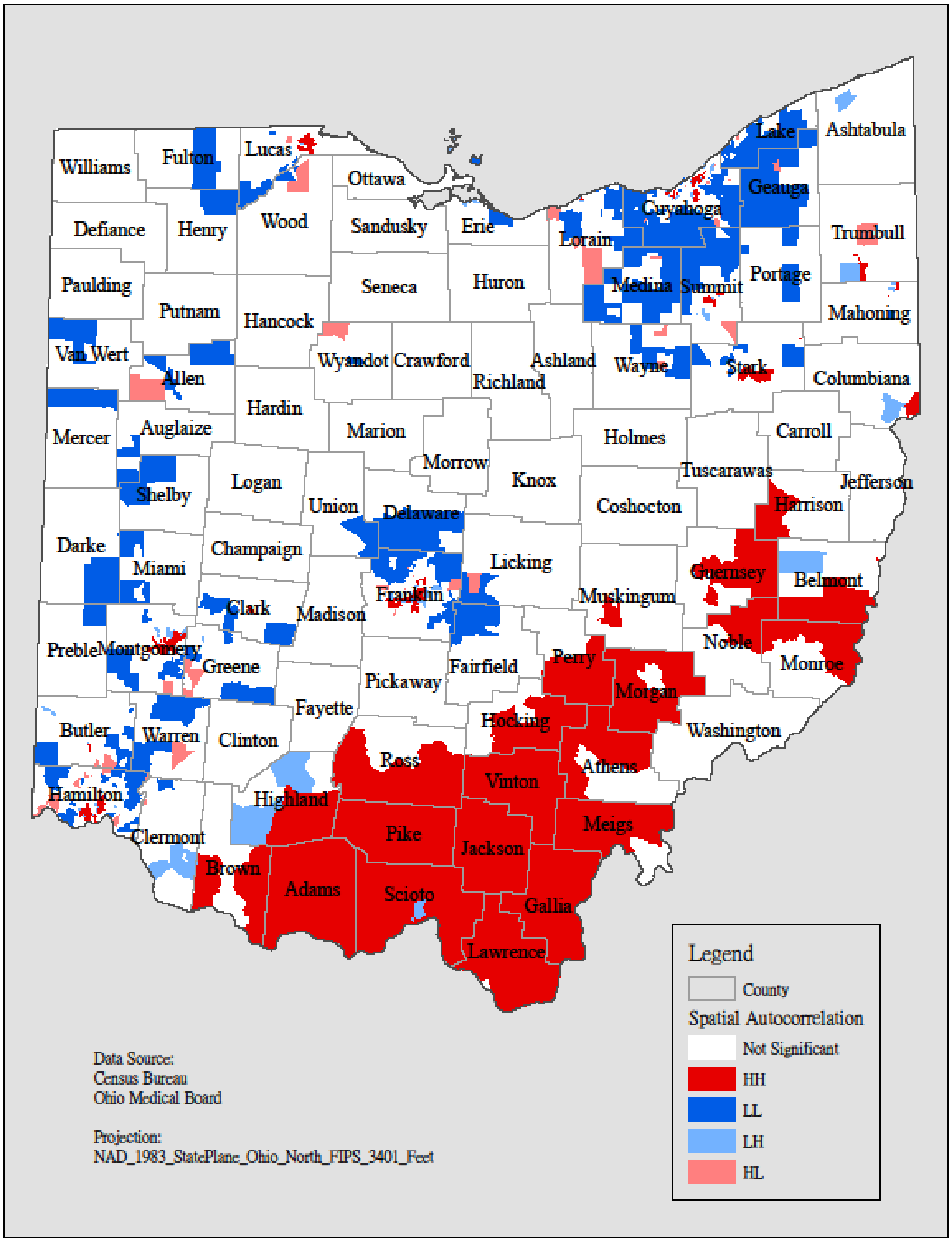

Figure 5-2 Spatial Cluster of Total Number of People with Disabilities

* The cluster map legend contains five categories:

- **Not significant** (Areas that are not significant at a default pseudo significance level of 0.05)
- **HH** (High values surrounded by high values)
- **LL** (Low values surrounded by low values)
- **LH** (Low values surrounded by high values)
- **HL** (High values surrounded by low values).

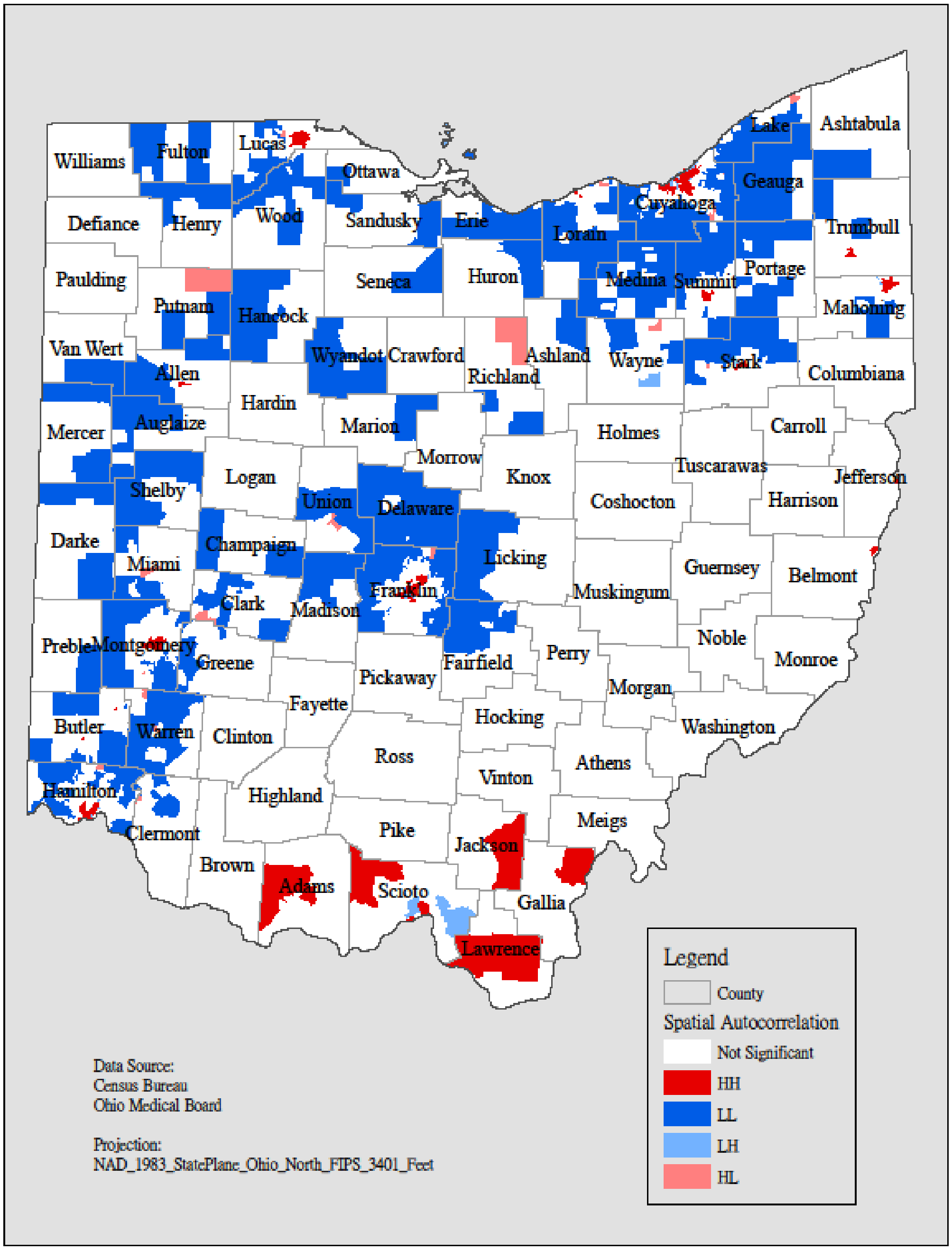

Figure 5-3 Spatial Cluster of Percentage of People with Disabilities

* The cluster map legend contains five categories:

- **Not significant** (Areas that are not significant at a default pseudo significance level of 0.05)
- **HH** (High values surrounded by high values)
- **LL** (Low values surrounded by low values)
- **LH** (Low values surrounded by high values)
- **HL** (High values surrounded by low values).

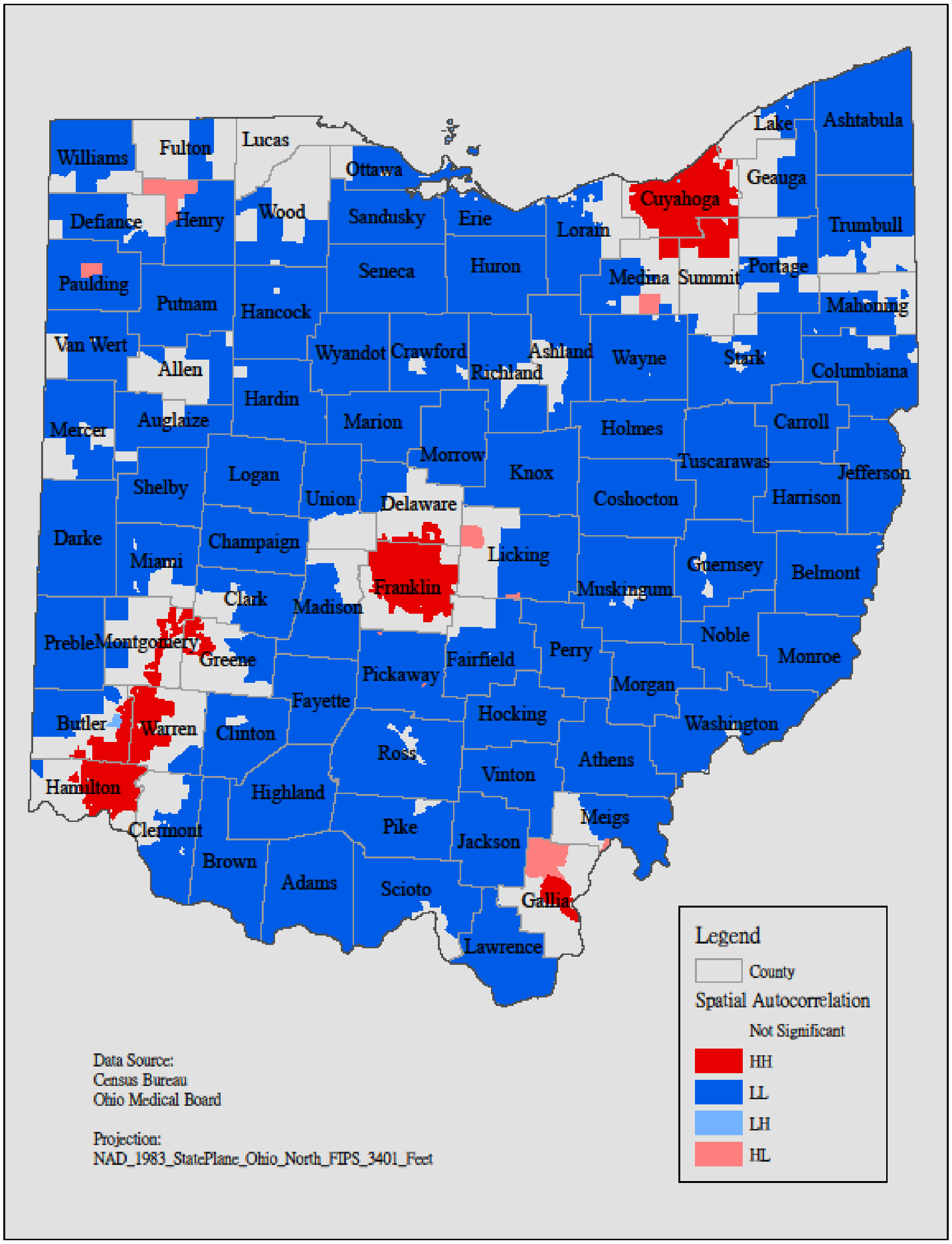

Figure 5-4 Spatial Cluster of Spatial Accessibility to Primary Care Physician

* The cluster map legend contains five categories:

- **Not significant** (Areas that are not significant at a default pseudo significance level of 0.05)
- **HH** (High values surrounded by high values)
- **LL** (Low values surrounded by low values)
- **LH** (Low values surrounded by high values)
- **HL** (High values surrounded by low values)

5.3 Limitations

This study has some limitations that must be considered; some of which are inherent to the study design. On account of the exclusively cross sectional nature of the data collected, individual results could not be compared over time. This might therefore, only show an association between health status and spatial accessibility, and not allow for inferences of causality.

The study involved an analysis of available survey data (secondary data), which limited the availability of certain variables and level of detail within these variables. An illustrative example is level of disabilities. Several questions were asked of the respondents in order to elicit disabilities information; however there is no question about the specific conditions that constitute physical or mental impairments. It is not possible to know if a respondent had visual, speech, and hearing impairments or mental retardation. In addition, transportation is a commonly identified barrier to health care seeking behavior among the people with disabilities as reported in previous studies. However, information about transportation was not included in the survey data. Due to the lack of location information on the respondents and their preferred health care service providers, a measure of potential spatial accessibility to the hospital and primary care services was employed as opposed to realized spatial accessibility. Although the Southern Rural Access Program Survey had a built-in question about the township in which the respondent's health care service provider was located, there was no information on the address of the health care service providers. Therefore, the measure of travel time as estimated in this study is an "estimate" and not the "actual".

The study is also limited in its focus on rural Southeast in the US and Ohio.

These regions may have some unique characteristics that prevent the generalizability of the study findings to other regions or states of the United States.

5.4 Future Research

For the purposes of this study, health care services utilization is defined as visits paid by the patient to the physician or other health care professionals for a health condition or routine checkup within the past 12 months, not considering the number of visits paid, i.e., the consideration is whether a visit was made or not and not necessarily how many visits were made. Future research can consider the number of health care visits that participants had over a year.

Future research has to address not only the concerns related to spatial accessibility of health care services but also the need for provision of transit options for the people with disabilities enabling them to better access health care services. Qualitative studies may help validate some of the findings of this study and thereby provide a better understanding of the relationship between spatial factors, health care seeking behavior and health status among the people with disabilities.

Similar studies that can replicate the sample observations or study the same subset of variables to examine the relationship between spatial accessibility to health care services providers and health status for persons with disabilities in other states of the country would be valuable in bolstering the knowledge gained about this association. Further research that attempt to replicate this study but study other vulnerable populations could aid in establishing the importance of spatial accessibility of health care services to health status of all vulnerable populations. Comparisons of the association between spatial accessibility and health care services utilization behavior among the people with disabilities and the general population could provide greater insight on whether the people with disabilities face a disproportionate burden due to inaccessibility of health care services.

Further spatial analysis is requisite; such research may help the administration identify areas with less medical resources and a greater incidence of vulnerable populations, and thereby target these areas for greater assistance through responsive health care policy. In-depth studies of identified spatial clusters can help identify the actual factors that are associated with poor spatial accessibility to primary care.

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APPENDICES

APPENDIX A

IMPLEMENTING THE NETWORK ANALYST

(1) Generating population-weighted centroids of town areas and zip code areas.

After the data of census blocks 2000 were downloaded and processed, a spatial layer of all blocks in the eight-state region was created. Using map overlay tool a layer with blocks corresponding to town areas as well as zip code areas was generated, and then used in the computation to generate population-weighted centroids of town and zip code areas. The computation was implemented in ArcToolbox by utilizing Spatial Statistics Tools > Measuring Geographic Distribution > Mean Center. In the dialog window, the layer of census block centroids was chosen as the Input Feature Class, and the population field was chosen as the Weight Field and the town ID or zip code as the Case Field.[32]

(2) Estimating travel times.

Road network was downloaded from ESRI (Environmental Systems Research Institute) website, and each segment was assigned a travel speed according to CFCC (Census Feature Class Codes). The CFCC codes were divided into five different groups:

- A10 – A18: Interstate highway (65 mile/hr)
- A20 – A28: U.S. and state highways, Primary Roads (45 mile/hr)
- A30 – A38: Secondary Roads (35 mile/hr)
- A40 – A48: Local, neighborhood, rural, or city streets (25 mile/hr)
- All other streets (15 mile/hr)

Travel speeds were used to define impedance values in the network shortest-route computation. This computation was implemented in Network Analyst by utilizing OD Cost Matrix (Origin-Destination Cost Matrix). It computed the travel time table between zip code centroids and town centroids.

[32] These data was downloaded from: http://arcdata.esri.com/data/tiger2000/tiger_puertorico.cfm

APPENDIX B

ESTIMATING TRAVEL TIME TO HOSPITALS IN OHIO

(1) After the data from census blocks 2000 were downloaded and processed, a spatial layer of all blocks in Ohio state region was created. Using Mean Center creates census tract centroids as residents' points.

(2) Utilizing OD Cost Matrix (Origin-Destination Cost Matrix) the travel time between zip code centroids and hospitals[33] are computed based on the road network of Ohio.

(3) For each tract centroid, hospital locations that are within a reasonable travel time (in this instance, 30 minutes), are selected and the number of hospitals in each tract are summed.

tract	hospital	time
101101	A	13.58
101102	B	2.14
…	…	…
101101	D	13.51
101102	E	23.76

↓

tract	N
101101	2
101102	5

Figure 3-2 Map Spatial Accessibility to Hospital

[33] Hospital points shapefile was purchased from ESRI.

APPENDIX C

THE TWO-STEP FLOATING CATCHMENT AREA METHOD

Radke and Mu (2000) developed the two-step floating catchment area method, a term coined by Luo and Wang (2003). This method can be implemented within GIS by following the procedures using a series of “join” and “sum” functions.

(1) The population-weighted centroids of Zip Code areas and tracts were generated by Mean Center function using block population point. Using GIS street network analysis the travel time between any pair of physician location (taken as the Zip Code area centroid) and population location (taken as the census tract centroid) was computed.

(2) For each physician location, population locations that are within a reasonable travel time (for the purposes of this study; 30 minutes) of that physician location are selected, thereby defining an imaginary catchment area for physician location.

zip	tract	time
44070	101101	13.58
44070	101102	2.14
…	…	…
44115	101101	13.51
44115	101102	23.76

Join by **zip**

zip	doc#
44070	50
44115	5

Join by **tract**

tract	pop#
101101	5000
101102	3500

(3) The physician-to-population ratio for the catchment area is computed by dividing the number of physician (s) by the sum of population within the catchment.

zip	tract	time	doc#	pop#
44070	101101	13.58	50	5000
44070	101102	2.14	50	3500
…	…	…	…	
44115	101101	13.51	5	5000

↓ sum pop# by zip
calc. r =

zip	sum-pop#	doc#	R
44070	22500	50	0.002311
44115	10650	5	0.000935

(4) For each population location, all physical locations that are within the reasonable travel time (i.e., 30 minutes) are searched, and the physician-to-population ratios are summed at these locations. The spatial accessibility score = r.

zip	tract	time	doc#	pop#	sum-pop#	r
44070	101101	13.58	50	5000	225000	0.002311
44070	101102	2.14	50	3500	225000	0.002311
…	…	…	…		…	…
44115	101101	13.51	5	5000	10650	0.000935
44115	101102	23.76	5	3500	10650	0.000935

↓ sum r by tarct

tract	r
101101	0.003246
101102	0.005678

(5) Map Spatial Accessibility (Figure 3-3).