THE RELATIONSHIP BETWEEN A SYNTHETIC ESTIMATE OF FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE USE IN A NATIONAL SAMPLE OF ELDERLY

by

Michael Joseph Miller

BS Pharmacy, University of Pittsburgh, 1988

MS Pharmacy, The University of Arizona, 1995

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This dissertation was presented

by

Michael Joseph Miller

It was defended on

August 9, 2004

and approved by

Chyongchiou Jeng Lin, PhD
Assistant Professor
Department of Health Policy and Management
Graduate School of Public Health
University of Pittsburgh

Edmund M. Ricci, PhD
Professor
Department of Behavioral and Community Health Sciences
Graduate School of Public Health
University of Pittsburgh

Susan M. Sereika, PhD
Associate Professor
Director, Center for Research and Evaluation
School of Nursing
University of Pittsburgh

Howard B. Degenholtz, PhD
Assistant Professor
Department of Health Policy and Management
Graduate School of Public Health
University of Pittsburgh
Dissertation Director

Howard B. Degenholtz, PhD

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Michael Joseph Miller, DrPH

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Functional health literacy is one path through which the educational system, health system, culture and society intersect to influence health outcomes and their associated costs. Inadequate functional health literacy can impair oral and written communication and subsequently the ability to understand the prevention and self-management of disease. Despite these concerns, the national prevalence of inadequate, marginal and adequate functional health literacy and their association with health status, health care utilization and subsequent health care outcomes remain largely unknown. For those tasked with the responsibility of managing population health, there is a void of tools and techniques that can be used to efficiently identify those at greatest risk of inadequate functional health literacy. Using standard regression modeling and diagnostic techniques, this study was the first to develop and validate a model to estimate functional health literacy and to confirm its direct relationship with preventive health services utilization in a nationally representative sample of elderly $\geq$ 65 years of age. The national prevalence of inadequate and marginal functional health literacy was estimated to be 39%. Preventive health care utilization varied by functional health literacy category. Individuals with inadequate or marginal functional health literacy had odds of not receiving a flu shot within the past 12 months

that was 1.26 times that of individuals with adequate functional health literacy (OR = 1.26, 95% CI (1.11 – 1.43)) after controlling for income, insurance coverage, having a usual source of care, and self-reported general health status. Women with inadequate or marginal functional health literacy had odds of not ever having a mammogram that was 2.21 times that of women with adequate functional health literacy (OR = 2.21, 95% CI (1.85 – 2.65)) in multivariate analysis. This research confirms the national public health relevance of functional health literacy in preventive health care utilization in the elderly. Race, education and age-related disparities in preventive health care utilization may, in part, be mediated through functional health literacy. As we move to equalize health care access, utilization and quality for all, functional health literacy must be considered part of the solution if we are to empower those in greatest need.

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PREFACE

Few were interested in the topic of health literacy when I began my doctoral study five years ago. It is with great pride that my dissertation addresses the void of research in this area, following on the heels of the first report from the Institute of Medicine that raised the awareness of the crisis of inadequate functional health literacy in America. My journey would not have been successful without the guidance, assistance, encouragement, generosity, kindness and compassion of many people. First and foremost, I must thank my wife, Diana, and son, Elliot. Diana, with her unconditional love and support, continually encouraged me to persevere. Elliot, with his arrival some 18 months ago, taught me about balancing professional and personal life, but also underscored the importance of completing this journey so that we can move on as a family. My mother and father, Mary and Joseph, always stressed the importance of higher education. They enlightened me to realize the importance of functional health literacy as I witnessed their struggles interfacing with the health care system in their advancing age. This body of work has allowed me to connect their desire for my educational advancement to address a problem that affects their daily life. Through his generosity, my advisor, Dr. Howard Degenholtz provided the opportunity and technical guidance for me to pursue my own research interests when no one else would. Seeing the value of health literacy research, he opened the necessary doors and encouraged me during the darkest hours to focus on the finish line. He continually challenged me to pursue the next higher order of learning. I will never be able to repay him for his compassion, generosity and understanding. Dr. Edmund Ricci has provided me essential senior mentorship. From my earliest days in the doctoral program, he took me under his wing and treated me like his own son. Always supportive, never judgmental, he always sought

opportunities for me to grow and succeed as a person and academic professional. Dr. Chyongchiou Jeng Lin taught the first course for which I was enrolled at the Graduate School of Public Health. Dr. Lin has followed and supported my growth throughout this journey serving as an advisor and confidant. Her faith in me has never wavered and for this I am grateful. When I was in need of biostatistical support, Dr. Susan Sereika graciously spent countless hours meeting with me to provide technical guidance. Her guidance was fundamental to completion of this research project. Finally, without Dr. Julie Gazmararian this project would not have been possible. Beyond providing the data essential for completing this research, she warmly welcomed me into the health literacy research community and has laid the groundwork for my future research.

1. CHAPTER 1 – OVERVIEW

1.1. INTRODUCTION

Imagine not being able to read and/or comprehend the instructions to prepare for a scheduled medical diagnostic test. More simply, imagine not being able to determine, from an appointment schedule, your next doctor visit or understand the instructions on how to properly use a medication for which you have been prescribed. These are just some of the reading comprehension and numeracy skills that define the measurement of functional health literacy (Parker, Baker, Williams, & Nurss, 1995; Baker, Williams, Parker, Gazmararian & Nurss, 1999). Individuals with inadequate or marginal functional health literacy lack these very skills. Functional health literacy is a conduit through which the educational system, health system, culture and society can affect health outcomes and their associated costs (Nielson-Bohlman, Panzer & Kindig, 2004). Inadequate functional health literacy can impair the ability to understand the prevention and self-management of disease by negatively influencing oral and written communication skills.

In an increasing complex health care system that relies on patient self management, less than adequate functional health literacy has potentially serious health consequences. Inadequate functional health literacy has been associated with decreased understanding of chronic disease and its management (Williams, Baker, Parker & Nurss, 1998; Gazmararian, Williams, Peel & Baker, 2003). Compounding this problem is a decrease in general clarity of patient-provider communication and explanations of conditions and processes of care as reported by patients with inadequate functional health literacy (Schillinger, Bindman, Wang, Stewart & Piette, 2004). A sense of shame associated with inadequate functional health literacy (Parikh, Parker, Nurss, Baker & Williams, 1996) may further widen the patient-provider communication gap as individuals often hide this inadequacy and may be reluctant to pursue deeper inquiry into their disease condition and management. Some may not even be fully aware of the extent to which their understanding of medical or health information fails to match what providers believe has been communicated.

Although limited by scope, generalizability and the use of observational, quasi-experimental methodology, research to date has documented associations between inadequate functional health literacy and a variety of less than optimal processes and outcomes of medical care. Individuals with inadequate functional health literacy were more likely to exhibit suboptimal adherence to combination anti-retroviral therapy (Kalichman, Ramachandran & Catz, 1999); were more likely to be hospitalized within the previous year (Baker, Parker, Williams, Clark & Nurss, 1997; Baker, Parker, Williams & Clark, 1998; Baker, Gazmararian, Williams, Scott, Parker, et al., 2002); were less likely to obtain preventive health care services (Scott, Gazmararian, Williams, & Baker, 2002); were more likely to report poor health (Baker et al.,1997); and have worse glycemic control and higher rates of retinopathy (Schillinger, Grumbach, Piette, Wang, Osmond, et al., 2002).

Much of the research into functional health literacy has come subsequent to the release of the results of the 1992 National Adult Literacy Survey (NALS) (Kirsch, Jungeblut, Jenkins & Kolstad, 1993). Defined as "…using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential," the 1992 NALS estimated that approximately 90 million adult Americans, 16 years of age or older, performed at the two lowest levels of functional literacy (Kirsch et al., 1993). In practical terms, these results suggested, for example, that a substantial proportion of adult Americans lacked the basic skills necessary to identify an important concept in a prose passage, could not identify and enter background information on an application for a social security card and/or could not complete basic arithmetic operations to compare prices or total costs. Those at greatest risk for low general functional literacy were poor, older, members of a racial minority group and had lower levels of education. In contrast to previous assessments, the emphasis of the 1992 NALS assessment focused on the ability to accurately read, comprehend and act on written information contained in prose passages and documents and to complete routine arithmetic operations encountered in everyday life. The 1992 NALS assessment tested skills fundamental to empowering one to adequately function in society across an increasingly complex continuum. With the emphasis on completion of practical, "real world" tasks, rather than on norm-referenced grade-level achievement, the 1992 NALS was the first nationally representative assessment of general functional prose, document and quantitative literacy in America, and until the results of the 2003 National Adult Literacy Survey are released, it remains the most authoritative assessment of general functional literacy.

The 1992 NALS lacked estimates of functional health literacy or "…the constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the health care environment" (American Medical Association, Council on Scientific Affairs, Ad Hoc Committee on Health Literacy, 1999), but served as the impetus for research into the development of methods to assess functional health literacy. Over the decade of the 1990s, instruments were developed to measure functional health literacy skills related to reading comprehension and numeracy, and were used to describe the regional prevalence of inadequate, marginal, and adequate functional health literacy in two distinct population subgroups: (1) adult patients who used urban, public hospitals (Williams, Parker, Baker, Parikh, Pitkin, et al., 1995); and (2) Medicare managed care enrollees (Gazmararian, Baker, Williams, Parker, Scott, et al., 1999). The findings from these two studies documented that 25 to 29% of study participants had inadequate functional health literacy and 11 to 14% of participants had marginal functional health literacy. Although samples with restricted demographic characteristics were used, these results coupled with the findings from the 1992 NALS reinforced concerns about the about the potentially high national prevalence of inadequate to marginal functional health literacy.

The cascade of research into the prevalence and consequences of inadequate functional health literacy beginning in the 1990s has been summarized in a comprehensive review and published in the April 2004 report of the Institute of Medicine (IOM), "Health Literacy: A Prescription to End Confusion" (Nielson-Bohlman et al., 2004). In general, the team of experts from the IOM team concluded that:

1. Functional health literacy is a multi-dimensional phenomenon involving reading, writing, numeric, listening, and speaking skills influenced by society, cultural beliefs, educational and health systems.
2. Inadequate functional health literacy is a widely prevalent problem and has the potential to significantly contribute to health care disparities.

Among its many recommendations, the IOM report proposed:

1. Development of uniform standards for measuring health literacy.
2. Public and private support for research into the causes and consequences of limited health literacy and development and use of culturally appropriate measures of health literacy.
3. Educators incorporate health-related tasks into lesson plans.
4. Professional schools incorporate health literacy into curricula.
5. Health-systems develop programs to reduce the negative consequences of limited health literacy.
6. Incorporation of health literacy standards into hospital and health-system accreditation standards.

1.2. STATEMENT OF THE PROBLEM

Despite the findings from the 1992 NALS and early studies of functional health literacy, the national prevalence of inadequate, marginal and adequate functional health literacy remain unknown. Because the functional health literacy data were derived from select population subgroups in regional samples (Williams et al., 1995; Gazmararian et al., 1999), questions remain about the generalizability of current research addressing functional health literacy prevalence and its associations with health status and various aspects of acute and preventive health care utilization.

Identification of those at greatest risk of inadequate functional health literacy is the essential first step to enable the provision of targeted educational interventions to overcome functional health literacy deficiencies. Current techniques for the direct measurement of functional health literacy are complex and time consuming and require personal interaction. Thus, there is a lack of tools and techniques that can be used to efficiently identify those at greatest risk of inadequate functional health literacy for those tasked with the responsibility of managing population health. Until instruments are developed, tested and implemented to directly and efficiently measure functional health literacy in large populations and routine practice, alternative methods to identify at-risk individuals for inadequate functional health literacy in large populations must be developed, tested and used.

1.3. PURPOSE OF THE STUDY

Given the lack of national data on the prevalence of inadequate functional health literacy, the first purpose of this research was to develop and validate a statistical model for generating synthetic estimates of functional health literacy using a large sample of existing data. The second purpose of this research was to test the relationship between a synthetic estimate of functional health literacy and two measures of preventive health care utilization (i.e., influenza vaccination and mammography screening) in a national sample of elderly who were 65 years of age or older.

The elderly population, 65 years of age or older, was chosen for this research in an attempt to corroborate earlier findings about the relationship between functional health literacy and preventive health care utilization, expanding the generalizability of the results from a restricted regional sample of select Medicare managed care beneficiaries to a broadly inclusive sample of elderly.

1.4. SPECIFIC AIMS

This study had three specific aims:

1. To develop a valid and reliable predictive model to estimate functional health literacy from the largest available sample of elderly $\geq$65 years of age that directly documented functional health literacy.
2. To evaluate the construct validity of the synthetic estimate of functional health literacy derived from the predictive model in a separate nationally representative sample of elderly $\geq$65 years of age.
3. To test the relationship between the synthetic estimate of functional health literacy and preventive healthcare utilization in a nationally representative sample of non-institutionalized elderly $\geq$65 years of age.

1.5. RESEARCH HYPOTHESES

The first two specific aims of this research involved model building and validation. To fulfill the third specific aim of this research, research hypotheses were tested to assess the relationship between synthetic estimates of functional health literacy and two measures of preventive health care utilization. Hypotheses were developed within the conceptual framework of the expanded behavioral model of health services research (Aday & Andersen, 1974; Aday, Andersen & Fleming, 1980). Using the 1996 Community Tracking Study (CTS) dataset (Kemper, Blumenthal, Corrigan, Cunningham, Felt, et al., 1996), functional health literacy, the independent variable of interest, was estimated from the predisposing characteristics of age, race, education and sex using the model developed and validated in the first two specific aims of this research. Enabling factors (i.e., income, insurance status and usual source of care) and a need factor (i.e., general health status) served as covariates in multivariate hypothesis tests. Dependent variables used for hypothesis testing included receipt of a flu shot within the past 12 months and receipt of a mammogram within one year, two years, or ever. Hypothesis tests were non-directional and an alpha probability value of 0.05 was used as the criterion for statistical significance. Specifically, the expected relationships for the two primary hypotheses are presented below:

1. For elderly men and women ≥ 65 years of age, there is a relationship between their synthetic estimate of functional health literacy and not receiving a flu shot within the past 12 months after controlling for income, usual source of care, insurance coverage, and general health status.
2. For elderly women ≥ 65 years of age, there is a relationship between their synthetic estimate of functional health literacy and not ever receiving a mammogram after controlling for income, usual source of care, insurance coverage, and general health status.

Secondary analyses were performed to evaluate role of functional health literacy while considering: (1) alternative specifications of the mammogram dependent variable; (2) the effect of sex in receipt of flu shot within the past 12 months; and (3) the role of Medicare health maintenance organization (HMO) participation.

1.6. ASSUMPTIONS

All data collected for this research relied on respondent self-report. It was assumed that all respondents answered interview items honestly and accurately.

The data for functional health literacy model building and validation were derived from a large, regional sample of Medicare, managed care enrollees ≥ 65 years of age whereas functional health literacy was estimated and its relationship with preventive health care utilization was tested in a national sample of elderly ≥ 65 years of age. The comparability of each of the sample demographics was assessed. To expand the generalizability and further improve confidence in the out of sample predictions of functional health literacy, the relationships between estimates of functional health literacy and various dimensions of general functional literacy in a national sample of elderly ≥ 65 years of age were also assessed with the expectation of a strong positive association between the estimates of functional health literacy and general functional literacy. Finally, to allay concerns about the functional health literacy model being derived only from a Medicare managed care sample of elderly, hypothesis tests were performed in the Medicare HMO subgroup, the Medicare non-HMO subgroup, and the overall sample of elderly ≥ 65 years of age.

1.7. LIMITATIONS

With respect to functional health literacy model development, the functional health literacy model is limited by the explanatory power of the four predictor variables considered (i.e., sex, race, education, and age). While there are other cultural, societal, education and health system factors in addition to sex, race, education and age that may improve the prediction of functional health literacy, this research was purposefully limited by the availability of explanatory variables that are common to all data sets that have been measured in a consistent manner.

Data for all variables used in this research represent cross-sectional estimates. Using an observational, cross-sectional design, there was no experimental manipulation of the independent variable (i.e., the synthetic estimate of functional health literacy). Theoretically, one may imagine that experience interacting with the health care system may increase functional health literacy. Alternatively, decreased functional health literacy may limit interaction with the health system, and therefore reduce the opportunity to accumulate health care experience. The bi-directional nature of the relationships between predictors of functional health literacy and functional health literacy as well as the relationships between functional health literacy and health care use and outcomes are not currently well understood. The temporal relationships between predictor variables and functional health literacy as well as estimates of functional health literacy, covariates and measures of preventive health care utilization cannot be assessed in this cross-sectional research. Thus, causal relationships between the synthetic estimate of functional health literacy and preventive health care utilization cannot be established from this research.

Due to sample size limitations, only White, Black and Hispanic respondents are represented in this research. These three racial/ethnic groups represent the overwhelming majority of the population of the United States (US Census Bureau 1990; US Census Bureau 2000). In the data set from which the functional health literacy model was developed (i.e., the Medicare Health Literacy Study (MHLS) (Gazmararian et al., 1999)), the "other" racial/ethnic groups were not represented in sufficiently large numbers to generate stable, representative estimates (n=42). In addition, grouping the "other" racial/ethnic groups as one to obtain sufficient sample size precludes meaningful interpretation of the findings due to the large ethnic diversity of the "other" race/ethnic group. In contrast, all Hispanic respondents were grouped together. Although the effect of cultural differences among different Hispanic sub-groups on functional health literacy was not controlled, the functional health literacy model was derived from functional health literacy data collected both in Spanish and English (Gazmararian et al., 1999) as were the data for general functional literacy in the 1992 NALS (Kirsch, Yamamoto, Norris, Rock, Jungeblut, et al., 2001) and data for preventive health care utilization in the 1996 CTS (Center for Studying Health System Change, 2000). Thus, it is believed that the primary language effect for Spanish-speaking and non-Spanish-speaking Hispanics would be minimized. Data pertaining to primary language spoken were not collected in the MHLS or the 1996 CTS and thus were not used in modeling functional health literacy. It is also assumed that the Hispanic subgroups were more homogeneous than the racial/ethnic mix of the "other" race category. Thus, the cultural differences across the Hispanics subgroups would be much less than would be expected in the "other" race category.

1.8. SIGNIFICANCE OF THE STUDY

The proposed study contributes to the body of health literacy research in a number of important ways. It was the first to develop and validate a model to estimate functional health literacy derived from commonly collected demographic variables. This method will enable researchers to generate estimates of functional health literacy in a variety of secondary data sets and to generate hypotheses about the relationships between functional health literacy and the structure, processes and outcomes of medical care. In managing population health, this modeling strategy can be used to identify at-risk individuals with inadequate functional health literacy to focus resources for primary data collection and future research. In addition, synthetic estimates of functional health literacy will make it possible to customize and target educational programs to the appropriate literacy skill level and to study the potential impact of policy directives such as the National Medicare Education Program (McCormack, Burrus, Garfinkel, Gibbs, Harris-Kojetin & Sangl, 2001).

A second contribution of the proposed research involves estimating the relationships between the synthetic estimate of functional health literacy and preventive health services utilization in a nationally representative sample of elderly $\geq$ 65 years of age. Because the variables (i.e., sex, age, race and education) in the predictive model for functional health literacy have been linked to both literacy and preventive health care utilization, this research compares the differences between two independent models. One model evaluates the direct relationship between an immutable set of demographic variables and preventive health care utilization. A second model assesses the relationship between a synthetic estimate of functional health literacy, derived from the immutable demographic variables (i.e., sex, age, race and education), and preventive health care utilization. Because this research proposes that the synthetic estimate of functional health literacy is, in part, a function of four demographic predictors, it is expected that the model incorporating the independent predictors of functional health literacy alone would have greater explanatory power than the model containing only the synthetic estimate of functional health literacy. However, the synthetic functional health literacy estimate represents the weighted relationship of sex, race, age and education variables that are associated with functional health literacy. If the synthetic estimate of functional health literacy derived from the restricted weights of sex, race, age and education remains a significant predictor of preventive health care utilization in multivariate analyses, it would support the conclusion that functional health literacy contributes to sex, race, education and age-related differences in preventive health care utilization.

Finally, by using a nationally representative data set, the 1996 CTS, this research is more broadly generalized than prior research evaluating the relationship between functional health literacy and preventive health care utilization. In contrast to prior research which was limited to Medicare managed care enrollees in specific geographic regions, the 1996 CTS includes subjects who were uninsured, enrolled in Medicare managed care plans, fee-for-service plans with or without supplemental coverage, covered under military insurance or other public insurance programs. The breadth of the 1996 CTS sample allowed for hypothesis testing in both HMO and non-HMO subgroups of the Medicare program.

1.9. OPERATIONAL DEFINITIONS

The following provides a list of working definitions of key variables used or discussed in the following study.

Age. This variable represents the age, in years, of respondent. Age was used in model building, validation and hypothesis testing to estimate functional health literacy.

Education Level. This variable was constructed from the highest grade level or year of school completed. Education level was divided into five categories: college graduate (4 or more years of college); some college or technical school (1 to 3 years of college or post-high school education); high school graduate or equivalent (12 year grade equivalent or general education diploma equivalent); some high school (9 to 11 year grade equivalent); less than high school (less than 9 year grade equivalent). The college graduate category served as the reference group for the education level variable. Education level was used in model building, validation and hypothesis testing to estimate functional health literacy.

General Functional Literacy. This variable was defined in the 1992 NALS as using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential (Kirsch et al., 1993).

General Functional Document Literacy. This variable was defined in the 1992 NALS as the knowledge and skills required to locate and use information contained in materials that include job applications, payroll forms, transportation schedules, maps, tables, and graphs; for example, locating a particular intersection on a street map, using a schedule to choose the appropriate bus, or entering information on an application form (Kirsch et al., 1993).

General Functional Prose Literacy. This variable was defined in the 1992 NALS as the knowledge and skills needed to understand and use information from texts that include editorials, news stories, poems, and fiction; for example, finding a piece of information in a newspaper article, interpreting instructions from a warranty, inferring a theme from a poem, or contrasting views expressed in editorials (Kirsch et al., 1993).

General Functional Quantitative Literacy. This variable was defined in the 1992 NALS as the knowledge and skills required to apply arithmetic operations, either alone or sequentially, using numbers embedded in printed materials; for example, balancing a checkbook, figuring out a tip, completing an order form, or determining the amount of interest from a loan advertisement (Kirsch et al., 1993).

General Health Status. This variable represents the respondents self-reported general health status and was used as a covariate in hypothesis testing. General health status was reported in one of five categories: excellent; very good; good; fair; and poor. The poor category served as the reference group for the general health status variable. This variable definition was derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000).

Functional Health Literacy. This variable represents the constellation of skills, including the ability to perform basic reading and numerical tasks required to function in the health care environment (American Medical Association, Council on Scientific Affairs, Ad Hoc Committee on Health Literacy, 1999). For this research, the degree of functional health literacy was measured on a 100 point scale using the Brief Test of Functional Health Literacy (Baker, et. al., 1999). The functional health literacy scale is categorized into three levels: inadequate, $0<x\leq 53$; marginal, $53<x\leq 66$; and adequate functional health literacy, $66<x\leq 100$. Observed functional health literacy was used in model building and validation phases of this research. A synthetic estimate of functional health literacy derived from a multivariate regression model was the primary independent variable of interest in the hypothesis testing phases of this research. To evaluate the effect of inadequate functional health literacy, marginal and adequate functional health groups were combined and used as the reference group in hypothesis testing. To evaluate the effect of inadequate or marginal functional health literacy, adequate functional health literacy was used as the reference group.

Income. This variable was constructed from the total income for each census family. The variable was top-coded at $150,000 for confidentiality reasons. Derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000), income was dichotomized at $25,000 to approximate the median split used as a covariate in hypothesis testing with income >$25,000 serving as the reference group.

Influenza Vaccination (i.e., Flu Shot). This variable is defined by receipt of a flu shot within the past 12 months and is categorized as yes or no. It follows the guidelines set forth by the US

Preventive Services Task Force which recommends annual influenza vaccination the elderly population 65 years of age or older (US Preventive Services Task Force, 1996). Derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000), influenza vaccination within the past 12 months was used as a dependent variable in hypothesis testing.

Insurance Status. This variable is constructed from the type of insurance coverage reported by the respondent. Respondents are assigned to one of seven possible insurance categories: uninsured; Medicaid-only; military insurance; private-direct purchase; Medicare-HMO; Medicare plus Medigap or other public insurance; Medicare-only. Derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000), insurance status was used as a covariate in hypothesis testing. Medicare-only served as the reference group for this variable.

Mammography (Ever). This variable is defined by whether the female respondent ever received a mammography screening examination and is categorized as yes or no. Derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000), mammography (ever) was used as a primary dependent variable in hypothesis testing.

Mammography within past 2 years. This variable is defined by receipt of a mammography screening examination within the past two years and is categorized as yes or no for female respondents. Derived from the Community Tracking Study Codebook (Center for Studying

Health System Change, 2000), mammography within the past two years was used as a dependent variable in hypothesis testing for secondary analyses.

Mammography within past year. This variable is defined by receipt of a mammography screening examination within the past one year and is categorized as yes or no for female respondents. Derived from the Community Tracking Study Codebook (Center for Studying Health System Change, 2000), mammography within the past one year was used as a dependent variable in hypothesis testing for secondary analyses.

Race. This variable describes the race/ethnicity of the respondent. Race is categorized as White, Black or African-American, or Hispanic with White race being the reference group. White and Black Hispanics are grouped together. Other races, including Native Americans, Asians and Pacific Islanders, were not used in this research. Race was used in model building, validation and hypothesis testing to estimate functional health literacy.

Sex. Sex of respondent categorized as male or female with male sex being the reference group. Sex was used in model building, validation and hypothesis testing to estimate functional health literacy.

Usual Source of Care. A yes or no response to the question whether the respondent has a place where they usually go when they are sick or need advice about their health. Having a usual source of care was the reference group. Derived from the Community Tracking Study Codebook

(Center for Studying Health System Change, 2000), usual source of care was used as a covariate in hypothesis testing.

2. CHAPTER 2 - BACKGROUND AND SIGNIFICANCE

The increasing complexity of the healthcare system places greater cognitive demands on people than ever before. Obtaining necessary acute and preventive care requires navigating a system that expects a high level of understanding of written and numeric information. In its landmark report about disparities in health care, the Institute of Medicine expert committee concluded that "…low literacy skill is a significant obstacle to full access to effective medical care." (Smedley, Stith & Nelson, 2003). The American Medical Association has recognized that adequate functional health literacy is fundamental to the efficient use of the healthcare system for patients, providers, and payers (American Medical Association, Council on Scientific Affairs, Ad Hoc Committee on Health Literacy, 1999). In addition, Healthy People 2010 has incorporated as an objective the improvement of health literacy for persons with inadequate or marginal literacy skills (US Department of Health and Human Services, 2000).

As with any new field of investigation, the exploration into the domain of functional health literacy has suffered from a lack of consistent definition and measurement, suboptimal translation from research into practice, and generalizability. In defining and measuring health literacy, the focus has shifted from the readability of prose and document passages to word recognition and subsequently to reading comprehension and numeracy skills (Rudd, Moeykens, & Colton, 1999). Thus, the definition of the concept of health literacy has evolved from the focus on readability of materials to patient ability. While experiencing ongoing improvement, the instruments for measuring functional health literacy currently available still fail to capture many dimensions that influence functional health literacy including cultural and conceptual knowledge, listening and speaking skills (Nielson-Bohlman, et al., 2004). While the utility of current instruments for measuring functional health literacy has been demonstrated in research environments, the complexity, sophistication and time required for their administration in practice precludes their routine use in practice. Finally, most studies examining the prevalence of functional health literacy and its association with the processes and outcomes of health care have not used a population-based approach. Studies have been conducted in small regional samples, raising the question about their national generalizability.

The cascade of research into the prevalence and consequences of inadequate functional health literacy beginning in the 1990s has been summarized in a comprehensive review and published in the April 2004 report of the Institute of Medicine (IOM), "Health Literacy: A Prescription to End Confusion" (Nielson-Bohlman, et al., 2004). In general, the team of experts from the IOM team concluded that:

1. Functional health literacy is a multi-dimensional phenomenon involving reading, writing, numeric, listening, and speaking skills influenced by society, cultural beliefs, educational and health systems.
2. Inadequate functional health literacy is a widely prevalent problem and has the potential to significantly contribute to health care disparities.

Among its many recommendations, the IOM report proposed…

1. Development of uniform standards for measuring health literacy.
2. Public and private support for research into the causes and consequences of limited health literacy and development and use of culturally appropriate measures of health literacy.
3. Educators incorporate health-related tasks into lesson plans.
4. Professional schools incorporate health literacy into curricula.
5. Health-systems develop programs to reduce the negative consequences of limited health literacy.
6. Incorporation of health literacy standards into hospital and health-system accreditation standards.

The IOM report on the status of health literacy in America serves as the most current and authoritative summary to direct healthcare practice, policy and research initiatives related to health literacy. In lieu of repeating the findings of the IOM report, the following review of the literacy literature establishes the historical precedent for current health literacy research and identifies the key studies that have served as the impetus for the subsequent research study which serves to broaden the understanding of the relationship between functional health literacy and preventive health care utilization in a national sample of elderly.

2.1. GENERAL FUNCTIONAL LITERACY

The definition of general functional literacy has evolved over time from simply the ability to read or write into the concept of functional literacy: the ability to use printed and written information to function in society (Snyder, 1993; Kirsch, et al., 1993). Through World War I, the measurement of general functional literacy primarily was dependent on self-report, which was quite unreliable (Campbell, Kirsch & Kolstad, 1992). From 1920 through 1970, national estimates of literacy were commonly measured by educational attainment through school enrollment statistics and successful completion of school-based, standardized reading tests (Campbell, et al., 1992). Therefore, the ability to read or write was assumed to be linked with the level of academic education completed. A variety of grade levels have been proposed and used as criteria for which to classify people as literate or illiterate. In the 1970s, there was a movement to more competency-based national performance surveys to evaluate literacy, which included materials commonly encountered in everyday life (Campbell, et al., 1992).

The 1980s and early 1990s witnessed revision in the definition and assessment of literacy. It was no longer sufficient to simply read and/or write to be considered literate. Rather, the concept of functional literacy (i.e., the ability to use printed and written information to function in society) was introduced (Kirsch, et al., 1993). General functional literacy came to be considered and measured across a continuum of increasingly complex skills rather than a simple binary classification of literate and illiterate. General functional literacy is comprised of three sets of knowledge and skills: *prose literacy* (i.e., ability to understand and use information from texts such as editorials, news stories, poems, and fiction); *document literacy* (i.e., ability to locate and use information contained in materials such as job applications, payroll forms, transportation schedules, maps, tables, and graphs); and *quantitative literacy* (i.e., ability to apply arithmetic operations, either alone or sequentially, using numbers embedded in printed materials) (Kirsch, et al., 1993). The continuum of general functional literacy skills was divided into five levels representing differing degrees of information processing ability across the literacy continuum. To illustrate the continuum of general functional literacy skills, those with the lowest level of general functional prose literacy skills can typically identify one piece of information in a short article whereas those at the highest level of general functional prose literacy skills can summarize, compare and contrast a variety of information in a lengthy article.

The 1988 Adult Education Amendments tasked the Department of Education to generate a national profile of adult literacy proficiency in American (Kirsch et al., 1993). These amendments, along with the National Adult Literacy Act of 1991 spurred the development and implementation of the 1992 National Adult Literacy Survey (NALS) (Kirsch, et al., 1993). Using this new definition of general functional literacy, the 1992 NALS estimated that 40 to 44 million Americans performed at the lowest level of functional literacy with an additional 50 million at the second lowest level of functional literacy (Kirsch et al., 1993). Individuals with low levels of literacy were older, less educated, in lower level/lower paying jobs, poor, and members of ethnic or racial minorities (Kirsch, et al., 1993). Interestingly, the profile of those with low to moderate functional literacy fit the profile of population subgroups that have commonly come to be associated with higher risk for lower health status, worse medical care outcomes, and decreased access to medical care (Smedley, et al., 2003).

2.2. FUNCTIONAL HEALTH LITERACY

Interest in functional health literacy, defined as the ability to perform basic reading and numerical tasks required to function in the health care environment, has been a relatively recent phenomenon (American Medical Association, Council on Scientific Affairs, Ad Hoc Committee on Health Literacy, 1999). Early studies of health literacy in the 1970s and 1980s focused on the readability of healthcare-related documents (Rudd, Moeykens, & Colton, 1999). Generally, studies found that consent forms, patient package information leaflets for medications, discharge instructions, and disease-specific treatment and prevention materials were written at a grade-level of readability that was too sophisticated for the average adult.

2.2.1. RAPID ESTIMATE OF ADULT LITERACY IN MEDICINE

In the 1990s, assessment tools were developed to assess the capacity of individuals to read and understand health care related material. The Rapid Estimate of Adult Literacy in Medicine (REALM) was the first practical instrument to measure individual patient ability to read medical terms in the healthcare setting by asking patients to read a list of increasingly difficult medical terms (Davis, Crouch, Long, Jackson, Bates, et al., 1991; Davis, Long, Jackson, Mayeaux, George, et al., 1993). Using this list, the number of correctly pronounced words is used to map a patient to grade equivalent reading levels. In developing the REALM, one study used a longer version (i.e., 125 words) and found 59% of 207 adult ambulatory care patients scored below the ninth grade reading level (Davis, et al., 1991). In a subsequent study, using a shortened version of the REALM (i.e., 66 words), 73% of 203 predominantly black, female patients, scored below the ninth grade level (Davis, et al., 1993). Sixty patients with reading ability below the sixth grade level, as measured by the REALM, were interviewed and indicated they had difficulty navigating through the hospital, completing registration forms, following treatment instructions, and interacting with providers because of provider unwillingness to listen (Baker, Parker, Williams, Pitkin, Parikh, et al., 1996). Patients managed their difficulties with persistence, using surrogate readers, and relying on oral, rather than written, explanations. If treated negatively by healthcare providers, patients were unlikely to pursue further understanding.

The REALM has been used in a number of studies to estimate patient reading level and this body of research has been previously summarized (Nielson-Bohlman et. al., 2004). For the most part, samples for these studies were small, non-random and not population-based. Thus, it is difficult to determine the national prevalence of patient ability to read commonly used medical terms and its associated grade-equivalent reading level. Based on the available literature, the REALM has been used infrequently in the elderly population.

The REALM has also been used in a number of studies attempting to link patient ability to read commonly used medical terminology with various processes and outcomes of medical care (Nielson-Bohlman, et. al., 2004). As with the prevalence studies, study samples were not randomly selected or population-based, making it difficult to draw definitive conclusions about the association between reading level and the processes and outcomes of medical care. Generally, reading ability, as measured by the REALM, was positively associated with knowledge of disease and processes of care. In addition, those with higher levels of reading ability were more likely to initiate positive health practices such as sexually transmitted disease testing and breastfeeding.

2.2.2. THE TEST OF FUNCTIONAL HEALTH LITERACY IN ADULTS

The Test of Functional Health Literacy in Adults (TOFHLA) and a shortened version, the S-TOFHLA, were designed to provide a broader assessment of functional health literacy that addresses dimensions of reading comprehension and quantitative literacy (Parker, et al., 1995; Baker, et al., 1999). The TOFHLA uses three prose passages: (1) instructions for the preparation for an upper gastrointestinal series; (2) the patient rights and responsibilities section of a Medicaid application form; and (3) a standard hospital consent form to assess reading comprehension. Additionally, an assortment of hospital forms and prescription bottles are used to assess patient ability to comprehend such tasks as medication taking instructions, appointment schedules, blood pressure and glucose monitoring, and obtaining financial assistance.

For reading comprehension, patients are required to complete each of the passages in which words have been randomly deleted. Grounded in Gestalt psychological theory, comprehension is measured by the "cloze" procedure (i.e., the patient's ability to successfully fill in or "cloze" the missing words) (Taylor, 1953). The principles behind the "cloze" procedure include word association and the total language context. That is, if one understands the complete passage, they can complete the individual parts of the passage through word association, redundancy and understanding the whole. The fact that words are randomly deleted from the passage protects against selection bias for any one particular word in the passage. With respect to the assessment of quantitative ability, the patient is required to read and react to a given set of instructions and determine when to take the next dose of medication, when to appear for the next physician visit or determine whether a blood pressure or glucose reading is normal or abnormal. In contrast with the REALM, which measured patient ability to correctly read and pronounce medical terms, both long and short versions of the TOFHLA have been demonstrated to be reliable and valid measures of functional health literacy. The TOFHLA and S-TOFHLA are the primary instruments by which reading comprehension and numeracy skills are measured in the health care environment.

2.3. PREVALENCE OF INADEQUATE FUNCTIONAL HEALTH LITERACY

During the 1990s, two large studies were conducted to measure and characterize those population subgroups at risk of low functional health literacy. These studies have been considered the fundamental basis of our understanding of the magnitude of the problem of inadequate functional health literacy. In a sample of 2,659 predominantly indigent and minority patients at two urban, public hospitals, 35.1% of English-speaking and 61.7% of Spanish-speaking patients had inadequate to marginal literacy as measured by the TOFHLA, with higher rates (>80%) in the elderly (Williams, et al., 1995). Greater than 59% of study participants could not understand a consent document, 26% could not understand when their next appointment was scheduled, and 42% could not comprehend instructions for taking medication.

A second study of 3,260 elderly enrollees in a Medicare managed care health plan found that 34% of English-speaking and 54% of Spanish-speaking participants had inadequate or marginal literacy when measured with the S-TOFHLA (Gazmararian, et al., 1999). In addition, 27% of the respondents with inadequate literacy did not know the date of their next appointment, 48 – 54% did not understand basic prescription instructions depending on the task, and 68% could not interpret blood sugar levels for commonly used diabetes tests. Race, primary language, age, years of school completed, sex, occupation, cognitive impairment, and region were also associated with inadequate or marginal literacy. In a separate study using the same sample, each year increase in age was associated with a 0.9 point decrease ($p < 0.001$) in functional health literacy after controlling for demographic characteristics, performance on the Mini Mental State Examination (MMSE), chronic diseases, physical functioning, mental health, corrected visual acuity, and newspaper reading frequency (Baker, Gazmararian, Sudano & Patterson, 2000).

2.4. FUNCTIONAL HEALTH LITERACY, DISEASE KNOWLEDGE AND PROCESSES OF CARE

Inadequate functional health literacy, as measured by the TOFHLA and S-TOFHLA, has the potential to impair the processes of optimal health care delivery and self management of disease. In one study, hypertensive patients with adequate functional health literacy had significantly higher mean knowledge scores on a 21-item test of hypertension knowledge compared to those with marginal and inadequate functional health literacy (16.5 vs. 15.2 vs. 13.2, $p < 0.001$) (Williams, et al., 1998). Similarly, diabetic patients with adequate functional health literacy attained significantly higher diabetes knowledge scores on a 10-item test of knowledge compared to those with inadequate functional health literacy (8.1 vs. 5.8, $p<0.001$). In a subsequent study of Medicare enrollees, multivariate analysis revealed that patients with one of four chronic diseases (i.e., asthma, congestive heart failure, diabetes, or hypertension) and inadequate functional health literacy were significantly less knowledgeable about their chronic disease than those with adequate functional health literacy (Gazmararian, et al., 2003). For each 10 point increase (i.e., improvement) on the 100 point functional health literacy scale, the percentage correct increased by 2.4% on the 20-item asthma test ($p<0.001$), 2.2% on the 11-item diabetes test ($p<0.001$), 1.6% on the 16-item heart failure test ($p=0.003$), and 1.3% on the 25-item hypertension test ($p<0.001$) after adjusting for age, disease duration, and prior attendance at a chronic disease class.

Inadequate functional health literacy also serves as a barrier to physician-patient communication. In a study of diabetic patients, those with inadequate functional health literacy were more likely to report decreased clarity (adjusted OR=6.29, $p<0.01$) as well as decreased explanation of condition (adjusted OR=4.85, $p=0.03$) and processes of care (adjusted OR=2.7, $p=0.03$) when communicating with their physician compared to those with adequate functional health literacy after adjusting for age, sex, race, education, insurance, patient language, HbA1c, treatment regimen, depression score, years with diabetes, length of time in physician's care, patient report of physicians' Spanish ability, and accounting (Schillinger, et al., 2004). This communication gap may be widened by the stigma associated with low functional health literacy. In a study evaluating the relationship between functional health literacy and shame, 39.7% of patients with low functional health literacy, who admitted having trouble reading, admitted shame. In addition, more than two-thirds (67.2%) did not discuss their reading difficulty with their spouse and more than half (53.4%) did not tell their children about their reading problem (Parikh, et al., 1996).

Inadequate functional health literacy also has the potential to impair the instructions for optimal care. For example, using an adapted TOFHLA, human immunodeficiency virus (HIV) patients with lower literacy were more likely to be non-adherent with their antiretroviral medication regimen (Kalichman, et al., 1999). Those who scored less than 86% on the modified reading comprehension component from the adapted TOFHLA were 3.9 times more likely to be non-adherent with their antiretroviral medications within the past two days compared to those who scored 86% or greater after adjusting for age, ethnicity, income, education, HIV symptoms, alcohol use, other drug use, social support, emotional distress, and provider attitudes.

2.5. FUNCTIONAL HEALTH LITERACY, HEALTH STATUS AND HEALTH SERVICES UTILIZATION

The TOFHLA and S-TOFHLA have been used to explore the relationships between functional health literacy, health status, and various aspects of health services utilization. While restricted to non-random, non-population-based studies, the body of evidence describing the relationship between inadequate functional health literacy and sub-optimal use of health care services continues to build.

One thousand six hundred eighty (1,680) patients presenting to emergency care and walk-in medical clinics with non-urgent medical problems at two public hospitals (one in Atlanta and one in Los Angeles), were administered the TOFHLA and a questionnaire about health status and previous health services use (Baker et al., 1997). English and Spanish-speaking patient subgroups in Los Angeles and all patients in Atlanta with inadequate functional health literacy were significantly more likely to report poor health status (OR(s) =2.19, 1.72, and 2.12, respectively) compared to those with adequate functional health literacy after adjusting for age, gender, race, and socioeconomic status. Inadequate health literacy was not significantly related to the use of ambulatory care in any patient subgroup in Los Angeles or Atlanta. Patients in the

Atlanta sample with inadequate functional health literacy were more likely (OR=1.53) to report being hospitalized during the previous year compared to those with adequate functional health literacy.

Another study with a convenience sample of 958 patients presenting to an emergency department at a public hospital in Atlanta found that the patients with inadequate functional health literacy (measured using the TOHFLA) were significantly more likely to be hospitalized (OR=1.69) compared to those with adequate functional health literacy after adjusting for age, gender, race, health status, insurance status and various indicators of socioeconomic status (Baker et al., 1998). The relationship between functional health literacy and hospital admission was even stronger in patients who had a prior hospitalization. Those with inadequate functional health literacy who reported a hospital admission during the year prior to study enrollment were significantly more likely to be hospitalized than those with adequate functional health literacy who were hospitalized during the previous year (OR=3.15) (Baker et al., 1998).

In a medical claims analysis, those with inadequate functional health literacy measured using the S-TOFHLA were significantly more likely to be hospitalized compared to those with adequate functional health literacy (OR=1.29) after adjusting for age, sex, race/ethnicity, language, years of school completed, and income in a sample of 3,260 enrollees in a Medicare managed care plan (Baker et al., 2002). Most recently, those with inadequate functional health literacy, as measured by the S-TOFHLA, were significantly less likely to have tight glycemic control (OR=0.57), significantly more likely to have poor glycemic control (OR=2.03) and have significantly higher rates of retinopathy (OR=2.33) compared to those adequate functional health literacy in a cross-sectional sample of 408 English and Spanish speaking patients attending public health clinics in San Francisco after adjusting for sociodemographic characteristics, depressive symptoms, social support, treatment regimen and years with diabetes (Schillinger, et al., 2002).

2.6. LITERACY, HEALTH STATUS AND MEDICAL COSTS

With inadequate functional health literacy being associated with impaired processes of care and increased utilization of health care services, it would be expected that excess costs would follow the same pattern. However, there is little empirical evidence to confirm this suspicion.

Using the Tests of Adult Basic Education to estimate grade-equivalent reading level and the Sickness Impact Profile (SIP) researchers evaluated the relationship between reading level and health status (Weiss, Hart, McGee & D'Estelle, 1992). This correlational study revealed that reading level was an independent predictor of physical, psychosocial, and overall health after adjusting for age, sex, ethnicity, marital status, insurance status, occupation, and income in 193 randomly selected persons from an Adult Education Program in Arizona. Specifically, those individuals who read at or below the 4^{th} grade level had significantly higher SIP physical scores (6.2 vs. 2.3, p=0.002), SIP psychosocial scores (15.4 vs. 8.0, p=0.02) and SIP overall scores (10.4 vs. 6.0, p=0.02) compared to those who read above the fourth grade level, indicating worse health status. In a randomly selected sample of 402 Medicaid enrollees, researchers used the Instrument for the Diagnosis of Reading and computerized billing records for physician services, inpatient, and outpatient medical care over one year to estimate the relationship between grade-equivalent reading level and aggregate charges for medical care (Weiss, Blanchard, McGee, Hart, Warren, et al., 1994). Reading level was not a significant predictor of medical care charges (R^2=0.0016; p=0.43). Both of these studies had small sample sizes, used highly selected samples, and lacked consistency with regard to the measurement of reading level. It is important to note that both studies measured reading level, not functional health literacy.

In the recent IOM report on health literacy, a simulation model was developed to estimate health care spending for elderly adults expected to have inadequate functional health literacy compared to those that have adequate functional health literacy (Nielson-Bohlman, et. al., 2004). In multivariate analyses controlling for sex, age, income, schooling, smoking, alcohol consumption, physical and mental status, and chronic conditions, there was no difference between inpatient, outpatient, and pharmacy costs for those estimated to have inadequate functional health literacy compared to those with adequate functional health literacy ($p>0.05$) (Nielson-Bohlman, et al., 2004). However, those with inadequate functional health literacy had significantly higher emergency room costs (mean difference = \$51, $p<0.05$) compared to those with adequate functional health literacy.

2.7. FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE UTILIZATION

A study of Medicare managed care enrollees found that inadequate functional health literacy was significantly associated with failure to receive basic preventive services such as ever having an influenza or pneumococcal vaccine (Scott et al., 2002). In multivariate analyses controlling for demographic characteristics, education level, income, number of physician visits and health status, individuals with inadequate functional health literacy had an odds of not ever receiving a flu shot that was 1.4 times greater than individuals with adequate functional health literacy (OR=1.4, 95% CI (1.1 – 1.9)). Individuals with inadequate functional health literacy had an odds of not ever receiving a pneumococcal vaccination that was 1.3 times greater than individuals with adequate functional health literacy (OR=1.3, 95% CI (1.1 – 1.7)). Women with inadequate functional health literacy had odds of not receiving a mammogram within the past two years and ever having a Papanicolaou smear that were 1.5 times (OR=1.5, 95% CI (1.0 – 2.2)) and 1.7 times (OR = 1.7, 95% CI (1.0 – 3.1)) greater than individuals with adequate functional health literacy, respectively (Scott et al., 2002). Although age, race and education were previously found to be associated with functional health literacy, when combined with functional health literacy in multivariate analyses as predictors of preventive health care utilization, education level was not associated with preventive health care utilization in this research. The odds of African-Americans never receiving influenza or pneumococcal vaccinations were 1.6 times (OR=1.6, 95% CI (1.2 – 2.2)) and 2.3 times (OR=2.3, 95% CI (1.7 – 3.0)) greater than White individuals. A similar significant relationship was found for Hispanics compared to Whites for both influenza vaccination and pneumococcal vaccination. No statistically significant associations between race and not having a mammogram within the past two years or never having a Papanicolaou smear were identified. Odds of individuals who were [70 to 74] and [75 to 79] years of age never having a pneumococcal vaccination were 0.7 (OR=0.7, 95% CI (0.6 – 0.8)) and 0.6 times (OR=0.6, 95% CI (0.5 – 0.8)) that of individuals who were [65 to 69] years of age. Increased age was not associated with receipt of a flu shot, mammogram or Papanicolaou smear.

In this research (Scott et al., 2002), specifications of the dependent variables may have limited its application and may have influenced the results. For example, the dependent variable, influenza vaccination, was specified as "never" having received a flu shot. However, the standard recommendation for receipt of a flu shot is annually for all persons aged 65 and over (US Preventive Services Task Force, 1996). Furthermore, there is insufficient evidence to recommend routine mammography screening beyond 70 years of age (US Preventive Services Task Force, 1996). Recent mammography experience within the past one or two years may inherently differ for those individuals $\leq$ 70 years of age compared to those greater than 70 years of age simply based on the guidelines set forth. Thus, specification of mammogram utilization within the past two years does not reflect the mammography screening experience for the study sample comprised of 65 to 80 year old women, the age of the women sampled in this study. Because health literacy is a culmination of a lifetime experience, perhaps the dependent variable, mammogram screening, should be specified to reflect a lifetime experience. Thus, "never" having received a mammogram may be the more optimal specification rather than mammography within the past two years. Finally, the narrow sample selection in this study (i.e., Medicare managed care enrollees) may not represent the entire Medicare population with respect to prevention behavior. For example, the odds of having a mammogram or Pap smear within the past year, or a flu shot during the past flu season for Medicare HMO enrollees was 1.36, 1.29 and 1.29 times that of the employer-sponsored fee-for-service enrollees ($p<0.05$), even after controlling for sociodemographics, health behaviors, health status and health functioning (Greene, Blustein & Laflamme, 2001).

2.8. DEMOGRAPHIC VARIATIONS IN PREVENTIVE HEALTH CARE UTILIZATION

2.8.1. INFLUENZA VACCINATION IN THE ELDERLY

Using data from the 1996 Medicare Current Beneficiary Survey (MCBS), bivariate analyses revealed statistical associations between age, sex, race and receipt of a flu shot during the past flu season ($p<0.05$). Higher proportions of individuals with an age 75 to 84 years (68.8%), 85 years of age or older (67.3%), males (64.9%), White (67%), high school (64.4%) or college educated (71.2%) received a flu shot during the previous flu season compared to those 64 to 75 years of age (60.9%), female (64%), Black (45.2%), Hispanic (52.6%) or "Other" minority group (58.6%), and less than a high school education (55.1%) (Greene, et al., 2001).

Consistent with these findings are the results of another study that used data on those 65 years of age and older from the 1996 Medicare Expenditure Panel Survey to describe characteristics associated with preventive health care utilization (Carrasquillo, Lantigua & Shea, 2001). In this study, multivariate analyses that included race, functional status, education, age and insurance type revealed that being Black (beta=-0.72, $p<0.01$) and having a high school education or lower (beta=-0.62, $p<0.01$) were inversely associated with receiving a flu shot within the past year. Increased age in years (beta=0.02, $p<0.05$) was directly associated with receiving a flu shot during the past year.

2.8.2. MAMMOGRAPHY SCREENING IN THE ELDERLY

Using data from the 1996 Medicare Current Beneficiary Survey (MCBS), bivariate analyses revealed significant statistical associations between age, education and receipt of a mammogram during the previous year ($p<0.05$). Higher proportions of individuals 64 to 75 years of age (50.4%) and college educated (50.5%) had received a mammogram during the previous year compared to those 75 to 84 years of age (38.6%), 85 years of age or greater (21.4%), high school educated (43.2%) or less than a high school educated (31.2%) (Greene, et al., 2001). Race was not significantly associated with receipt of a mammogram within the previous year.

Another study used data on those 65 years of age and older from the 1996 Medicare Expenditure Panel Survey to describe characteristics associated with preventive health care utilization (Carrasquillo, et al. 2001). In this study, multivariate analyses that included race, functional status, education, age and insurance type revealed that having a high school education (beta=-0.57, $p<0.01$), less than a high school education (beta=-0.61, $p<0.05$) and increased age in years (beta=-0.08, $p<0.05$) was inversely associated with having received a mammogram within the past two years. In contrast with receipt of a flu shot, increased age was associated with a decreased likelihood of receiving a mammogram during the past two years. In this study, being Black (beta=0.16, $P>0.05$) or Hispanic (beta=0.24, $p>0.05$) was not significantly associated with receipt of a mammogram within the past two years.

2.9. SUMMARY AND SIGNIFICANCE OF THE PROPOSED STUDY

In independent studies, socio-demographic characteristics have been linked to both functional health literacy and preventive health care utilization. The high prevalence of inadequate functional health literacy has been documented in the Medicare managed care population. In addition, research has provided evidence that inadequate health literacy is related to poor use of preventive health care utilization in the Medicare managed care population. Unfortunately, narrow sample selection, limited study location, and reported regional variation in results suggest that a more broadly applicable sample be tested to enhance the generalizability of the results. In addition, specification of the measures of influenza vaccination and mammography should be consistent with current recommendations for care. Questions remain whether functional health literacy, in part, explains demographic differences in preventive health care utilization. In the absence of a nationally representative dataset that includes measures of demographic characteristics, functional health literacy and preventive health care utilization, additional research and methods are needed to estimate and document the impact of inadequate health literacy on preventive health care utilization across the entire elderly population $\geq$ 65 years of age.

The study proposed henceforth contributes to the body of health literacy research in a number of important ways. First, it will be the first to develop and validate a model to calculate synthetic estimates of functional health literacy derived from commonly collected demographic variables. This method will enable researchers to generate estimates of functional health literacy for different populations using a variety of secondary data sets. Future research can use this modeling strategy to target resources for primary data collection. Synthetic estimates of functional health literacy will make it possible to customize and target educational programs to the appropriate literacy skill level and to study the impact of policy directives such as the National Medicare Education Program.

A second contribution of the proposed research involves estimating the relationships between the synthetic estimate of functional health literacy and preventive health services utilization in a nationally representative sample of Medicare-eligible elderly. Because model predictors (i.e., age, race and education) have been linked to both literacy and preventive health care utilization, the proposed research will compare the differences between two independent models. One model will evaluate the direct relationship between an immutable set of demographic variables and preventive health care utilization. A second model will assess the relationship between a synthetic estimate of functional health literacy, a latent characteristic derived from the immutable demographic variables, and preventive health care utilization.

Finally, by using a nationally representative data set, the 1996 CTS, the proposed research will broaden the generalizability of prior research evaluating the relationship between functional health literacy and preventive health care utilization, which was limited to the Medicare managed care sector in specific geographic regions. The 1996 CTS includes subjects who participated within and outside of Medicare managed care plans allowing for hypothesis testing in both the traditional and managed care subgroups of the Medicare program.

3. CHAPTER 3 - RESEARCH DESIGN AND METHODS

3.1. SPECIFIC AIMS

This research used data from three existing datasets to evaluate the relationship between a synthetic estimate of functional health literacy and preventive health care utilization in a nationally representative sample of elderly beneficiaries $\geq$ 65 years of age. This study had three specific aims:

1. To develop a valid and reliable predictive model to estimate functional health literacy from the largest available sample of elderly $\geq$65 years of age that directly documented functional health literacy.
2. To evaluate the construct validity of the synthetic estimate of functional health literacy derived from the predictive model in a separate nationally representative sample of elderly $\geq$65 years of age.
3. To test the relationship between the synthetic estimate of functional health literacy and preventive healthcare utilization in a nationally representative sample of non-institutionalized elderly $\geq$65 years of age.

The first specific aim involved the development and validation of a predictive model. This predictive model for functional health literacy was constructed using data from the Medicare Health Literacy Study (MHLS). The model's predictive accuracy was assessed. The second specific aim involved expanding the generalizability of the derived functional health literacy model. The predictive model for functional health literacy derived from the MHLS was used to compute a synthetic estimate of functional health literacy in the 1992 National Adult Literacy Survey (NALS) sample. Correlations between the synthetic estimate of functional health literacy and reported general functional prose, document and quantitative literacy were computed to establish construct validity of the synthetic estimate of functional health literacy in a national representative data set. It was expected that there would be a moderate to strong association between the synthetic estimate of functional health literacy and reported general functional prose, document and quantitative literacy in the 1992 NALS. For the third specific aim, the predictive model was also used to compute a synthetic estimate of functional health literacy in the 1996 Community Tracking Study (CTS) dataset. To generate national estimates, the relationships between the synthetic estimate of functional health literacy and not receiving a flu shot within the past 12 months; not having a mammogram within the past one year, two years, or ever were tested using the 1996 CTS dataset while controlling for covariates.

3.2. CONCEPTUAL MODEL

The decision to pursue acute health care services is often catalyzed by the presentation of a constellation of symptoms. For example, chest pain from a myocardial infarction or pain from a broken hip may stimulate action to seek emergency health care. Although requiring an individual to connect a set of symptoms and the need to seek care, the need to seek acute care services is often made apparent through the manifestation of symptoms. Contrasted with those who are generally healthy and without symptoms, the need to pursue preventive health care services may be more abstract and less apparent than the need for acute care services. To optimize preventive health care utilization, an individual must comprehend their level of risk and act according to currently accepted recommendations (US Preventive Services Task Force, 1996). Preventive health care information is provided through a variety of sources (e.g., public service announcements, medical providers, public health organizations and health insurers) in written and oral format and across a number of venues and requires interpretation and action. An adequate level of functional health literacy is, therefore, fundamental to understanding and processing most messages about preventive health care. In 1995, the approximate historical time frame for data collection in this study, state-specific estimates of men and women ≥ 65 years of age who had received a flu shot within the previous 12 months ranged from 46.2% to 70.3% (Centers for Disease Control and Prevention, 1997). The proportion of women ≥ 65 years of age who had received a mammogram during the previous two years ranged from 52.7% to 80.4% (Centers for Disease Control and Prevention, 1997). The evidence that preventive health care utilization, in general, remains less than complete for the elderly raises the question as to whether they can read, comprehend and act properly on educational efforts related to prevention.

Sex, age, race/ethnicity, and education have been empirically linked to functional health literacy (Gazmararian, et al., 1999) and preventive health care utilization (Greene et al., 2001) in the elderly in separate research studies. However, when education and functional health literacy were measured together and evaluated in the same study using multivariate analyses, only functional health literacy, race and sex were identified as significant predictors of ever having a flu shot in a Medicare managed care sample of elderly beneficiaries between 65 and 80 years of age (Scott, et al., 2002). Furthermore, only functional health literacy remained a significant predictor of having a mammogram within the past two years when used together with age, race and education in multivariate analyses (Scott, et al., 2002). Due to the differences in the sample composition for the study of functional health literacy and prevention (Scott, et al., 2002), and the study of independent characteristics and preventive health care utilization (Greene, et al., 2001), the origin of this discrepancy is not known. Questions remain as to whether demographic disparities associated with preventive health care utilization are explained or mediated, in part, through functional health literacy and/or whether the differences in study samples explain these findings. In addition, national estimates about the relationship between functional health literacy and preventive health care utilization remain unknown.

The relationship between key demographic characteristics (i.e., age, race/ethnicity, education, and sex), functional health literacy and preventive health care utilization can be conceptualized and tested in a variety of ways. The ideal model would simultaneously measure and test the relationships between demographic characteristics and functional health literacy; demographic characteristics and preventive health care utilization; as well as functional health literacy and preventive health care utilization. This specification would allow for the assessment of the intervening or moderating role of literacy between demographic characteristics and preventive health care utilization. To test this scenario, a dataset that directly measures all variables of interest would be necessary. Unfortunately, no nationally representative dataset that measures all variables of interest exists and therefore precludes the implementation of the ideal model.

The proposed conceptual model (Figure 3-1) is a modification of the Behavioral Model of Health Services Utilization (Aday & Andersen, 1974; Aday, et al., 1980). The traditional model posits that an individual's predisposing, enabling, and need characteristics influence the use of healthcare services. Within the traditional model, predisposing characteristics of the individual such as age, sex, race and ethnicity are considered immutable, while others such as health beliefs, knowledge, education and occupation are thought to be mutable. However, in the elderly, education and occupation are more likely to be immutable or stable. If functional health literacy empowers people to seek and obtain necessary preventive care when appropriate, it would then be expected that low levels of functional health literacy can create a barrier to access and lead to sub-optimal use of preventive health care services. As previously demonstrated in the Medicare managed population, inadequate functional health literacy is associated with decreased use of preventive health care (Scott et al. 2002). This research introduces a synthetic estimate of functional health literacy into the conceptual model shifting the emphasis from a group of predisposing, immutable predictor variables to a latent construct, functional health literacy, which is hypothesized to be an independent predictor of preventive healthcare utilization, while controlling for the effect of enabling factors (i.e., income, type of insurance coverage, and usual source of care) and a need factor (i.e., general health status).

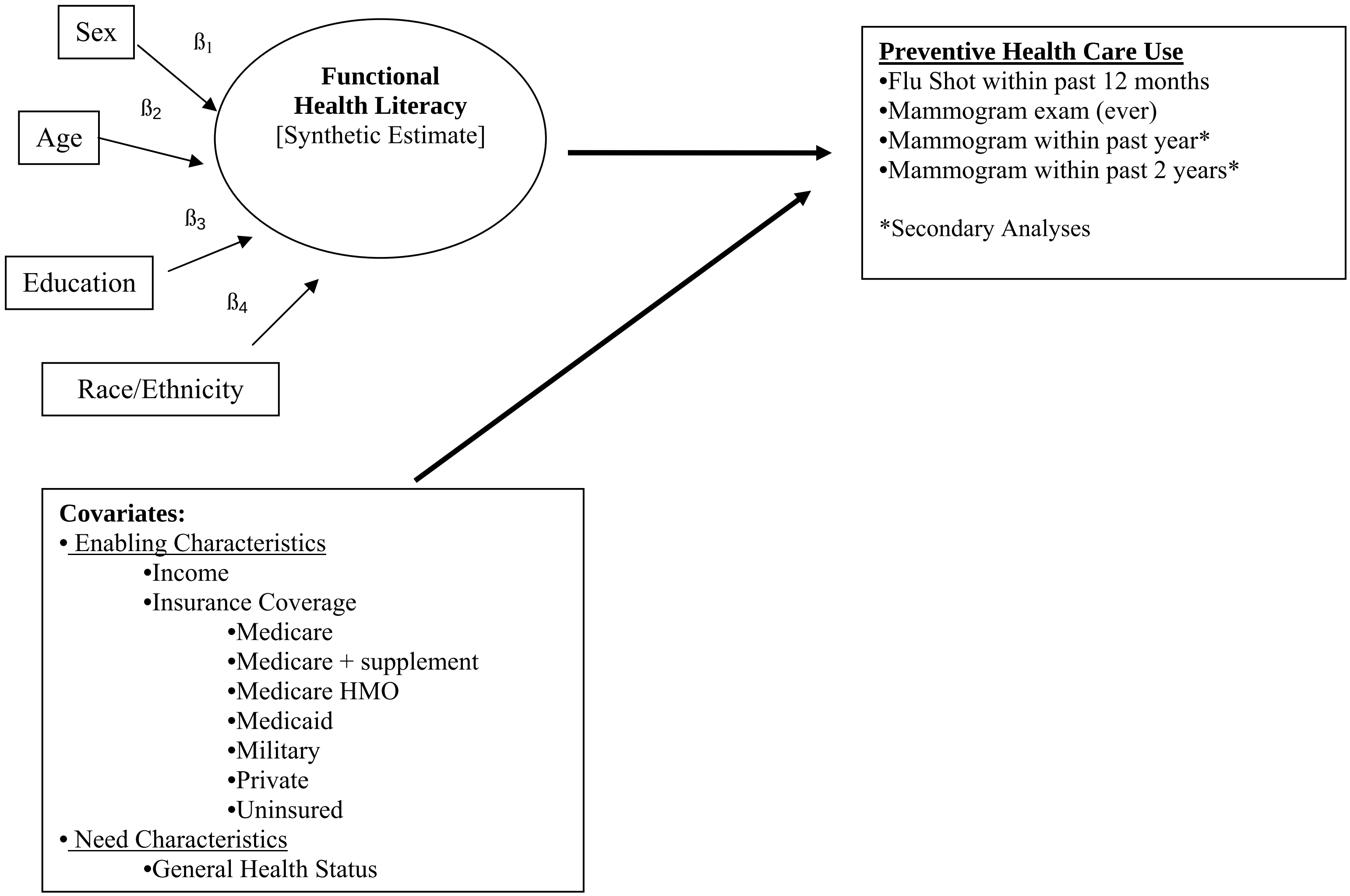

Figure 3-1 Conceptual Model

Consistent with the traditional behavioral model of health services utilization, the relationships between sex, race/ethnicity, education, age and preventive health care utilization were also tested without the synthetic estimate of functional health literacy while controlling for the enabling and need covariates. The results of the testing of the proposed conceptual model and traditional model were compared to assess differences in explanatory power. In addition, the results were compared with previously published research (Greene, et al., 2001; Carrasquillo, et al., 2001; Scott et al., 2002) to investigate the consistency of results.

3.3. HYPOTHESIS TESTING

Two primary non-directional hypotheses were tested to determine the relationship between the synthetic estimate of functional health literacy and two proposed dimensions of preventive healthcare utilization: (1) influenza vaccination within the past 12 months; and (2) ever having a mammography screening examination.

3.3.1. HYPOTHESIS #1: FUNCTIONAL HEALTH LITERACY AND FLU SHOT WITHIN THE PAST 12 MONTHS

In previous research, Medicare managed care enrollees with inadequate functional health literacy had significantly greater odds of never receiving a flu shot (Scott et al., 2002). The pervasiveness of this relationship across a nationally representative population, 65 years or older, is unknown. Thus, it was hypothesized, in null form, that there is no relationship between the synthetic estimate of functional health literacy and not receiving a flu shot within the past 12 months. In contrast with the previous research, the dependent variable, flu shot within the past 12 months, was chosen because of its consistency with the US Preventive Services Task Force Guidelines for influenza vaccination (US Preventive Services Task Force, 1996) as well as its availability in the 1996 CTS.

3.3.2. HYPOTHESIS #2: FUNCTIONAL HEALTH LITERACY AND RECEIPT OF A MAMMOGRAM "EVER"

In previous research, Medicare managed care enrollees with inadequate functional health literacy had significantly greater odds of not receiving a mammogram within the previous two years (Scott et al., 2002). For this research, it was hypothesized, in null form, that there is no relationship between the synthetic estimate of functional health literacy and never having received a mammogram. Functional health literacy may, in part, be a function of the cumulative health care experience over a lifespan. In contrast with previous research, "never" receipt of a mammogram was chosen as the primary dependent variable for this research because it reflects a specification of mammography screening experience that is consistent with the lifetime experience. In addition, the US Preventive Services Task Force Guidelines indicate that there is insufficient evidence to recommend routine mammography screening beyond 70 years of age (US Preventive Services Task Force, 1996). Thus, recent mammography experience within the past one or two years may inherently differ for those individuals $\leq$ 70 years of age compared to those greater than 70 years of age. To restrict or stratify the sample by age groups would severely limit study power. The relationships between the synthetic estimate of functional health literacy and mammography screening within the past one and two years were explored in secondary analyses.

3.4. STUDY DESIGN

Cross-sectional data were used to estimate and validate a predictive model for functional health literacy from common demographic characteristics (i.e., sex, age, education and race/ethnicity). To test the proposed hypotheses, an analytical cross-sectional design was used to examine the statistical association between the synthetic estimate of functional health literacy and each of the measures of preventive health care utilization.

3.5. DATA

Data for the proposed study were derived from three existing independent data sets: the MHLS; the 1992 NALS; and the 1996 CTS Household Survey.

3.5.1. MEDICARE HEALTH LITERACY STUDY (MHLS)

A predictive model of functional health literacy was derived from data collected in the only known multi-site study of functional health literacy in the Medicare-eligible population, (a.k.a., MHLS) (Gazmararian et al, 1999). The MHLS conducted in-person interviews with a consecutive sample of 3,260 new Medicare managed care enrollees of a large national health insurer in four geographic regions (Cleveland, OH; Houston, TX, Tampa, FL; Ft. Lauderdale-Miami, FL). Individuals who were not comfortable speaking English or Spanish, were blind, lived in a nursing home, or demonstrated severe cognitive impairment were excluded. To provide access to the MHLS data, a data use agreement with the Prudential Center for Health Care Research was executed with the assistance of Julie A. Gazmararian, Ph.D., a consultant to the study. A copy of the data use agreement is provided in Appendix A.

Functional health literacy in the MHLS was measured on a scale of zero to 100 using the brief test of functional health literacy. The functional health literacy score derived from the brief test of functional health literacy can be categorized using externally validated cut-points (i.e., Inadequate Functional Health Literacy, $0 < x \leq 53$; Marginal Functional Health Literacy, $53 < x \leq 66$; Adequate Functional Health Literacy, $66 < x \leq 100$), to allow for the placement of respondents into one of the three categories (Baker et al., 1999). Data management, descriptive analyses and functional literacy model development in the MHLS were performed using Stata 7.0 (StataCorp, 2001).

3.5.1.1. DATA CLEANING AND PREPARATION

Of the 3,260 respondents to the Medicare Health Literacy Study (MHLS), 17 respondents refused to answer questions about their education or race or had missing data on these variables for some unknown reason. These respondents were excluded from the analytical file since race and education variables are critical predictor variables in the building of the functional health literacy model, leaving a remaining sample of 3,243 respondents. There were no missing data for questions related to age or sex. A randomly generated indicator variable was created in the data set for partitioning the MHLS data into two sub samples (i.e., SS1=1,632 and SS2=1,628). Sub-sample 1 was used for model development and selection whereas the second sub-sample, SS2, was used for model validation including an assessment of model reliability and predictive accuracy.

Only 1.05% (n=34) of the respondents had their race variable coded as “other”. The “other” race category included respondents of Asian descent as well as other races that were not White, Black or Hispanic. The small sample size and racial mix of the "other" race category may lead to unstable coefficient estimates and may be potentially difficult to interpret. Thus, the "other" race category was excluded from model building, validation, and hypothesis testing in this research. After excluding "other" race, 3,209 respondents remained in the analytical sample and were used for subsequent analyses.

The variable, income, was excluded from the health literacy model building for two primary reasons. First, the large amount of missing data for the income variable (i.e., 16%) would substantially reduce the sample size if respondents without a populated income variable were excluded. Second, income questions are asked differently across different studies, calling into question the comparability of the data generated from items related to income. For example, in the MHLS, household income was defined as "…any money from work, interest, and dividends or any other source of income." (Gazmararian et al., 1999) Whereas, in the Community Tracking Study household income was defined as "…wages and salaries from jobs, net income from farms or businesses, interest or dividends, pensions or social security, income from rental property, estates, or trust, public assistance or welfare, social security, child support, and other sources." (Center for Studying Health System Change, 2000) The CTS specifically requested household income prior to taxes and other deductions. The lack of consistency with income-related questions raised concerns about the comparability of the data they generate.

The demographic variables sex, race/ethnicity, education level and age were used in subsequent analyses as independent predictor variables of functional health literacy. For analysis, sex was treated as a dichotomous variable (female and male) with male being the reference group.

Race/ethnicity was treated as a three level categorical variable (White, Black, and Hispanic) with White being the reference group. Education level was treated as a five level categorical variable (college graduate or higher, some college, high school graduate or equivalent, some high school, or less than high school) with college graduate being the reference group. Age was treated as a continuous variable and was top-coded at 91 years to ensure comparability with the Community Tracking Study data set. That is, all respondents whose age exceeded 91 years had the age variable recoded to 91 years of age. Variables representing all two-way, three-way and four-way interaction terms among the sex, race, education and age variables were also constructed.

3.5.2. 1992 NATIONAL ADULT LITERACY SURVEY (NALS)

Data from the 1992 NALS were used to assess the construct validity of the synthetic estimate of functional health literacy. Conducted by the Department of Education, the 1992 NALS used a national, four-stage stratified random sample of 13,591 adults at least 16 years of age to ascertain the level of functional prose, document, and quantitative literacy in the United States (Kirsch et al., 2001). Participants were interviewed in their homes. A separate state-specific sample added 11,353 respondents for a total of 24,944 respondents. The sample excluded children under 16 years of age and adults not residing in either private households or college dormitories. Blacks and Hispanics were over sampled to ensure adequate representation. The data are publicly available from the National Center for Education Statistics.

Three dimensions of general functional literacy were assessed in the NALS: prose, document, and quantitative literacy. Each dimension of general functional literacy was measured over a continuum of increasingly complex, dimension-representative tasks. To ensure a wide range of literacy skills assessment while minimizing respondent burden, the 1992 NALS used a variant matrix sampling technique in which individual respondents answered only a subset of the available questions. Applying principles of item response theory, individual item responses, item parameter characteristics and various background (i.e., “conditioning”) variables were combined to estimate a posterior distribution for each dimension of literacy proficiency. Five literacy estimates were imputed from the posterior distribution of literacy proficiency for each respondent based on their common background characteristics and represent the “plausible values” for each literacy dimension. Plausible values are not individual test scores and are biased estimates of individual proficiency. However, the plausible values represent valid, unbiased population estimates of literacy proficiency. Each survey participant in the 1992 NALS has five imputed estimates or “plausible values” for each dimension of general functional literacy proficiency (i.e., prose, document, and quantitative literacy) ranging on a continuum from zero to 500. The 1992 NALS developed numerical cut points to categorize respondents into 5 levels of proficiency on each dimension of literacy, ranging from Level I (basic skills) to Level V (complex skills). Each level is defined in terms of specific tasks the individual is capable of, reflecting the external validity of the scale.

The 1992 NALS was used to establish the construct validity of the synthetic estimate of functional health literacy by assessing the direction and magnitude of association of the synthetic estimate of functional health literacy with each dimension of general functional literacy. A strong, positive relationship between the synthetic estimate of functional health literacy and the observed measures of general functional prose, document and quantitative literacy was expected. All data management, descriptive analyses, functional literacy estimation, and bivariate analyses were performed using Stata 7.0 (StataCorp, 2001). To ensure stable, nationally representative population estimates of construct validity, the recommended stratification, sampling, and final weighting variables were used for all descriptive and bivariate analyses.

3.5.2.1. DATA CLEANING AND PREPARATION

Of the 24,944 respondents to the 1992 National Adult Literacy Survey (1992 NALS) between 16 and 99 years of age, 22,745 were excluded because their age was less than 65 years and nine were excluded because their age was missing. An additional eleven respondents were excluded because they did not report their level of education, did not know their level of education or reported being still in high school. Thirty-three respondents were excluded because their race was not White, Black or Hispanic. An additional two respondents were excluded because their sex was not reported. After exclusions, the remaining analytical sample included 2,144 respondents greater than 65 years of age with complete data on their sex, race, education and age variables.

3.5.3. 1996 COMMUNITY TRACKING STUDY (CTS).

The 1996 CTS is a nationally representative, longitudinal household telephone survey administered by the Center for Studying Health System Change and represents approximately 60,446 civilian, non-institutionalized individuals (Kemper, et. al, 1996). Generating responses from 60 different primary sites and a random supplemental sample from the 48 states in the continental United States, a three-tier sampling design was used to develop and track community-level and national estimates of health care access, satisfaction, use of services, insurance coverage, health status and socio-demographic characteristics.

For this research, the 1996 CTS dataset was primarily used for the hypothesis testing. The synthetic estimate of functional health literacy was computed for the 1996 CTS respondents. The relationships between the synthetic estimate of functional health literacy and self-reported receipt of a flu shot within the past 12 months and ever having received a mammogram were tested while controlling for enabling and need covariates consistent with the modified Behavioral Model of Health services Utilization. The CTS data includes imputed responses for the education, race, income, general health status and Medicare HMO participation variables used in either functional health literacy estimation or hypothesis testing in this research. Data management was performed using Stata 7.0 (StataCorp, 2001) whereas calculation of descriptive statistics and hypothesis testing were performed using SUDAAN 8.0.2 and SUDAAN 9.0.0 (Research Triangle Institute, 2003; Research Triangle Institute, 2004). To ensure stable, nationally representative population estimates of the relationships between estimated functional health literacy and preventive health care utilization, the recommended stratification, sampling, and final weighting variables were used for all descriptive and bivariate analyses (Center for Studying Health System Change, 2000).

3.5.3.1. DATA CLEANING AND PREPARATION

Of the 60,446 respondents to the 1996 Community Tracking Study, 53,270 were excluded because their age was less than 65 years. Two-hundred sixty-six respondents were excluded because their race was not White, Black or Hispanic. After exclusions, the remaining analytical sample had 6,910 respondents greater than 65 years of age with complete data on their sex, race, education and age variables.

3.6. ANALYSIS

The analytical strategy for the proposed study involved model development and construct validation (Specific Aims #1 and #2) and hypothesis testing (Specific Aim #3). Prior to model development, validation, and hypothesis testing, univariate statistics were computed for all variables in each of the three datasets. Data discrepancies were assessed and missing data was recoded or cases were dropped where appropriate. Variables were recoded as necessary to ensure consistency in specification across all three data sets.

3.6.1. MODEL DEVELOPMENT, SELECTION AND ACCURACY

The MHLS dataset was used to develop and validate a prediction model for estimating functional health literacy. The MHLS dataset was randomly partitioned into model fitting and model validation sub-samples for development and cross validation of the selected functional health literacy prediction model (Myers, 1990). Multiple linear regression modeling was used to construct a prediction model for functional health literacy using observed raw data from the individual participants in the MHLS to estimate the regression coefficients (i.e., betas) and intercept. Equation 1 (E1) describes the general regression modeling approach:

$$\text{(E1) } y = \beta_0 + \beta_1(\text{Sex}) + \beta_2(\text{Race/Ethnicity}) + \beta_3(\text{Education}) + \beta_4(\text{Age}) + e$$

where: y = Functional Health Literacy.

Commonly accepted methods for development and selection of the prediction model of choice were employed (Kleinbaum, Kupper, Muller, & Nizam, 1998). First, the full saturated model (i.e., maximum model) was specified. Included in this model were the main effects (i.e., sex, race, education, age), all two-way, three-way and four-way interaction terms, and higher order polynomial terms for the continuous variable age (i.e., age^2, age^3) to capture non-linearity and non-additivity. An all possible regressions strategy was chosen as the preferred method compared to a forward or backward selection strategy to maintain control in keeping related interaction and hierarchical model terms together in specified models. Following specification of the full model, a series of restricted models were computed and compared to the full model to identify the most parsimonious model with maximum predictive power. Criteria for model evaluation and selection included the R^2, mean square error, partial F statistic and Mallows Cp statistic (i.e., Conceptual Predictive Criterion). The four aforementioned criteria were used to identify a model that was (1) not significantly different than the specified maximum model; (2) included variables that had a strong association with the functional health literacy score; (3) had a small residual variance; and (4) had the optimal, yet parsimonious, number of predictor variables. Subsequent to selecting the optimal model, standard regression diagnostics (i.e., residual analysis, outlier analysis, and collinearity analysis) were computed and evaluated to assess for non-standard conditions (i.e., heteroscedasticity, multicollinearity and nonlinearity as well as non-normality of the residuals). All diagnostic results were reported. It must be noted that the set of independent variables listed above is restricted to those variables available in all three datasets and in most national surveys. Although other factors might be strong predictors of functional literacy, variables selected for inclusion in the proposed model have the strongest demonstrated relationship with functional health literacy. In addition, they are the variables that are consistently measured with a common metric across independent datasets.

The selected prediction model was used to estimate functional health literacy proficiencies in the model validation sub-sample. To assess the reliability of the prediction model, the predicted functional health literacy score was subtracted from the observed values in the model validation sub-sample (i.e., SS2) and squared. The squared values were summed and divided by the sample size to obtain the mean square prediction error (MSPR). The MSPR was compared to the mean square error from the model fitting sample (i.e., SS1) and evaluated for comparability. The model fitting and validation samples were then combined and the final prediction model was computed from the combined sample.

The sensitivity, specificity, positive and negative predictive value, and receiver operating characteristic curve (ROC) characteristics for the prediction model developed in the model fitting sub-sample were also assessed in the model validation sub-sample (Hennekens & Buring, 1987; Henderson, 1993). New cut points for the predicted literacy score that maximized the area under the ROC curve for identifying individuals with inadequate functional health literacy and individuals with either inadequate or marginal functional health literacy were identified and used to place individuals into various categories of functional health literacy. A ROC area under the curve in excess of 0.70 was sought (Swets, 1988).

3.6.2. MODEL CONSTRUCT VALIDITY

Using the selected functional health literacy prediction model developed in specific aim one, a synthetic estimate of functional health literacy was generated in the 1992 NALS dataset. A Pearson correlation matrix was computed using the synthetic estimate of functional health literacy and each of the five plausible values from each dimension of general functional literacy, the nationally representative standard for general functional literacy. The direction and magnitude of the correlations among the variables were reported as a measure of construct validity. The correlation method for assessing construct validity has been previously described (Aday, 1996). It was expected that the synthetic estimate of functional health literacy would be positively and highly correlated with estimated general functional literacy.

3.6.3. HYPOTHESIS TESTING

3.6.3.1. DESCRIPTIVE CHARACTERISTICS

Using the selected functional health literacy prediction model developed in specific aim one, a synthetic estimate of functional health literacy was generated for each respondent in the 1996 CTS dataset. In addition to describing the distributions of the respondent demographic characteristics (i.e., predisposing characteristics) of the 1996 CTS, the distributions of enabling and need characteristics, functional health literacy estimates, flu shot utilization and various specifications of mammogram utilization were computed and reported.

The 1996 CTS sample was divided into three categories based on the estimated functional health literacy score: (1) inadequate functional health literacy; (2) inadequate or marginal functional health literacy; and (3) adequate functional health literacy. Sample characteristics were also described by estimated functional health literacy category.

3.6.3.2. DEPENDENT VARIABLES

Two primary measures of preventive health care utilization (i.e., flu shot within the past 12 months and mammogram "ever") were used as the primary dependent variables of interest for hypothesis testing. Table 3-1 provides the 1996 CTS root variables and derived variables used to define the study dependent measures along with their corresponding coding.

Although not part of the primary analysis, alternative specifications of mammogram utilization (i.e., within the past one or two years) were also explored in secondary analyses. The 1996 CTS variable "MAMLASX" reflects only the subgroup that ever received a mammography screening examination. Therefore, the variable "MAMLASX" was recoded from missing to "no" if respondents reported "no" to ever having a mammogram (i.e., MAMMGM) to reflect overall population utilization within the past one or two years rather than only use among users of mammography. The reported categories for the "MAMLASX" variable in the 1996 CTS were mutually exclusive. For example, the category, "Within the past 2 years", does not include individuals who had a mammogram "Within the past year". Therefore, the categories "Within the past year" and "Within the past 2 years" were combined to reflect the mammography screening experience within the past 2 years for purposes of this research.

For hypothesis testing, the dichotomous dependent measures of preventive health care utilization were reverse coded to facilitate interpretation of the relationships between the indicator variable, functional health literacy, and not receiving each of the various dimensions of preventive health care. Therefore, not receiving a flu shot within the past 12 months, a mammogram within the past year, 2 years or ever were coded as (1) and the reference group (i.e., receiving one of the preventive health care measures) being coded as (0).

3.6.3.3. INDEPENDENT VARIABLES

The primary independent variable under study is the synthetic estimate of functional health literacy as described in Equation 1 above. As previously described, the synthetic estimate of functional health literacy was specified as a multivariate linear combination of four indicator variables (sex, age, education, and race/ethnic origin), their interaction terms and higher order specifications. Table 3-2 provides the 1996 CTS root variables and derived variables used to define study independent variables along with their corresponding coding used in the analysis.

Sex was treated a dichotomous variable (female and male) with male being the reference group. Age was treated as a continuous variable and was top-coded at 91 years to ensure consistency across data sets. That is, all respondents whose age exceeded 91 years had the age variable recoded to 91 years of age. Three dummy variables were created to represent race/ethnicity (i.e., White, Black, and Hispanic) with White being the reference group. Five dummy variables were created to represent education level (i.e., college graduate or higher, some college, high school graduate or equivalent, some high school, or less than high school) with college graduate being the reference group. Variables representing all two-way, three-way and four-way interaction terms among the sex, race, education and age variables were also constructed along with higher order polynomial terms for the age variable.

After estimation, the continuous synthetic estimate of functional health literacy was divided into three categories using cut points derived from specific aim one that best identified individuals with inadequate functional health literacy; inadequate or marginal functional health literacy; and adequate functional health literacy. Each specification of the functional health literacy estimate was used in hypothesis testing. For the estimated inadequate functional health literacy variable, the reference group was those individuals estimated to have marginal or adequate functional health literacy. For the estimated inadequate or marginal functional health literacy variable, the reference group was those individuals estimated to have adequate functional health literacy.

3.6.3.4. COVARIATES

A subset of enabling and need characteristics described in the traditional Behavioral Model of Health Services Utilization (Aday & Andersen, 1974; Aday, et al., 1980) was used as covariates in hypothesis testing. The criteria for selecting the covariates was determined by considering variables used in prior research on preventive health care utilization (Greene, et al., 2001; Carrasquillo, et al., 2001; Corbie-Smith, Flagg, Doyle & O'Brien, 2002; Scott, et al., 2002; DeVoe, Fryer, Phillips & Green, 2003), factors that would be expected to influence preventive health care utilization and variable availability in the 1996 CTS dataset. The enabling (i.e., income, insurance coverage, and usual source of care) and perceived need (i.e., general health status) characteristics from the 1996 CTS used to construct covariates for use in the hypothesis testing are described in Table 3-3.

Household income was recoded as a dichotomous variable using a category using the \$25,000 cut point which best represented the median household income in the 1996 CTS respondents $\geq$

65 years of age. Income greater than $25,000 served as the reference category. The variables "INSTYPE" and MCRHMOP were combined to derive an insurance coverage variable with seven mutually exclusive categories: (1) Medicare-only; (2) Medicare plus supplemental – public or private; (3) Medicare HMO; (4) Medicaid; (5) Private Direct Purchase; (6) Military; and (7) Uninsured. Medicare-only served as the reference category for this variable. The variable MCRHMOP was also used as an indicator variable to stratify the dataset to separately test the proposed hypotheses for those respondents in Medicare (non-HMO) and Medicare (HMO) plans. Usual source of care was recoded to a dichotomous yes/no variable with no being the reference category.

3.6.3.5. WEIGHTING/SAMPLING VARIABLES

Weighting and sampling variables were used in descriptive analyses and hypothesis testing to ensure stable, nationally representative population estimates of the relationships between the synthetic estimate of functional health literacy and preventive health care utilization. These variables are described in Table 3-4.

3.6.3.6. PRIMARY BIVARIATE ANALYSES

As part of the primary analysis, the bivariate associations between the continuous and categorical estimates of functional health literacy and the two primary dependent measures: (1) not receiving a flu shot within the past 12 months; and (2) never having received a mammogram (Hypotheses 1 and 2) were assessed using binary logistic regression models considering functional health literacy as a single predictor. The beta coefficients, odds ratios and associated 95% confidence intervals for the estimate of the functional health literacy variable were presented and their significance interpreted. In addition, the bivariate associations between the continuous and categorical estimates of functional health literacy and alternative specifications of not receiving mammogram (i.e., within one or two years) were also evaluated as part of the secondary analyses and served to only confirm the findings of previous research.

3.6.3.7. PRIMARY MULTIVARIATE ANALYSES

As part of the primary analysis, the multivariate associations between the continuous and categorical estimates of functional health literacy and the two primary dependent measures: (1) not receiving a flu shot within the past 12 months; and (2) never having received a mammogram (Hypotheses 1 and 2) were assessed using a multivariate binary logistic regression models, controlling for the effects of income, insurance coverage, usual source of care and general health status. A simplified conceptual model describing this model was previously shown in Figure 3-1. The synthetic estimate of functional health literacy is modeled as a linear combination of four general indicators (i.e., sex, age, race/ethnicity and education). The regression weights of each indicator was fixed using beta weights determined during the model development and validation steps described above. Equation 2 (E2) describes the general multivariate approach to hypothesis testing.

$$\text{(E2)}\ DV = \beta_0 + \beta_1(L^*) + \beta_2(\text{Covariates}) + e^*$$

where: DV = Flu shot within the past 12 months or
Mammogram "ever"
L* = Synthetic estimate of functional health literacy from Equation (1)
Covariates = Income, Type of Insurance Coverage, Usual source of care, and General Health Status

In addition, the multivariate associations between the continuous and categorical estimates of functional health literacy and alternative specifications of not receiving a mammogram (i.e., within one or two years) were also evaluated as part of the secondary analyses and served to only confirm the findings of previous research. The statistical significance for each of the beta coefficients along with their associated odds ratios for the synthetic estimates of functional health literacy was assessed. The two-tailed, a-priori alpha level for statistical significance was set at 0.05.

3.6.3.8. SENSITIVITY ANALYSES FOR FUNCTIONAL HEALTH LITERACY ESTIMATES

The 95% confidence limits for the continuous estimate of functional health literacy for each individual were computed using the standard error of the forecast (StataCorp, 2001). This option accounts for the variation in the point estimate of functional health literacy as well as the model residual error. A series of hypothesis tests assessing the relationship between the upper and lower confidence limits of the continuous estimate of functional health literacy and the two primary dependent measures of functional health literacy were performed. The identified relationships between the upper and lower confidence limits and the measures of preventive health care utilization were compared with the relationships between the point estimate of functional health literacy and measures of preventive health care utilization to ensure consistency in the findings after accounting for the estimation error.

3.6.3.9. SECONDARY ANALYSES

A number of secondary analyses were performed to confirm conceptual model performance. First, the relationship between the synthetic estimate of functional health literacy and not receiving a flu shot within the past 12 month was evaluated in the restricted female-only subgroup. The consistency of the direction and significance of the relationships were compared to those relationships identified between functional health literacy and mammography examination, a female-only sample.

The relationships between the synthetic estimate of functional health literacy and alternative specifications of mammography utilization (i.e., not receiving a mammogram within the past one year or two years) were also evaluated. These results were compared to what is already known about the observed relationship between functional health literacy and mammography use within the past two years in the Medicare managed population (Scott, et al., 2002) and assessed for consistency.

The multivariate relationships between sex, race/ethnicity, education, age and each dimension of preventive health care utilization were also tested while controlling for the identified covariates without including the synthetic estimate of functional health literacy in the model. The statistical significance of the coefficients and odds ratios for each of the demographic predictor variables was assessed. It was expected that the pseudo-R^2 for models with independent predictors of functional health literacy would exceed the pseudo-R^2 for the models incorporating the synthetic estimate of functional health literacy derived from the independent predictor variables. This expectation is based on the fact that the model incorporating the synthetic estimate of functional health literacy restricts the weighting of the sex, race/ethnicity, education and age to represent their relationship with functional health literacy. However, if the synthetic estimate of functional health literacy remains significant after placing this restriction, evidence would be generated to support the notion that functional health literacy, in part, may explain sex, race/ethnicity, education, and age disparities associated with preventive health care utilization.

Last, the study sample was stratified by Medicare HMO participation and the relationships between the synthetic estimate of functional health and each of the four measures of preventive health care utilization (i.e., not receiving a flu shot within the past 12 months; never having a mammogram; and not having a mammogram within the past one or two years) were computed. The observed relationships were compared across HMO and non-HMO subgroups as well as to the published literature.

3.7. SAMPLE SIZE ESTIMATION

Sample size estimates for hypothesis testing were calculated based on the proportions of individuals who never received a flu shot stratified by functional health literacy category which is described in the only known study of functional health literacy and preventive health care utilization (Scott, et al., 2002). While this variable used to estimate sample size differs from the primary dependent variable prescribed in hypothesis one (i.e., flu shot within the past 12 months), it remains the best and only available estimate of flu shot utilization by functional health literacy category. The results of the sample size estimate are provided in Table 3-5 (Fleiss, 1981). With a 1996 CTS study sample of 6,910 individuals $\geq$65 years of age, is sufficiently large for identifying statistically significant pair-wise differences between the collective “inadequate or marginal” functional health literacy and adequate functional health literacy groups considering a desired alpha level equal to 0.05 and power equal to 0.80. The sample size is not sufficient to detect significant differences between marginal-only and adequate functional health literacy groups.

3.8. LIMITATIONS

In the absence of a nationally representative dataset that includes socio-demographic, health literacy and preventive health care utilization data, the results of the proposed study are largely dependent on the development and validation of the synthetic estimate of functional health literacy. It is not uncommon in public health research to employ census-based aggregate variables as proxy measures for missing socioeconomic data that are of interest, but not contained, in a dataset used for analysis (Geronimus & Bound, 1998; Geronimus, Bound & Neidert, 1995). For example, an aggregate measure of census reported income for individuals within a given zip code might be used to estimate income for individuals in a dataset that contains zip code but not income. This concept known as geocoding is not without limitation as it may over- or underestimate the relationship between the estimated variable and the outcome measure of interest. If there is significant variation of income within a zip code, there will be a tendency to underestimate the relationship between a proxy measure for income and outcome of interest in the analytical dataset. Alternatively, if zip code represented a broader construct beyond income, the tendency would be to overestimate the relationship between proxy income and the outcome of interest. The current proposal to construct a synthetic estimate of functional health literacy can be thought of as analogous to the principle of geocoding. A proxy measure for functional health literacy will be estimated from a combination of four variables, sex, age, race/ethnicity and education. This approach incorporates more specific information than traditional geocoding that may often assume a one-to-one relationship between one proxy measure and specific variable of interest. The precedent for constructing synthetic estimates of literacy have previously been established (Reder, 1997; Sentell, 2003).

This proposed research includes a number of steps to ensure confidence in the synthetic estimate of health literacy. First, the variables selected to construct the synthetic estimate of functional health literacy have been demonstrated to be the strongest predictors of general functional literacy and functional health literacy. Preliminary analysis confirmed a moderate relationship between the proposed predictors age, race, education and general functional literacy (Miller & Degenholtz, 2003). In addition, the proposed method to calculate the synthetic estimate of functional health literacy includes only the weightings of age, race/ethnicity and education that covary with functional health literacy, therefore reducing the potential to overestimate the latent construct of functional health literacy. The forecasting error for the estimate of functional health literacy will be used to calculate upper and lower 95% confidence limits for the synthetic estimate of functional health literacy. The relationship between the upper and lower confidence limits and the outcomes of interest will be assessed to evaluate consistency of the findings. To establish construct validity, the functional health literacy estimates will be compared with the general functional literacy estimates reported in the 1992 NALS to establish construct validity. Finally, for hypothesis testing, the proposed literacy predictor variables will not be used as covariates concomitantly with functional health literacy so as to avoid problems of collinearity between age, race/ethnicity, education and the synthetic estimate of functional health literacy.

Although data for this study are drawn from large, representative samples of Medicare-eligible elderly, the data pose several study limitations. The synthetic estimate of functional health literacy is derived from Medicare enrollees in one managed care plan at four locations; however, the model will be applied to the entire elderly Medicare population, which includes fee-for-service beneficiaries. To address this limitation, the hypotheses will be tested in the 1996 CTS dataset with and without those respondents who report participation in a Medicare HMO. The results will be compared for consistency.

The dependent measures for hypothesis testing are determined from self-report and cannot be objectively verified with claims data or medical record. While potentially subject to response bias, it is assumed that respondents accurately recalled and truthfully reported their influenza vaccination and mammography screening experience.

3.9. IRB REVIEW

The proposed study meets the criteria for exempt status (category 4) because it will use publicly available secondary data with no identifying information about the individuals in the sample. This study was reviewed and approved by the University of Pittsburgh Institutional Review Board. A copy of the letter indicating approval is provided in Appendix B.

Table 3-1 1996 Community Tracking Study Variables Used to Construct Dependent Variables for Hypothesis Testing

Variable	Question/Definition	CTS Coding	Analysis Coding
FLUSHOT	During the past 12 months, has [fill NAME] had a flu shot? A flu shot is usually given in the fall and protects against influenza for the flu season.	• No = 0 • Yes = 1 • Not ascertained = -9 • Don't Know = -8 • Refused = -7 • Inapplicable = -1	• No = 1 • Yes = 0
MAMMGM	A mammogram is an x-ray of the breast to look for breast cancer. Has [fill NAME] ever had a mammogram?	• No = 0 • Yes = 1 • Not ascertained = -9 • Don't Know = -8 • Refused = -7 • Inapplicable = -1	• No = 1 • Yes = 0
MAMLASX	How long has it been since [fill NAME] had (her/your) last mammogram?	• Within past year = 1 • Within past 2 years = 2 • Within past 3 years = 3 • 3 or more years = 4 • Don't Know = -8 • Refused = -7 • Inapplicable = -1	• Not used in hypothesis testing
MAM_1	Mammogram in the last year? Constructed from MAMLASX.	• None	• No = 1 • Yes = 0
MAM_2	Mammogram in the last 2 years? Constructed from MAMLASX.	• None	• No = 1 • Yes = 0

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Table 3-2 1996 Community Tracking Study Variables Used To Estimate Functional Health Literacy

Variable	Question/Definition	CTS Coding	Model Estimation Coding
AGEX	Beginning with [fill HOUSEHOLDER'S NAME], what is his/her age?	• Age in years • 0 to 91 years	• 65 – 91 years
SEX	Beginning with [fill HOUSEHOLDER'S NAME], what is his/her sex?	• Male = 1 • Female =2	• Not used in estimation
Male Sex	Male sex variable constructed from SEX. Reference category.	• None	• Reference category for sex
Female Sex	Female sex variable constructed from SEX.	• None	• No = 0 • Yes = 1
RACEREX	Variable derived from RACEX and HISPAN variables.	• White = 1 • African American = 2 • Native / Asian / Pacific / Other = 3 • Hispanic = 4	• Not used in estimation
RACEX	What race (does/do) [fill NAME] consider (himself/herself/yourself) to be?	• White = 1 • African American = 2 • Native / Asian / Pacific / Other = 3 • Not ascertained = -9 • Don't Know = -8 • Refused = -7	• Not used in estimation
HISPAN	(Do you/Does [fill NAME] consider (yourself/himself/herself) to be of Hispanic origin, such as Mexican, Puerto Rican, Cuban, or other Spanish background?	• No = 0 • Yes = 1 • Not ascertained = -9 • Don't Know = -8 • Refused = -7	• Not used in estimation

Table 3-2 (Continued)

White Race / Ethnicity	Variable derived from RACEREX and HISPAN variables.	• None	• Reference category for race
African-American Race / Ethnicity	Variable derived from RACEREX and HISPAN variables	• None	• No = 0 • Yes = 1
Hispanic Race / Ethnicity	Variable derived from RACEREX and HISPAN variables	• None	• No = 0 • Yes = 1
HIGRADX	[If AGE>=18] What is the highest grade or year of school [fill NAME] completed?	• Education in years • Bottom code = 6 years • Top code = 19 years • Inapplicable = -1	• Not used in estimation
College Graduate	16 or more years of school. Variable derived from HIGRADX variable.	• None	• Reference variable for education
Some College	13 to 15 years of school. Variable derived from HIGRADX variable.	• None	• No = 0 • Yes = 1
High School Graduate / Equivalent	12 years of school. Variable derived from HIGRADX variable.	• None	• No = 0 • Yes = 1
Some High School	9 to 11 years of school. Variable derived from HIGRADX variable.	• None	• No = 0 • Yes = 1
Less than High School	Less than 9 years of school. Variable derived from HIGRADX variable.	• None	• No = 0 • Yes = 1
Inadequate Functional Health Literacy	Synthetic estimate for inadequate functional health literacy	• None	• No = 0 • Yes = 1
Inadequate or Marginal Functional Health Literacy	Synthetic estimate for inadequate or marginal functional health literacy	• None	• No = 0 • Yes = 1

Table 3-3 1996 Community Tracking Study Variables Used to Construct Covariates for Hypothesis Testing

Variable	Question/Definition	CTS Coding	Hypothesis Testing Coding[1]
CENSINX	Constructed variable that provides total income for each census family.	• Income in dollars • Bottom code = $0 • Top code = $150,000	• Not used in hypothesis testing
Income	Income variable constructed from CENSINX	• None	• ≤$25,000 = 1 • >$25,000 = 0
INSTYPE	Constructed variable which categorizes the type of insurance coverage for each person.	• Medicare = 1 • Medicare and Medigap = 2 • Medicare and other public = 3 • Private – employment related = 4 • Private – direct purchase = 5 • Private – coverage outside family = 6 • Military insurance = 7 • Medicaid = 8 • Other public coverage = 9 • Uninsured = 10	• Not used in hypothesis testing
MCRHMOP	Constructed variable that indicates whether the person's Medicare insurance is an HMO.	• No = 0 • Yes = 1 • Inapplicable = -1	• Not used in hypothesis testing

Table 3-3 (Continued)

Insurance Status	Type of insurance. Variable derived from INSTYPE and MCRHMOP	• None	• Medicare = 0 • Medicare plus supplemental - public or private = 1 • Medicare HMO = 2 • Medicaid = 3 • Private – direct purchase = 4 • Military = 5 • Uninsured = 6
USCARE	Is there a place that [fill NAME] USUALLY goes to when (you/he/she) (is/are) sick or need(s) advice about your health?	• No place = 0 • Yes = 1 • More than 1 place = 3 • Don't Know = -8 • Refused = -7	• Not used in hypothesis testing
Usual Source of Care	Variable derived from USCARE.	• None	• No = 1 • Yes = 0
GENHLH	Constructed variable that combines proxy-reported and self-reported values of general health statues for adults, using self-reported values when available.	• Excellent = 1 • Very good = 2 • Good = 3 • Fair = 4 • Poor = 5	• Excellent = 4 • Very good = 3 • Good = 2 • Fair = 1 • Poor = 0

[1]The reference category for variables used in hypothesis testing is coded as zero.

Table 3-4 1996 Community Tracking Study Weighting and Sampling Variables Used in Hypothesis Testing

Variable	Question/Definition	Coding
PSTRATA	Pseudo stratum	• 1 to 30
PPSU	Pseudo primary sampling unit	• 1 to 203
SECSTRA	Second stage stratification	• 0 to 19
NFSUX	Final sampling unit when making national estimates	• 191 to 1026747
PSTRTOT3	Sampling counts for finite population correction factors	• 1 to 118
P1X to P7X	Joint primary sampling unit inclusion probabilities	• <1 • 1 • Inapplicable
WTSRM4	Person-level weight for making national estimates from the combined 60 site and supplemental samples.	• 0 • 121 to 74231

Table 3-5 Sample Size Estimation for Hypothesis Testing

Pairwise Comparison of Functional Health Literacy Categories	% Without Influenza Vaccination[1]	Sample Size Required
Inadequate vs. Adequate	29 vs. 19	835 (i.e., 191 + 644)
Marginal vs. Adequate	22 vs.19	12,417 (i.e., 1,649 + 10,768)
Inadequate/Marginal vs. Adequate	26.62[2] vs. 19	1,149 (i.e., 357 + 792)

Note: alpha .05; power .80; [1] Scott et al., (2002); [2]Weighted estimate from available data in Scott et al., (2002)

4. CHAPTER 4 - RESULTS

4.1. SPECIFIC AIM #1: MODEL DEVELOPMENT AND SELECTION

4.1.1. MEDICARE HEALTH LITERACY STUDY (MHLS)

4.1.1.1. DEMOGRAPHIC CHARACTERISTICS

Table 4-1 presents descriptive statistics for selected demographic variables in the MHLS sample. The MHLS sample was predominantly female (57%), White (76%), and had a high school diploma, an equivalent to a high school diploma or higher level of education (64%). The mean age was 72.83 years (median = 72 years) with 64% of the sample between 65 and 74 years of age.

4.1.1.2. FUNCTIONAL HEALTH LITERACY

The total functional health literacy scores ranged from zero to 100 with a mean of 71.36 (SD = 26.80) and median equal to 81. The total functional health literacy score distribution was skewed to the left. When the total functional health literacy score was categorized using previously defined and validated cut points (i.e., Inadequate Functional Health Literacy, $0 < x \leq 53$; Marginal Functional Health Literacy, $53 < x \leq 66$; Adequate Functional Health Literacy, $66 < x \leq 100$), 24.45% of the respondents were classified as having inadequate functional health literacy, 11.22% had marginal functional health literacy, and 64.32% had adequate functional health literacy. The distribution of respondents with inadequate, marginal and adequate functional health literacy did not change appreciably after excluding the "other" race category as 24.46% of the remaining 3,209 White, Black and Hispanic respondents were classified as having inadequate functional health literacy, 11.28% had marginal functional health literacy, and 64.26% had adequate functional health literacy.

4.1.1.3. RELATIONHIPS BETWEEN FUNCTIONAL HEALTH LITERACY AND DEMOGRAPHIC CHARACTERISTICS

The bivariate relationships among sex, race, education and total functional health literacy score variables are presented in Table 4-2. An independent groups t-test was performed comparing the mean total functional health literacy score for male (mean = 71.05) and female (mean = 71.59) subgroups. There was no statistically significant relationship found between sex and total functional health literacy score ($t\ (3207) = -0.57$, $p = 0.57$).

A one-way analysis of variance was used to compare the mean total functional health literacy score for Whites, Blacks and Hispanics. A statistically significant relationship was found, $F\ (2, 3206) = 153.90$, $p=0.00$. Post-hoc analysis using the Bonferroni multiple comparison tests revealed that the mean total functional health literacy score was significantly higher for Whites (mean = 75.59) compared to Blacks (mean = 53.60) and Hispanics (mean = 61.26). The mean total functional health literacy score for Hispanics was significantly greater than for Blacks. The strength of the relationship as measured by eta^2 was 0.088.

A one-way analysis of variance was used to compare the mean total functional health literacy scores for each of the five levels of education. A statistically significant relationship was found, F (4, 3204) = 248.87, p=0.00. Post-hoc analysis using the Bonferroni multiple comparison test revealed that the mean total functional health literacy scores were significantly higher for higher levels of education. Each level of education had significantly higher mean total functional literacy score when compared to the next lower level of education (i.e., college graduate (mean = 86.25), some college education (mean = 81.59), high school graduate or equivalent (mean = 76.90), some high school education (mean = 64.61) and less than a high school education (mean = 46.69)). This significant finding was consistent for all pair wise comparisons. The strength of the relationship between education and total functional health literacy score as measured by eta^2 was 0.237. Finally, a significant negative Pearson correlation (r = -0.2930, p = 0.00) was found between age and mean functional health literacy score.

4.1.1.4. RELATIONSHIPS AMONG DEMOGRAPHIC CHARACTERISTICS

The pair-wise relationships among demographic predictor variables, sex, race, education and age were also evaluated. Chi-square analyses were used to assess the bivariate relationships among the categorical variables sex, race and education.

The relationship between sex and race was found to be statistically significant, X^2 (2, n = 3209) = 24.48, p = 0.00. The strength of the relationship was 0.09 when measured by Cramer's V statistic. The majority of White and Black respondents was female (57.46% and 66.15%, respectively), whereas the majority of Hispanic respondents (51.81%) was male.

The relationship between sex and education level was also statistically significant, X^2 (4, n = 3209) = 81.20, p = 0.00. The strength of the relationship was 0.16 when measured by Cramer's V statistic. A majority of college graduates was male (60.21%) whereas the majority of respondents with some college education, a high school education or equivalent, some high school education or less than a high school education was female (55.87%, 65.71%, 58.35%, and 54.30%, respectively).

The relationship between race and education was also statistically significant, X^2 (4, n = 3209) = 541.34, p = 0.00. The strength of the relationship was 0.29 when measured by Cramer's V statistic. The majority of White respondents (72.43%) had at least a high school education or equivalent, whereas a minority of Black and Hispanic respondents (40.11% and 32.87%) had at least a high school education or equivalent.

The bivariate relationships between sex, race, education level and age are presented in Table 4-3. An independent groups t-test was performed comparing the mean age for male and female sample subgroups. There was a statistically significant relationship found between sex and age, t(3207) = -3.95, p = 0.00. The mean age of males (72.32 years) was significantly lower than the mean age of females (73.21 years). Although statistically significant, the strength of the relationship as measured by eta^2 was only 0.004.

A one-way analysis of variance was used to compare the mean age for Whites, Blacks and Hispanics. A statistically significant relationship was found, $F (2, 3206) = 40.79$, $p=0.00$. Post-hoc analysis using the Bonferroni multiple comparison test revealed that the mean age was significantly higher for Whites (73.30 years) compared to that of Blacks (mean = 72.28 years) and Hispanics (mean = 70.19 years). The mean age for Blacks was significantly greater than for Hispanics. The strength of the relationship as measured by eta^2 was 0.025.

A one-way analysis of variance was used to compare the mean age for each of the five levels of education. A statistically significant relationship was found, $F (4, 3204) = 4.01$, $p=0.00$. Post-hoc analysis using the Bonferroni multiple comparison tests revealed that the mean age was significantly lower for college graduates (71.91 years) compared to respondents with some college (mean = 73.18 years) and respondents with less than a high school education (mean = 73.37 years). All other pair wise comparisons were not significantly different. The strength of the relationship as measured by eta^2 was only 0.005.

4.1.1.5. FUNCTIONAL HEALTH LITERACY MODEL DEVELOPMENT AND SELECTION

The MHLS data was randomly partitioned into two sub-samples (SS1 and SS2). After the exclusion criteria were applied, SS1 had 1607 respondents for model development and selection. Sub-sample 2 (SS2) had 1602 respondents remaining in the holdout sample for model reliability and predictive accuracy assessment.

To identify the optimal predictive model for functional health literacy, the full saturated model was first specified considering the main effect predictor variables (i.e., sex, race, education, and age), higher order powers of age (i.e., age^2, age^3), all two-way, three-way, and four-way interactions of the main effect predictor variables to account for possible non-linearity and non-additivity. The maximum model had 53 terms and yielded a multiple correlation coefficient (R^2) equal to 0.3917 and a mean square error (MSE) equal to 457.94.

One hundred and five (105) restricted models were constructed and compared to the maximum model. A model description, the R^2, MSE, partial F statistic and Mallows C_P statistic are provided for each of the restricted candidate models in Table 4-4.

All restricted models (Model 1 through 24) containing only main effects terms (i.e., sex, race, education, age and higher order powers of age) either alone or in combination had significantly less predictive power than the maximum model as indicated by statistically significant partial-F tests ($p<0.05$). Therefore, interaction terms were added to the model and evaluated.

When used individually in conjunction with the main effects terms, the interaction terms that significantly improved the predictive power of the main effects model were education*age (Model 37) and race*education (Model 40). The interaction terms, sex*age (Model 25), sex*race (Model 28), sex*education (Model 34), and race*age (Model 31) did not significantly improve the predictive capacity of the main effects only model as these models had significantly less predictive power than the maximum model.

During model development, it was determined that adding the interaction term, race*age, to models containing the main effect term, race, introduced substantial collinearity. The Variance inflation factor (VIF) values for model terms Hispanic race, Hispanic race*age, Black race, and Black race*age were 235.13, 233.42, 129.30, 129.29, respectively. To address concerns about non-essential collinearity, the age variable was centered (Kleinbaum, et al., 1998) by subtracting the mean age of the top-coded age variable (72.83 years) from the reported age of each respondent in the entire data set. The regression model was re-computed using the centered age variable alone and with interaction terms. The VIF values for the Hispanic race, Hispanic race*age, Black race, and Black race*age model terms were reduced to acceptable values of 1.67, 1.58, 1.09 and 1.18, respectively. For all regression analyses the top-coded, centered age term was used as a main effect term for age and was also used in the calculation of the interaction terms involving age.

Of the restricted candidate models that were not significantly different than the maximum model, the model (i.e., Model 46) containing the terms sex, race, education, age, race*education and education*age was selected because it was the most parsimonious model with a relatively high R^2 value (0.3797), low MSE (457.23) and a Mallows C_P statistic (18.56) that closely approximated the number of terms in the candidate model (20). Neither age^2 nor age^3 were significant predictors of total functional health literacy score and therefore were not included in the selected model. These terms added only a negligible contribution to the absolute increase in R^2 value (0.0006). Although the addition of the interaction terms sex*age, sex*race, sex*education, and race*age slightly increased the R^2 values of candidate prediction models, their addition resulted in either over-specification or unacceptable increases in collinearity. The estimated regression coefficients and their associated significance for the selected prediction model (Model 46) are provided in Table 4-5.

4.1.1.6. FUNCTIONAL HEALTH LITERACY MODEL DIAGNOSTICS

Residual Analysis

A histogram of the studentized jackknife residuals for the selected functional health literacy model is provided in Figure 4-1. The histogram suggests a slightly negatively skewed distribution of jackknife residuals. Deviation from a straight for the cumulative normal probability plot of the studentized jackknife residuals as shown in Figure 4-2 suggests a non-normal distribution of studentized jackknife residuals.

The negatively skewed distribution of studentized jackknife residuals was normalized by squaring the observed functional health literacy score and re-computing the functional health literacy model per published recommendations (Kleinbaum et al., 1998). After squaring the observed functional health literacy score, the transformed score ranged from zero to 10,000. A histogram of the studentized jackknife residuals for the selected functional health literacy model using the squared transformation of the functional health literacy score is presented in Figure 4-3. The distribution of the studentized jackknife residuals for the transformed functional health literacy score approaches normality. The straight line cumulative normal probability plot of the studentized jackknife residuals confirms the improvement in the distribution of the studentized jackknife residuals (Figure 4-4).

Outlier Analysis

Residuals

Because the studentized jackknife residuals assume a t distribution with n-k-2 degrees of freedom where (n = number of residuals) and (k = number of predictor variables), the observed studentized jackknife residuals were compared to a critical t value of ±4.12 to check for outlying observations. A corrected significance level, 0.00002 (two-tailed, 0.025/1607), was used to account for multiple testing. The largest and smallest studentized jackknife residuals were 2.75 and -3.00, respectively. Thus, no outlying studentized jackknife residuals were detected.

Leverage

Leverage values follow an F distribution with (k) and (n-k-1) degrees of freedom and an alpha level of ($1-\alpha/n$). A leverage value of 0.035 corresponded to a critical value, $F(20,1584) = 2.83$ at an adjusted significance level of 0.00003. Thus, observations with leverage values in excess of 0.035 were evaluated for plausibility.

There were 7.59% (n=122) of the observations in the model building sample with leverage values in excess of 0.035. All observations had plausible values for sex, race, education, age and total functional health literacy score. Thus, deletion of these observations could not be justified on the grounds of plausibility.

In the subgroup of respondents with leverage values greater than 0.035, there was a higher proportion who were college graduates or had some college or technical school (60.76%) compared to the subgroup of respondents who did not have high leverage values. Whereas, the subgroup of respondents with leverage values less than or equal to 0.035, had a higher proportion of respondents with a high school education or less (71.12%) compared to the subgroup with leverage values in excess of 0.035. This pattern of education distribution by low/high leverage was statistically significant, X^2 (4, n = 1607) = 81.15, p = 0.00.

There also was a significant relationship between leverage values and race. The subgroup with leverage values greater than 0.035 had a larger proportion of minorities (i.e., 35.25% Blacks and 60.66% Hispanics) in contrast to the subgroup with leverage values less than or equal to 0.035 which was predominantly White (83.32%). This pattern of distribution by low/high leverage was statistically significant, X^2 (2, n = 1607) = 464.67, p = 0.00. The subgroup of respondents with leverage values in excess of 0.035 also had a lower age (mean = 71.5 years) compared to those with leverage values less than or equal to 0.035 (mean = 72.87 years), t (1605) = -2.32, p = 0.02. There was no significant relationship between high leverage values and sex or total functional health literacy score.

Influence

Cook's distance was used to measure the influence of observations. A threshold value for Cook's distance equal to one is recommended (Kleinbaum, et al., 1998). No Cook's distance values exceeded one for the model building sample which suggests that no particular observation affects the regression coefficients appreciably.

Collinearity Analysis

The variance inflation factor values for each of the terms in the selected model were used to assess collinearity and are provided in Table 4-6. Only the Black race model term exhibited moderate collinearity as indicated by the VIF value in excess of 10 at 12.81.

Model Selection

After transforming the dependent variable, the functional health literacy model selected for prediction took the final form as represented by equation (M1):

(M1) Total Functional Health Literacy Score Squared =

446.45*Female – 3599.78*Black – 2929.65*Hispanic – 675.14*Some College

- 1650.75*High School – 3129.10*Some High School – 5058.99*Less than high School

- 119.60*Age + 1518.30*(Black*Some College) + 2185.10*(Black*High School)

+ 1893.70*(Black*Some High School) + 2370.36*(Black* Less than High School)

- 488.75*(Hispanic*Some College) + 1120.45*(Hispanic*High School)

+ 2505.01*(Hispanic*Some High School) + 2711.62*(Hispanic*Less than High School)

- 27.34*(Some College*Age) – 79.92*(High School*Age) – 66.40*(Some High School*Age)

+ 25.95*(Less than High School*Age) + 7917.24

4.1.1.7. FUNCTIONAL HEALTH LITERACY MODEL RELIABILITY ASSESSMENT

The mean squared prediction error (MSPR) was 7053682.90 in the model validation sub-sample (i.e., SS2) and was compared to the mean square error (MSE) of the prediction equation, 6738890.47 derived from the model fitting sub-sample (i.e., SS1). The MSPR was within an acceptable 4.67% of the MSE.

4.1.1.8. FUNCTIONAL HEALTH LITERACY MODEL PREDICTION ACCURACY

The prediction accuracy of the functional health literacy model for identifying individuals with inadequate functional health literacy was evaluated by calculating the sensitivity, specificity, positive and negative predictive value, percent correctly classified, and area under the receiver operating characteristic (ROC) curve. Using previously validated cut points for observed total functional health literacy scores, respondents in SS2 were divided into two dichotomous categories of functional health literacy. Individuals with observed total functional health literacy scores less than or equal to 53 were classified as having inadequate functional health literacy with the remainder of the sample classified as having marginal or adequate functional health literacy. The dichotomously classified observed functional health literacy score from this classification served as the reference or true state of functional health literacy. Each value of the transformed (i.e., squared) predicted functional health literacy score was used as the classification variable for respondents to determine the cut-point that achieved the optimal predictive accuracy for individuals with inadequate functional health literacy. The list of predicted values was narrowed to those values with likelihood ratio of a positive test greater than or equal to two and a likelihood ratio of a negative test less than or equal to 0.5. From this reduced list, cut-points for the transformed functional health literacy score that maximized sensitivity, specificity, alone and concomitantly, were evaluated and are presented in Table 4-7. Of the three cut-points evaluated, the cut-point with the highest sensitivity (i.e., 6223) correctly classified the fewest respondents (i.e., 63.86%). The cut-point with the highest specificity (i.e., 4055) correctly classified the greatest portion of respondents (i.e., 78.21%). However, the high-specificity cut-point also had substantially lower sensitivity compared to the other cut-points, leading to under-identification of cases with inadequate functional health literacy. The cut-point that concomitantly maximized both sensitivity and specificity (i.e., 5207) also maximized the area under the ROC curve, suggesting the most optimal diagnostic accuracy of the candidate models in discerning between respondents with inadequate functional health literacy and marginal or adequate functional health literacy. The transformed cut-point, 5207, corresponded to a value of approximately 72 on the previously validated, 100-point functional health literacy scale and was used in subsequent analyses that required the identification of subjects with inadequate functional health literacy. The proportion of respondents correctly classified as having inadequate functional health literacy using this cut point was 76.72%.

Using an alternative classification, individuals with an observed total functional health literacy score less than or equal to 66 were classified as having inadequate or marginal functional health literacy with the remainder of the sample classified as having adequate functional health literacy. A second receiver operating characteristic analysis was performed to assess the sensitivity, specificity, percent of respondents correctly classified for each predicted value of the transformed functional health literacy score to determine the cut-point that achieved the highest predictive accuracy for individuals with either inadequate or marginal functional health literacy.

Each value of the transformed (i.e., squared) predicted functional health literacy score was used as the classification variable for respondents to determine the cut-point that achieved the optimal predictive accuracy for individuals with inadequate or marginal functional health literacy. The list of predicted values was narrowed to those values with a likelihood ratio of a positive test greater than or equal to two and a likelihood ratio of a negative test less than or equal to 0.5. From this reduced list, cut-points for the transformed functional health literacy score that maximized sensitivity, specificity, alone and concomitantly, were evaluated and are presented in Table 4-8. Of the three cut-points evaluated, the cut-point with the highest sensitivity (i.e., 6267) correctly classified the fewest respondents (i.e., 67.98%). The cut-point with the highest specificity (i.e., 4485) correctly classified the greatest portion of respondents (i.e., 75.72%). However, the high-specificity cut-point also had substantially lower sensitivity compared to the other cut-points, leading to under-identification of cases with inadequate or marginal functional health literacy. The cut-point that concomitantly maximized both sensitivity and specificity (i.e., 5621), also maximized the area under the ROC curve, suggesting the most optimal diagnostic accuracy of the candidate models in discerning between respondents with inadequate or marginal functional health literacy and adequate functional health literacy. The transformed cut-point, 5621, corresponded to a value of approximately 75 on the previously validated, 100-point functional health literacy scale and was used in subsequent analyses that required the identification of subjects with inadequate or marginal functional health literacy. The proportion of respondents correctly classified as having inadequate or marginal functional health literacy using this cut point was 73.22%.

4.1.1.9. FINAL FUNCTIONAL HEALTH LITERACY MODEL

Sub-sample 1 (SS1) and SS2 were combined and the final prediction model was estimated. The final functional form of the prediction model is presented as equation (M2). The R^2 for the final model was 0.3648. The estimated regression coefficients and their associated significance for the final prediction model are provided in Table 4-9.

(M2) Total Functional Health Literacy Score Squared =

332.08*Female – 2818.21*Black – 2048.23*Hispanic – 644.45*Some College

- 1402.63*High School – 2826.17*Some High School – 4888.72*Less than high School

- 153.34*Age + 1086.76*(Black*Some College) + 577.78*(Black*High School)

+ 1265.85*(Black*Some High School) + 1594.95*(Black* Less than High School)

- 684.68*(Hispanic*Some College) + 255.21*(Hispanic*High School)

+ 1263.62*(Hispanic*Some High School) + 2187.51*(Hispanic*Less than High School)

- 5.83*(Some College*Age) – 27.91*(High School*Age) – 31.91*(Some High School*Age)

+ 65.68*(Less than High School*Age) + 7862.11

4.2. SPECIFIC AIM #2: ASSESSMENT OF MODEL VALIDITY

4.2.1. 1992 NATIONAL ADULT LITERACY SURVEY

4.2.1.1. DEMOGRAPHIC CHARACTERISTICS

Table 4-10 presents descriptive statistics for selected demographic variables in the 1992 NALS sample. The 1992 NALS sample was predominantly female (64%), White (74%), and had a high school diploma, an equivalent to a high school diploma or higher level of education (52%). The mean age was 73.56 years (median = 72 years) with 61% of the sample between 65 and 74 years of age. Compared to the MHLS sample, the 1992 NALS sample was slightly older, had higher proportions of females and minorities (i.e., Blacks and Hispanics) and a lower proportion of high school graduates or higher level of education. After adjusting for the complex survey design of the 1992 NALS, 56% of the 1992 NALS were female, 87% were White, and 52% had an equivalent to a high school diploma or higher. The mean age dropped slightly to 73.28 years. As in the MHLS a large proportion (33%) of the 1992 NALS income data were missing. Using the 1992 NALS data, the proportions of the national population estimated to have inadequate, marginal and adequate functional health literacy were 39.14%, 5.28%, and 55.58%, respectively.

4.2.1.2. CONSTRUCT VALIDITY

For each respondent in the 1992 NALS, the transformed (i.e., squared) total functional health literacy score was estimated using equation M2. Subsequent to estimation, pair-wise Pearson correlations among the transformed total functional health literacy score and each of the reported five plausible values of general functional prose, document and quantitative literacy were computed. The weighted correlation matrix between the estimated total functional health literacy score and the prose, document and quantitative literacy scores are provided in Table 4-11. In this nationally representative sample, moderate positive relationships were found between the estimated functional health literacy score and general prose literacy (r = 0.62 to 0.64), general document literacy (r = 0.61 to 0.63), and general quantitative literacy (r = 0.58 to 0.60). As expected, the relationships among the dimensions of general functional literacy were higher, ranging from 0.77 to 0.85 for prose and document literacy, 0.75 to 0.82 for prose and quantitative literacy, and 0.78 to 0.86 for document and quantitative literacy.

4.3. SPECIFIC AIM #3: TESTING THE RELATIONSHIP BETWEEN THE SYNTHETIC ESTIMATE OF FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE UTILIZATION

4.3.1. 1996 COMMUNITY TRACKING STUDY

4.3.1.1. SAMPLE DEMOGRAPHIC CHARACTERISTICS

Table 4-12 presents descriptive statistics for selected demographic variables in the 1996 CTS sample. The 1996 CTS sample was predominantly female (57%), White (87%), and had a high school diploma, an equivalent to a high school diploma, or higher level of education (76%). The mean age was 73.32 years (median = 72 years) with 62% of the sample between 65 and 74 years of age. Compared to the MHLS sample, the 1996 CTS sample was slightly older, had a similar proportion of females, as well as lower proportions of minorities (i.e., Blacks and Hispanics) and high school graduates or higher level of education.

Unlike the MHLS, the data for the income variable was populated for all remaining respondents. The income variable was dichotomized using a $25,000 cut-point, a rounded value which best approximated the median income split in this nationally representative sample. The $25,000 value represented a common cut-point used in previous studies used to support this research (Greene et al., 2001; Scott et al., 2002). Approximately 52% of the respondents had a median income less than or equal to $25,000. Approximately 6% of respondents reported not having a usual source of care with 0.20% not having data on this variable. With respect to self-reported general health, a majority of the respondents (74%) reported having good to excellent health. A small number of respondents reported being uninsured (0.84%). As expected, the majority of respondents reported having either Medicare plus public or private supplemental insurance coverage (53%), Medicare only coverage (27%), or insurance coverage through a Medicare health maintenance organization (16%).

4.3.1.2. POPULATION DEMOGRAPHIC CHARACTERISTIC ESTIMATES

To provide accurate population estimates, the appropriate sampling weights provided with the 1996 CTS were used to adjust for the complex survey design. After weighting, the sample represented a population that was estimated to be comprised of 59% females, 84% Whites, and 66% with an equivalent to a high school diploma or higher. The mean population age was estimated to be 73.47 years.

4.3.1.3. DISTRIBUTION OF INADEQUATE AND MARGINAL FUNCTIONAL HEALTH LITERACY

For each respondent in the 1996 CTS, the squared total functional health literacy score was estimated using equation M2. Using the weighted, nationally representative sample from the 1996 CTS, approximately 33% (95% CI, 30.15% – 36.78%) of the elderly population $\geq$ 65 years of age who were White, Black or Hispanic were estimated to have inadequate functional health literacy. Approximately 39% (95% CI, 35.69% - 42.81%) were estimated to have either inadequate or marginal functional health literacy (Table 4-12).

4.3.1.4. DISTRIBUTION OF FLU SHOT AND MAMMOGRAM UTILIZATION

Using the weighted, nationally representative sample from the 1996 CTS, approximately 37% (95% CI, 34.79% - 39.14%) of the elderly population $\geq$ 65 years of age who were White, Black or Hispanic reported not receiving a flu shot within the past 12 months. Among the female population, approximately 20% (95% CI, 18.49% - 21.82%) reported not ever receiving a mammography screening examination; 36% (95% CI, 34.18% - 38.25%) reported not receiving a mammogram within the past 2 years; and 52% (95% CI, 49.84% - 53.59%) reported not receiving a mammogram within the past year (Table 4-12).

4.3.1.5. DEMOGRAPHIC CHARACTERISTICS BY ESTIMATED FUNCTIONAL HEALTH LITERACY CATEGORY

Respondents were categorized into inadequate, inadequate or marginal, and adequate functional health literacy categories based on the newly validated cut-points of the transformed functional health literacy score. Table 4-13 presents national estimates of the demographic characteristics by three functional health literacy categories: (1) those estimated to have inadequate functional health literacy; (2) those estimated to have either inadequate or marginal functional health literacy; and those estimated to have adequate functional health literacy. Due to the small sample size of the marginal functional health literacy group (n = 427), the inadequate and marginal functional health literacy groups were combined. The statistical significance of the relationships among the demographic characteristics and functional health literacy categories were not formally tested. Descriptive statistics show that males and females were distributed similarly across all three functional health literacy categories. Descriptive statistics show that compared to the group estimated to have adequate functional health literacy, the groups estimated to have inadequate functional health literacy and inadequate or marginal functional health literacy had higher proportions of minorities, individuals with less than high school equivalence as well as individuals with lower income. Groups with inadequate functional health literacy and inadequate or marginal functional health literacy had higher proportions of individuals reporting a lack of a usual source of health care; smaller proportions of individuals reporting participation in a Medicare health maintenance organization or Medicare plus supplemental insurance along with a higher proportion of individuals reporting participation in Medicare only without supplemental insurance. Those groups estimated to have inadequate functional health literacy or inadequate or marginal functional health literacy had higher proportions of individuals who reported poor to fair health compared to those estimated to have adequate functional health literacy. Individuals estimated to have inadequate functional health literacy and inadequate or marginal functional health literacy were also older (i.e., mean = 77 years) than those estimated to have adequate functional health literacy (i.e., mean = 71 years). Finally, there were higher proportions of individuals with estimated inadequate functional health literacy and inadequate or marginal functional health literacy who reported not receiving a flu shot within the past 12 months (i.e., 41% for both groups); not ever receiving a mammogram (i.e., 31% and 29%, respectively); and not receiving a mammogram within the past one year (i.e., 63% for both groups) or two years (i.e., 51% and 49%, respectively) compared to those estimated to have adequate functional health literacy.

4.3.2. PRIMARY ANALYSES

4.3.2.1. BIVARIATE ASSOCIATIONS BETWEEN FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A FLU SHOT OR MAMMOGRAM

Tables 4-14 to 4-17 describe the bivariate associations between functional health literacy, and not receiving a flu shot or mammography examination. Because the SUDAAN software required for analysis reports the beta coefficients for each predictor variable to only two decimal places, the continuous synthetic estimate of the transformed functional health literacy score was reduced from a 10,000-point scale to a 10-point scale by dividing by a constant of 1000. This rescaling facilitated the practical interpretation of the significance of the relationship between a 10-unit change in the continuous functional health literacy estimate and not receiving a flu shot or mammography examination.

The bivariate association between the rescaled continuous functional health literacy estimate and not receiving of a flu shot within the past 12 months; not ever receiving a mammogram; and not receiving a mammogram within the past one or two years was assessed using a univariate binary logistic regression model. A 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not receiving a flu shot within the past 12 months (OR = 0.95, 95% CI (0.93 – 0.98)); not ever receiving a mammogram (OR = 0.78, 95% CI (0.75 – 0.81)); not receiving a mammogram within the past two years (OR = 0.78 95% CI (0.75 – 0.81)); and not receiving a mammogram within the past year (OR = 0.82, 95% CI (0.79 – 0.85)).

Those individuals estimated to have inadequate functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.31 times that of individuals with marginal or adequate functional health literacy (OR = 1.31, 95% CI (1.17 – 1.46)). Women estimated to have inadequate functional health literacy had an odds of not ever receiving a mammogram that was 2.52 times that of women with marginal or adequate functional health literacy (OR = 2.52, 95% CI (2.10 – 3.02)). Women estimated to have inadequate functional health literacy had an odds of not receiving a mammogram in the past 2 years that was 2.46 times that of women with marginal or adequate functional health literacy (OR = 2.46, 95% CI (2.13 – 2.85)). Women estimated to have inadequate functional health literacy had an odds of not receiving a mammogram in the past year that was 2.03 times that of women with marginal or adequate functional health literacy (OR = 2.03, 95% CI (1.73 – 2.37)).

Those individuals estimated to have inadequate or marginal functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.29 times that of individuals with adequate functional health literacy (OR = 1.29, 95% CI (1.15 – 1.43)). Women estimated to have inadequate or marginal functional health literacy had an odds of not ever receiving a mammogram that was 2.45 times that of women with marginal or adequate functional health literacy (OR = 2.45, 95% CI (2.07 – 2.89)). Women estimated to have inadequate or marginal functional health literacy had an odds of not receiving a mammogram in the past 2 years that was 2.48 times that of women with adequate functional health literacy (OR = 2.48, 95% CI (2.19 – 2.81)). Women estimated to have inadequate functional health literacy had an odds of not receiving a mammogram in the past year that was 2.05 times that of women with adequate functional health literacy (OR = 2.05, 95% CI (1.79 – 2.36)).

4.3.2.2. MULTIVARIATE ASSOCIATION BETWEEN FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A FLU SHOT OR MAMMOGRAM

Functional Health Literacy and Not Receiving a Flu Shot

The association between the rescaled continuous functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-18. A 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not receiving a flu shot within the past 12 months (OR = 0.96, 95% CI (0.93 – 0.99)) after controlling for the effects of income, usual source of care, insurance status and general health status.

To account for the forecasting error in the point estimate of functional health literacy, the 95% confidence limits of the estimate were computed. The relationships between the upper and lower bounds of the 95% confidence limits of the rescaled, continuous functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status were assessed using a multivariate binary logistic regression model. Results of the analyses are provided in Tables 4-19 and 4-20. Using the upper and lower 95% confidence boundaries of the point estimate of functional health literacy, a 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not receiving a flu shot within the past 12 months (OR = 0.96, 95% CI (0.93 – 0.99)) after controlling for the effects of income, usual source of care, insurance status and general health status.

The association between the inadequate functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-21. Those individuals estimated to have inadequate functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.28 times that of individuals with marginal or adequate functional health literacy (OR = 1.28, 95% CI (1.13 – 1.44)).

The association between the inadequate or marginal functional health literacy estimate and receipt of a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-22. Those individuals estimated to have inadequate or marginal functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.26 times that of individuals with adequate functional health literacy (OR = 1.26, 95% CI (1.11 – 1.43)).

Functional Health Literacy and Not "Ever" Receiving a Mammogram

The association between the rescaled continuous functional health literacy estimate and not ever receiving a mammogram while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-23. A 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not ever receiving a mammogram (OR = 0.79, 95% CI (0.75 – 0.83)) after controlling for the effects of income, usual source of care, insurance status and general health status.

To account for the forecasting error in the point estimate of functional health literacy, the 95% confidence limits of the estimate were computed. The relationships between the upper and lower bounds of the 95% confidence limits of the rescaled, continuous functional health literacy estimate and not ever receiving a mammogram while controlling for the effects of income, usual source of care, insurance status and general health status were assessed using a multivariate binary logistic regression model. Results of the analyses are provided in Tables 4-24 and 4-25. Using the upper and lower 95% confidence boundaries of the point estimate of functional health literacy, a 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not ever receiving a mammography (OR = 0.79, 95% CI (0.75 – 0.83)).

The association between the inadequate functional health literacy estimate and not ever receiving a mammogram while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-26. Those women estimated to have inadequate functional health literacy had an odds of not ever receiving a mammogram that was 2.27 times that of women with marginal or adequate functional health literacy (OR = 2.27, 95% CI (1.85 – 2.79)).

The association between the inadequate or marginal functional health literacy estimate and not ever receiving a mammogram while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-27. Those women estimated to have inadequate or marginal functional health literacy had an odds of not ever receiving a mammogram that was 2.21 times that of women with adequate functional health literacy (OR = 2.21, 95% CI (1.85 – 2.65)).

4.3.3. SECONDARY ANALYSES

4.3.3.1. FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A FLU SHOT (FEMALE-ONLY)

The association between the estimate of functional health literacy and not receiving a flu shot within the past 12 months was assessed after restricting the data set to females only. This restriction was applied to mimic the sample used to assess the relationships between functional health literacy and not receiving a mammogram which inherently contains a female only sample. The consistency of the relationships between functional health literacy and not receiving a flu shot, and not receiving a mammography screening examination for the female-only samples were compared to assess gender-specific effects.

In the restricted, female-only sample, the association between the rescaled continuous functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-28. A 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not receiving a flu shot within the past 12 months (OR = 0.94, 95% CI (0.90 – 0.98)) after controlling for the effects of income, usual source of care, insurance status and general health status.

The associations between the upper and lower bounds of the 95% confidence limits of the rescaled, continuous functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status in the restricted, female-only sample were assessed using a multivariate binary logistic regression model. Results of the analyses are provided in Tables 4-29 and 4-30. Using the upper and lower 95% confidence limits of the rescaled continuous estimate of functional health literacy, a 10-unit increase on the 100-unit functional health literacy scale was associated with a significant reduction in the odds of not receiving a flu shot within the past 12 months (OR = 0.94, 95% CI (0.90 – 0.98)) after controlling for the effects of income, usual source of care, insurance status and general health status.

The association between the inadequate functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status in the restricted, female-only sample was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-31. Those women estimated to have inadequate functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.36 times that of women with marginal or adequate functional health literacy (OR = 1.36, 95% CI (1.15 – 1.60)).

The association between the inadequate or marginal functional health literacy estimate and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status was assessed in the restricted, female-only sample using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-32. Those women estimated to have inadequate or marginal functional health literacy had an odds of not receiving a flu shot within the past 12 months that 1.28 times that of women with adequate functional health literacy (OR = 1.28, 95% CI (1.11 – 1.48)).

4.3.3.2. FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A MAMMOGRAM WITHIN THE PAST 2 YEARS

The association between the inadequate functional health literacy estimate and not receiving a mammogram within the past two years while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-33. Those women estimated to have inadequate functional health literacy had an odds of not receiving a mammogram within the past two years that was 2.20 times that of women with marginal or adequate functional health literacy (OR = 2.20, 95% CI (1.82 – 2.66)).

The association between the inadequate or marginal functional health literacy estimate and not receiving a mammogram within the past two years while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-34. Those women estimated to have inadequate or marginal functional health literacy had an odds of not receiving a mammogram within the past two years that was 2.23 times that of women with adequate functional health literacy (OR = 2.23, 95% CI (1.90 – 2.62)).

4.3.3.3. FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A MAMMOGRAM WITHIN THE PAST YEAR

The association between the inadequate functional health literacy estimate and not receiving a mammogram within the past year while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-35. Those women estimated to have inadequate functional health literacy had an odds of not receiving a mammogram within the past year that was 1.81 times that of women with marginal or adequate functional health literacy (OR = 1.81, 95% CI (1.52 – 2.16)).

The association between the inadequate or marginal functional health literacy estimate and not receiving a mammogram within the past year while controlling for the effects of income, usual source of care, insurance status and general health status was assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-36. Those women estimated to have inadequate or marginal functional health literacy had an odds of not receiving a mammogram within the past year that was 1.84 times that of women with adequate functional health literacy (OR = 1.84, 95% CI (1.58 – 2.15)).

4.3.3.4. MULTIVARIATE ASSOCIATION BETWEEN INDEPENDENT PREDICTORS OF FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A FLU SHOT OR MAMMOGRAM

The associations between the independent predictors of functional health literacy (i.e., sex, race, education, and age) and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status were assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-37. Sex was not associated with receipt of a flu shot within the past 12 months (OR = 1.11, 95% CI (0.96 – 1.28) for females compared to males). With respect to race, individuals identifying themselves as Black or African-American had odds of not receiving a flu shot within the past 12 months that was 1.91 times that of White individuals (OR = 1.91, 95% CI (1.53 – 2.38)). However, there was no relationship between individuals of Hispanic race and not receiving a flu shot within the past 12 months (OR = 1.37, 95% CI (0.73 – 2.57)) when compared to White individuals. Those individuals with a high school education or equivalent; some high school education; or less than a high school education had odds of not receiving a flu shot within the past 12 months that were 1.43, 1.59 and 1.74 times that of individuals who were college graduates, respectively [(OR = 1.43, 95% CI (1.21 – 1.67)); (OR = 1.59, 95% CI (1.30 – 1.93)); (OR = 1.74, 95% CI (1.38 – 2.19))]. There was no relationship between individuals with some college education and not receiving a flu shot within the past 12 months compared to college graduates (OR = 1.14, 95% C I (0.94 – 1.37)). Yearly increases in age were associated with reduced odds of not receiving a flu shot within the past 12 months (OR = 0.97, 95% CI (0.96 – 0.98)).

The associations between the independent predictors of functional health literacy (i.e., sex, race, education, and age) and not ever receiving a mammogram while controlling for the effects of income, usual source of care, insurance status and general health status were assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-38. With respect to race, women identifying themselves as Black or African-American had an odds of not ever receiving a mammogram that was 1.44 times that of White women (OR = 1.44, 95% CI (1.08 – 1.92)). However, there was no relationship between women of Hispanic race and not ever receiving a mammogram (OR = 0.89, 95% CI (0.42 – 1.90)) when compared to White women. Those women with a high school education or equivalent; some high school education; or less than a high school education had odds of not ever receiving a mammogram that were 1.57, 2.26 and 2.84 times that of individuals who were college graduates, respectively [(OR = 1.57, 95% CI (1.10 – 2.22)); (OR = 2.26, 95% CI (1.55 – 3.28)); (OR = 2.84, 95% CI (1.95 – 4.16))]. There was no relationship between women with some college education and not ever receiving a mammogram compared to college graduates (OR = 1.12, 95% CI (0.75 – 1.67).

Yearly increases in age were associated with increased odds of not ever receiving a mammogram (OR = 1.05, 95% CI (1.03 – 1.07)).

The associations between the independent predictors of functional health literacy (i.e., sex, race, education, and age) and not receiving a flu shot within the past 12 months while controlling for the effects of income, usual source of care, insurance status and general health status in the restricted female-only sample were assessed using a multivariate binary logistic regression model. Results of the analysis are provided in Table 4-39. With respect to race, women identifying themselves as Black or African-American had odds of not receiving a flu shot within the past 12 months that was 1.89 times that of White women (OR = 1.89, 95% CI (1.37 – 2.61)). There was no relationship between women of Hispanic race and not receiving a flu shot within the past 12 months (OR = 1.07, 95% CI (0.67 – 1.70)) when compared to White women. Women with a high school education or equivalent; some high school education; or less than a high school education had odds of not receiving a flu shot within the past 12 months that were 1.70, 1.83 and 2.32 times that of women who were college graduates, respectively [(OR = 1.70, 95% CI (1.33 – 2.17)); (OR = 1.83, 95% CI (1.39 – 2.40)); (OR = 2.32, 95% CI (1.66 – 3.25))]. There was no relationship between women with some college education and not receiving a flu shot within the past 12 months compared to women who were college graduates (OR = 1.26, 95% CI (0.94 – 1.68). Yearly increases in age were associated with reduced odds of not receiving a flu shot within the past 12 months (OR = 0.97, 95% CI (0.96 – 0.98)).

4.3.3.5. BIVARIATE AND MULTIVARIATE ASSOCIATION BETWEEN FUNCTIONAL HEALTH LITERACY AND NOT RECEIVING A FLU SHOT OR MAMMOGRAM BY MEDICARE HMO PARTICIPATION

Because the functional health literacy estimation model was derived from a Medicare HMO sample and the 1996 CTS included both Medicare HMO and fee-for-service (FFS) enrollees, the 1996 CTS sample was stratified and described by Medicare HMO participation. The bivariate and multivariate associations between the estimates of functional health literacy and not receiving a flu shot within the past 12 months; not ever receiving a mammogram; and not receiving a mammogram within the past one or two years were evaluated by Medicare HMO participation.

The demographic characteristics of individuals stratified by estimated functional health literacy category and Medicare HMO participation are presented in Table 4-40. Although not formally tested, descriptive statistics show that there were higher proportions of males, Hispanics, and individuals with a high school education, its equivalent or higher level of education who participated in a Medicare HMO compared to those who did not participate in a Medicare HMO for those individuals estimated to have inadequate functional health literacy and inadequate or marginal functional health literacy. Among the Medicare HMO enrollees with estimated inadequate functional health literacy or inadequate and marginal functional health literacy, there were lower proportions of respondents who reported poor to fair health and reported an income of less than $10,000 annually compared to non-HMO participants. Age and the proportion of individuals reporting an absence of a usual source of care did not vary much by Medicare HMO status. For those estimated to have adequate functional health literacy, the distribution of demographic characteristics did not vary as greatly by Medicare HMO participation.

The pattern of utilization of preventive health care services was consistent across each of the categories of estimated functional health literacy. For each category of functional health literacy, higher proportions of individuals who participated in a Medicare HMO reported receipt of a flu shot within the past 12 months; a mammogram at some time in their life; and receipt of a mammogram within the past one or two years compared to non-HMO participants.

After dividing the 1996 CTS sample by Medicare HMO participation, the bivariate associations between inadequate functional health literacy, inadequate or marginal functional health literacy and each dimension of preventive health care utilization were assessed using univariate binary logistic regression. The results are presented in Table 4-41.

For non-HMO participants, those individuals estimated to have inadequate functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.29 times that of individuals with marginal or adequate functional health literacy (OR = 1.29, 95% CI (1.15 – 1.45)). As well, those individuals estimated to have inadequate functional health literacy had odds of not receiving a mammogram ever, within the past one year, or within the past two years that were 2.38, 2.03 and 2.41 times that of individuals with marginal or adequate functional health literacy, respectively [(OR = 2.38, 95% CI (1.94 – 2.92)); (OR = 2.03, 95% CI (1.69 – 2.44)); (OR = 2.41, 95% CI (2.04 – 2.85))] .

For non-HMO participants, those individuals estimated to have inadequate or marginal functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.25 times that of individuals with adequate functional health literacy (OR = 1.25, 95% CI (1.11 – 1.42)). As well, those individuals estimated to have inadequate or marginal functional health literacy had odds of not receiving a mammogram ever, within the past one year or within the past two years that were 2.36, 2.05 and 2.48 times that of individuals with adequate functional health literacy, respectively [(OR = 2.36, 95% CI (1.96 – 2.85)); (OR = 2.05, 95%CI (1.75 – 2.39)); (OR = 2.48, 95% CI (2.15 – 2.85))].

For Medicare HMO participants, those individuals estimated to have inadequate functional health literacy had odds of not receiving a mammogram ever, within the past one year, or within the past two years that were 2.28, 1.59 and 2.13 times that of individuals with marginal or adequate functional health literacy, respectively [(OR = 2.28, 95% CI (1.04 – 5.02)); (OR = 1.59, 95% CI (1.06 – 2.37)); (OR = 2.13, 95% CI (1.25 – 3.63))]. There was no significant relationship between those individuals with inadequate functional health literacy and not receiving a flu shot within the past 12 months (OR = 1.21, 95% CI (0.88 – 1.68)) when compared to those individuals with adequate functional health literacy for Medicare HMO participants.

For Medicare HMO participants, those individuals estimated to have inadequate or marginal functional health literacy had odds of not receiving a mammogram within the past one or two years that were 1.88 and 2.00 times that of individuals with adequate functional health literacy, respectively [(OR = 1.88, 95% CI (1.30 – 2.72); (OR = 2.00, 95% CI (1.23 – 3.25))]. There were no significant relationships between those individuals with inadequate or marginal functional and not receiving a flu shot within the past 12 months for Medicare HMO participants (OR = 1.31, 95% CI (0.94 – 1.83)) and not ever receiving a mammogram (OR = 1.87, 95% CI (0.88 – 3.97)) when compared to those individuals with adequate functional health literacy.

After dividing the 1996 CTS sample by Medicare HMO participation, the multivariate associations between inadequate functional health literacy, inadequate or marginal functional health literacy and each dimension of preventive health care utilization after controlling for income, usual source of care and general health status were assessed using multivariate binary logistic regression. The results are presented in Table 4-42.

For non-HMO participants, those individuals estimated to have inadequate functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.31 times that of individuals with marginal or adequate functional health literacy after controlling for income, usual source of care and general health status (OR = 1.31, 95% CI (1.14 – 1.50)). As well, those individuals estimated to have inadequate functional health literacy had odds of not receiving a mammogram ever, within the past one year, or within the past two years that were 2.34, 1.90 and 2.27 times that of individuals with marginal or adequate functional health literacy, respectively [(OR = 2.34, 95% CI (1.92 – 2.86)); (OR = 1.90, 95% CI (1.58 – 2.28)); (OR = 2.27, 95% CI (1.89 – 2.72))] .

For non-HMO participants, those individuals estimated to have inadequate or marginal functional health literacy had an odds of not receiving a flu shot within the past 12 months that was 1.27 times that of individuals with adequate functional health literacy after controlling for income, usual source of care and general health status (OR = 1.27, 95% CI (1.10 – 1.47)). As well, those individuals estimated to have inadequate or marginal functional health literacy had odds of not receiving a mammogram ever, within the past one year, or within the past two years that were 2.34, 1.90 and 2.34 times that of individuals with adequate functional health literacy, respectively [(OR = 2.34, 95% CI (1.97 – 2.79)); (OR = 1.90, 95%CI (1.63 – 2.23)); (OR = 2.34, 95% CI (2.01 – 2.73))].

For Medicare HMO participants, those estimated to have inadequate functional health literacy had an odds of not receiving a mammogram within the past two years that was 1.89 times that of individuals with marginal or adequate functional health literacy (OR = 1.89, 95% CI (1.05 – 3.42)). Other multivariate relationships between those estimated to have inadequate functional health literacy and not receiving a flu shot within the past 12 months, not ever receiving a mammogram and not receiving a mammogram within the past year in the Medicare HMO subgroup were not significant.

For Medicare HMO participants, those estimated to have inadequate or marginal functional health literacy had odds of not receiving a mammogram within the past one year or two years that were 1.77 and 1.86 times that of individuals with adequate functional health literacy, respectively [(OR = 1.77, 95% CI (1.17 – 2.66)); OR = 1.86, 95% CI (1.08 – 3.19))]. Other multivariate relationships between those individuals estimated to have inadequate or marginal functional health literacy and not receiving a flu shot within the past 12 months and not ever receiving a mammogram in the Medicare HMO subgroup were not significant.

Table 4-1 Medicare Health Literacy Study Demographic Characteristics

		N	(%)
Sex			
	Male	1382	42.61
	Female	1861	57.39
Race			
	White	2466	76.04
	Black	384	11.84
	Hispanic	359	11.07
	Other	34	1.05
Education			
	< HS[1]	561	17.30
	Some HS	596	18.38
	GED/HS Equiv/HS Graduate	1087	33.52
	Some College/Technical or Trade School	612	18.87
	College Graduate	387	11.93
Family Income (in dollars)			
	<10,000	586	18.07
	10,000 – 14,999	693	21.37
	15,000 – 19,999	448	13.81
	20,000 – 24,999	379	11.69
	25,000 – 34,999	281	8.66
	35,000 – 49,999	196	6.04
	50,000 – 74,999	94	2.90
	≥75,000	41	1.26
	Refused/Missing	525	16.19
Functional Health Literacy Category			
	Inadequate	793	24.45
	Marginal	364	11.22
	Adequate	2086	64.32

[1]HS = High School

Table 4-2 Bivariate Relationships Between Total Functional Health Literacy Score and Categorical Demographic Characteristics in the Medicare Health Literacy Study

		N	FHL[1] Score Mean (SD)	p-value
Sex				
	Male	1365	71.05 (26.40)	0.57[3]
	Female	1844	71.59 (27.10)	
Race				
	White	2466	75.59 (24.89)	0.00[4]
	Black	384	53.60 (29.87)	
	Hispanic	359	61.26 (25.58)	
Education				
	< HS[2]	377	46.69 (26.51)	0.00[4]
	Some HS	605	64.61 (26.08)	
	GED/HS Equiv/HS Graduate	1076	76.90 (23.19)	
	Some College/Technical or Trade School	593	81.59 (21.01)	
	College Graduate	558	86.25 (17.83)	

[1]FHL = Functional Health Literacy; [2]HS = High School; [3]Independent groups t-test; [4]One-way ANOVA

Table 4-3 Bivariate Relationships Between Age and Categorical Demographic Characteristics in the Medicare Health Literacy Study

		N	Age (Years) Mean (SD)	p-value
Sex				
	Male	1365	72.32 (6.22)	0.00[2]
	Female	1844	73.21 (6.37)	
Race				
	White	2466	73.30 (6.36)	0.00[3]
	Black	384	72.28 (6.23)	
	Hispanic	359	70.19 (5.34)	
Education				
	< HS[1]	377	73.37 (6.72)	0.00[3]
	Some HS	605	73.00 (6.36)	
	GED/HS Equiv/HS Graduate	1076	72.59 (6.10)	
	Some College/Technical or Trade School	593	73.18 (6.45)	
	College Graduate	558	71.91 (5.92)	

[1]HS = High School; [2]Independent groups t-test; [3]One-way ANOVA

Table 4-4 Candidate Regression Models Predicting Total Functional Health Literacy Score

Model #	Model Description	$R^2(p)$[a]	MSE(p)[b]	F(p)[c]	p[d]	C(p)[e]
1	Sex	0.0003	728.1123	19.2164	1	948.9282
2	Age	0.0832	667.7932	15.1463	1	737.5187
3	Race	0.0926	661.3480	14.9727	2	715.4848
4	age, age^2	0.0853	666.6530	15.3381	2	734.0665
5	sex, age	0.0849	666.9400	15.3581	2	735.0720
6	age, age^2, age^3	0.0853	667.0408	15.6449	3	735.9683
7	sex, race	0.0935	661.0970	15.2262	3	715.1620
8	race, age	0.2025	581.6132	9.6606	3	436.9301
9	educ (education)	0.2529	545.1456	7.2318	4	310.0852
10	sex, race, age	0.2055	579.7529	9.7015	4	431.1521
11	sex, age, age^2, age^3	0.0870	666.2317	15.8756	4	733.6811
12	sex, educ	0.2534	545.1805	7.3559	5	311.0169
13	educ, age	0.3277	490.9335	3.4040	5	121.3626
14	sex, age, age^2, race	0.2062	579.6336	9.8663	5	431.4690
15	race, educ	0.2789	526.8503	6.1272	6	247.7817
16	sex, educ, age	0.3294	489.9653	3.3841	6	118.9078
17	sex, age, age^2, age^3, race	0.2062	579.9490	10.0763	6	433.3052
18	sex, race, educ	0.2800	526.3940	6.1994	7	247.0380
19	race, educ, age	0.3634	465.4324	1.5707	7	34.1749
20	sex, age, age^2, educ	0.3301	489.7732	3.4188	7	119.1671
21	sex, race, educ, age	0.3664	463.5038	1.4354	8	28.4288
22	sex, age, age^2, age^3, educ	0.3304	489.8502	3.4778	8	120.3661
23	sex, race, educ, age, age^2	0.3667	463.5657	1.4506	9	29.6322
24	sex, race, educ, age, age^2, age^3	0.3669	463.7254	1.4724	10	31.1767
25	sex, race, educ, age, sex*age	0.3679	462.7233	1.3809	9	26.6946
26	sex, race, educ, age, sex*age, age^2	0.3680	462.8921	1.4071	10	28.2724
27	sex, race, educ, age, sex*age, age^2, age^3	0.3682	463.0650	1.4285	11	29.8639

Table 4-4 (Continued)

28	sex, race, educ, age, sex*race	0.3667	463.8883	1.4843	10	31.7444
29	sex, race, educ, age, sex*race, age^2	0.3670	463.9416	1.5014	11	32.9172
30	sex, race, educ, age, sex*race, age^2, age^3	0.3672	464.0942	1.5256	12	34.4352
31	sex, race, educ, age, race*age	0.3676	463.2011	1.4309	10	29.3493
32	sex, race, educ, age, race*age, age^2	0.3678	463.3723	1.4528	11	30.9340
33	sex, race, educ, age, race*age, age^2, age^3	0.3680	463.4844	1.4758	12	32.3126
34	sex, race, educ, age, sex*educ	0.3677	463.6882	1.4944	12	33.0220
35	sex, race, educ, age, sex*educ, age^2	0.3681	463.7392	1.5063	13	34.1869
36	sex, race, educ, age, sex*educ, age^2, age^3	0.3682	463.9123	1.5384	14	35.7760
37	sex, race, educ, age, educ*age	0.3712	461.1560	1.2765 [f]	12	24.2078
38	sex, race, educ, age, educ*age, age^2	0.3715	461.2128	1.2893 [f]	13	25.3984
39	sex, race, educ, age, educ*age, age^2, age^3	0.3718	461.3059	1.3027 [f]	14	26.7147
40	sex, race, educ, age, race*educ	0.3752	459.4041	1.1385 [f]	16	22.0970
41	sex, race, educ, age, race*educ; age^2	0.3756	459.4016	1.1418 [f]	17	23.0850
42	sex, race, educ, age, race*educ; age^2; age^3	0.3757	459.5776	1.1671 [f]	18	24.6920
43	sex, race, educ, age, race*educ, sex*age	0.3767	458.5621	1.0638 [f]	17	20.1721
44	sex, race, educ, age, race*educ, sex*age, age^2	0.3769	458.6861	1.0796 [f]	18	21.6005
45	sex, race, educ, age, race*educ, sex*age, age^2, age^3	0.3771	458.8732	1.0963 [f]	19	23.2472
46	sex, race, educ, age, race*educ, educ*age	0.3797	457.2318	0.9284 [f]	20	18.5606
47	sex, race, educ, age, race*educ, educ*age, age^2	0.3801	457.2024	0.9255 [f]	21	19.4605
48	sex, race, educ, age, race*educ, educ*age, age^2, age^3	0.3803	457.3403	0.9389 [f]	22	20.9388
49	sex, race, educ, age, sex*age, educ*age	0.3724	460.5793	1.2318 [f]	13	23.1946
50	sex, race, educ, age, sex*age, educ*age, age^2	0.3726	460.7355	1.2503 [f]	14	24.7318
51	sex, race, educ, age, sex*age, educ*age, age^2, age^3	0.3728	460.8436	1.2698 [f]	15	26.1013
52	sex, race, educ, age, sex*age, sex*race	0.3683	462.9803	1.4224	11	29.5689
53	sex, race, educ, age, sex*age, sex*race, age^2	0.3685	463.1525	1.4446	12	31.1572
54	sex, race, educ, age, sex*age, sex*race, age^2, age^3	0.3686	463.3185	1.4744	13	32.7233
55	sex, race, educ, age, sex*age, sex*educ	0.3690	463.0258	1.4488	13	31.7051

Table 4-4 (Continued)

56	sex, race, educ, age, sex*age, sex*educ,age^2	0.3692	463.1825	1.4729	14	33.2387
57	sex, race, educ, age, sex*age, sex*educ,age^2	0.3694	463.3663	1.4982	15	34.8658
58	sex, race, educ, age, sex*race, sex*educ	0.3680	464.0740	1.5514	14	36.3380
59	sex, race, educ, age, sex*race, sex*educ, age^2	0.3684	464.1160	1.5654	15	37.4705
60	sex, race, educ, age, sex*race, sex*educ, age^2, age^3	0.3685	464.2816	1.6008	16	39.0321
61	sex, race, educ, age, sex*race, educ*age	0.3715	461.5303	1.3223 [f]	14	27.4949
62	sex, race, educ, age, sex*race, educ*age, age^2	0.3718	461.5764	1.3370 [f]	15	28.6472
63	sex, race, educ, age, sex*race, educ*age, age^2, age^3	0.3721	461.6594	1.3524 [f]	16	29.9276
64	sex, race, educ, age, sex*race, race*educ	0.3754	459.8106	1.1890 [f]	18	25.5000
65	sex, race, educ, age, sex*race, race*educ, age^2	0.3758	459.8053	1.1939 [f]	19	26.4775
66	sex, race, educ, age, sex*race, race*educ, age^2, age^3	0.3760	459.9779	1.2146 [f]	20	28.0714
67	sex, race, educ, age, sex*educ, educ*age	0.3727	461.2418	1.3110 [f]	16	28.4775
68	sex, race, educ, age, sex*educ, educ*age, age^2	0.3730	461.2846	1.3262 [f]	17	29.6187
69	sex, race, educ, age, sex*educ, educ*age, age^2, age^3	0.3732	461.3915	1.3495 [f]	18	30.9822
70	sex, race, educ, age, sex*educ, race*educ	0.3773	458.9937	1.1140 [f]	20	24.6626
71	sex, race, educ, age, sex*educ, race*educ, age^2	0.3777	458.9577	1.1169 [f]	21	25.5357
72	sex, race, educ, age, sex*educ, race*educ, age^2, age^3	0.3779	459.1470	1.1365 [f]	22	27.1883
73	sex, race, educ, age, race*educ, educ*age, sex*race	0.3799	457.6279	0.9718 [f]	22	21.9337
74	sex, race, educ, age, race*educ, educ*age, sex*race, age^2	0.3804	457.5944	0.9616 [f]	23	22.8186
75	sex, race, educ, age, race*educ, educ*age, sex*race, age^2, age^3	0.3806	457.7275	0.9772 [f]	24	24.2792
76	sex, race, educ, age, race*educ, educ*age, sex*age	0.3809	456.6124	0.8616 [f]	21	17.4181
77	sex, race, educ, age, race*educ, educ*age, sex*age, age^2	0.3812	456.7044	0.8647 [f]	22	18.7395
78	sex, race, educ, age, race*educ, educ*age, sex*age, age^2, age^3	0.3814	456.8540	0.8765 [f]	23	20.2592
79	sex, race, educ, age, race*educ, educ*age, race*age	0.3804	457.2435	0.9306 [f]	22	20.6041
80	sex, race, educ, age, race*educ, educ*age, race*age, age^2	0.3807	457.3299	0.9361 [f]	23	21.9043
81	sex, race, educ, age, race*educ, educ*age, race*age, age^2, age^3	0.3810	457.4143	0.9420 [f]	24	23.1973

Table 4-4 (Continued)

82	sex, race, educ, age, race*educ, educ*age, sex*educ	0.3819	456.7849	0.8627 [f]	24	21.0230
83	sex, race, educ, age, race*educ, educ*age, sex*educ, age^2	0.3823	456.7127	0.8571 [f]	25	21.7760
84	sex, race, educ, age, race*educ, educ*age, sex*educ, age^2, age^3	0.3825	456.8641	0.8699 [f]	26	23.3011
85	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age	0.3813	456.8757	0.8850 [f]	23	20.3341
86	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, age^2	0.3816	456.9768	0.8892 [f]	24	21.6858
87	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, age^2, age^3	0.3818	457.1224	0.9027 [f]	25	23.1905
88	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age	0.3813	456.8757	0.8850 [f]	23	20.3341
89	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, age^2	0.3816	456.9768	0.8892 [f]	24	21.6858
90	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, age^2, age^3	0.3818	457.1224	0.9027 [f]	25	23.1905
91	sex, race, educ, age, pw(race*educ, educ*age, sex*race), race*age	0.3807	457.6695	0.9684 [f]	24	24.0787
92	sex, race, educ, age, pw(race*educ, educ*age, sex*race), sex*race, age2	0.3809	457.7525	0.9847 [f]	25	25.3658
93	sex, race, educ, age, race*educ, educ*age, sex*race, sex*race, age^2, age^3	0.3812	457.8338	0.9928 [f]	26	26.6470
94	sex, race, educ, age, race*educ, educ*age, sex*race, sex*educ	0.3821	457.2014	0.9077 [f]	26	24.4648
95	sex, race, educ, age, race*educ, educ*age, sex*race, sex*educ, age^2	0.3826	457.1247	0.8936 [f]	27	25.2021
96	sex, race, educ, age, race*educ, educ*age, sex*race, sex*educ, age^2, age^3	0.3828	457.2707	0.9089 [f]	28	26.7070
97	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, sex*educ	0.3833	456.5750	0.8248 [e]	27	23.3066

Table 4-4 (Continued)

98	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, sex*educ, age^2	0.3836	456.6367	0.8272 [f]	28	24.5223
99	sex, race, educ, age, race*educ, educ*age, sex*race, sex*age, sex*educ, age^2, age^3	0.3838	456.7918	0.8404 [f]	29	26.0591
100	sex, race, educ, age, race*educ, educ*age, sex*age, sex*educ	0.3829	456.2973	0.8024 [f]	25	20.3421
101	sex, race, educ, age, race*educ, educ*age, sex*age, sex*educ, age^2	0.3832	456.3479	0.8037 [f]	26	21.5202
102	sex, race, educ, age, race*educ, educ*age, sex*age, sex*educ, age^2, age^3	0.3834	456.5088	0.8150 [f]	27	23.0785
103	sex, race, educ, age, sex*race, sex*educ, sex*age, race*educ, race*age, educ*age	0.3842	456.5115	0.7978 [f]	29	25.0940
104	sex, race, educ, age, sex*race, sex*educ, sex*age, race*educ, race*age, educ*age, age^2	0.3843	456.6715	0.8214 [f]	30	26.6477
105	sex, race, educ, age, sex*race, sex*educ, sex*age, race*educ, race*age, educ*age age^2, age^3	0.3846	456.7715	0.8239 [f]	31	27.9942
Max	sex, race, educ, age, sex*race, sex*educ, sex*age, race*educ, race*age, educ*age, sex*race*educ, sex*race*age, sex*educ*age, sex*race*educ*age, age^2, age^3	0.3917	457.9362	NA	53	54.0000

[a]Squared multiple correlation coefficient
[b]Mean Square Error
[c]Partial F statistic
[d]Number of model parameters omitting the intercept.
[e]Mallows Cp (Conceptual Predictive Criterion)
[f]Model not significantly different than the maximum model (p>0.05).

Table 4-5 Estimated Regression Coefficients for Predicting Functional Health Literacy Score (Sub-Sample 1)[1]

Model Term	Beta Coefficient	SE	t	P	95% Confidence Interval	
Female Sex	3.01	1.10	2.73	0.006	0.85	5.18
Black Race	-24.54	5.78	-4.24	0.000	-35.89	-13.20
Hispanic Race	-18.65	5.52	-3.38	0.001	-29.47	-7.83
Some College	-4.22	2.15	-1.96	0.050	-8.44	-0.001
HS Graduate	-11.41	1.99	-5.74	0.000	-15.32	-7.51
Some HS	-21.93	2.27	-9.66	0.000	-26.38	-17.48
Less than HS	-39.42	2.60	-15.16	0.000	-44.52	-34.32
Age	-0.82	0.27	-3.01	0.003	-1.36	-0.29
Black Race*Some College	9.18	7.37	1.25	0.213	-5.27	23.62
Black Race*HS Graduate	12.74	6.62	1.93	0.054	-0.23	25.72
Black Race*Some HS	8.50	6.71	1.27	0.205	-4.66	21.67
Black Race*Less than HS	9.96	6.66	1.49	0.135	-3.11	23.02
Hispanic Race*Some College	-5.39	7.61	-0.71	0.479	-20.32	9.53
Hispanic Race*HS Graduate	7.41	7.21	1.03	0.304	-6.73	21.56
Hispanic Race*Some HS	15.57	7.90	1.97	0.049	0.08	31.05
Hispanic Race*Less than HS	16.66	6.32	2.64	0.008	4.26	29.07
Some College*Age	-0.26	0.34	-0.78	0.435	-0.92	0.40
HS Graduate*Age	-0.72	0.31	-2.29	0.022	-1.33	-0.10
Some HS*Age	-0.78	0.34	-2.30	0.022	-1.45	-0.12
Less than HS*Age	-0.14	0.34	-0.41	0.679	-0.82	0.53
Constant	87.09	1.77	49.25	0.000	83.62	90.56

[1]n = 1,607

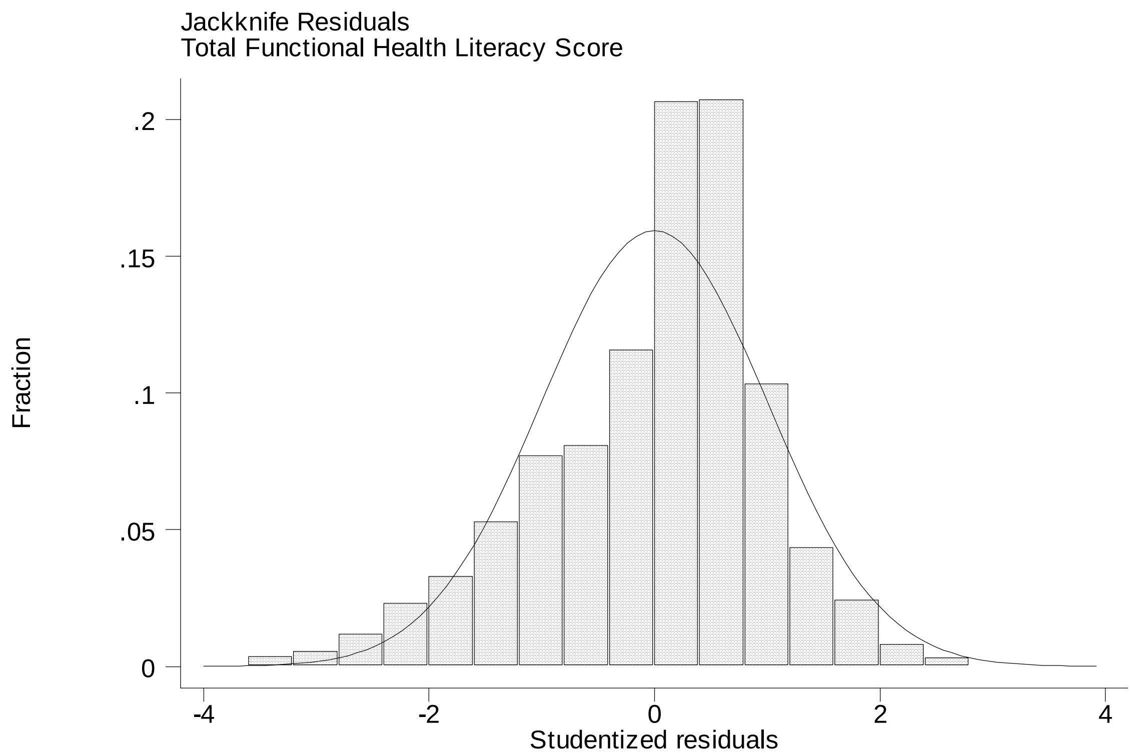

Figure 4-1 Jackknife Residuals for Total Functional Health Literacy Score

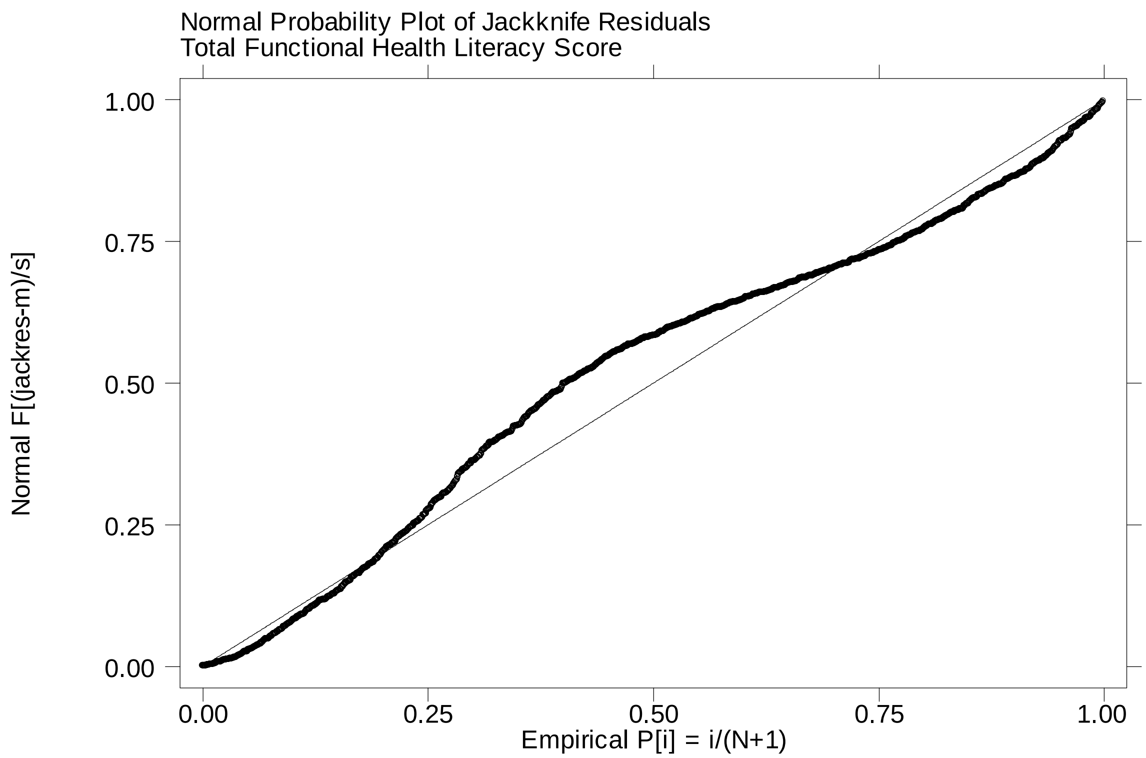

Figure 4-2 Normal Probability Plot of Jackknife Residuals for Total Functional Health Literacy Score

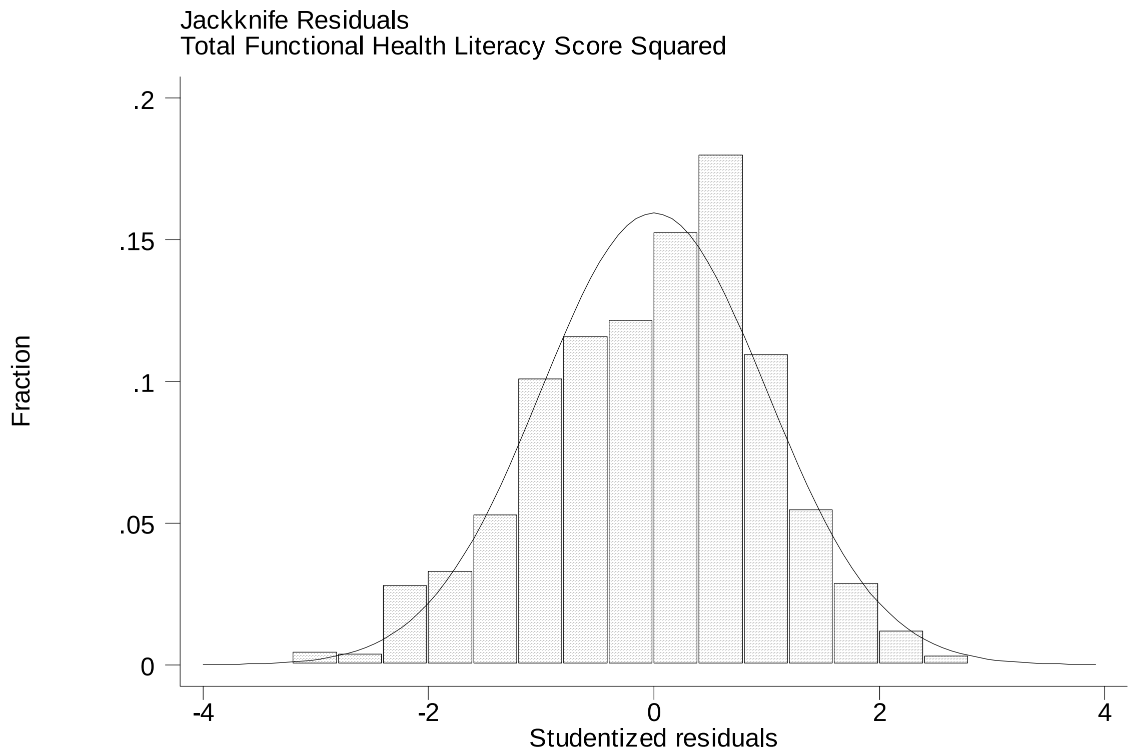

Figure 4-3 Jackknife Residuals for Total Functional Health Literacy Score Squared

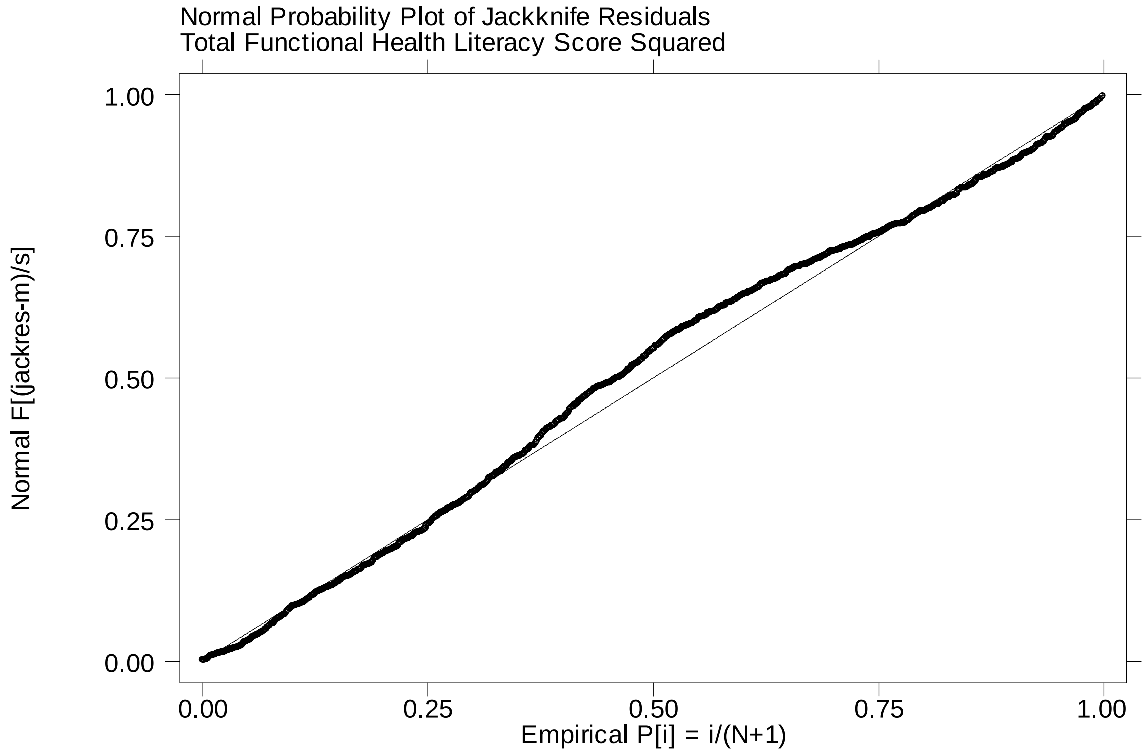

Figure 4-4 Normal Probability Plot of Jackknife Residuals for Total Functional Health Literacy Score Squared

Table 4-6 Collinearity Diagnostics – Variance Inflation Factor

	Variance Inflation Factor (VIF)
Black Race	12.81
Age	10.25
Hispanic Race	10.01
Hispanic Race*Less than High School	7.74
Black Race*Less than High School	5.87
Black Race*Some High School	4.68
Black Race*High School Graduate or Equivalent	4.55
High School Graduate or Equivalent*Age	4.30
Less than High School	3.43
Less than High School*Age	3.12
High School Graduate or Equivalent	3.11
Some College*Age	3.03
Some High School*Age	2.94
Black Race*Some College	2.80
Hispanic Race*High School Graduate or Equivalent	2.58
Some College	2.57
Some High School	2.57
Hispanic Race*Some College	2.25
Hispanic Race*Some High School	2.16
Female	1.04

Table 4-7 Predictive Accuracy of Model Cut Points for Identifying Individuals with Inadequate Functional Health Literacy

Predicted Transformed[1] Total Functional Health Literacy Score Cut Point	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Correctly Classified (%)	ROC Curve Area
6223 (High Sensitivity)	87.67	56.63	38.02	93.80	63.86	0.7215
4055 (High Specificity)	57.37	84.54	52.97	86.73	78.21	0.7096
5207 (High Sensitivity and Specificity)	74.26	72.82	45.34	90.31	76.72	0.7354

[1]Where Transformed Total Functional Health Literacy Score is squared and on a scale from 0 to 10,000

Table 4-8 Predictive Accuracy of Model Cut Points for Identifying Individuals with Either Inadequate or Marginal Functional Health Literacy

Predicted Transformed[1] Total Functional Health Literacy Score Cut Point	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)	Correctly Classified (%)	ROC Curve Area
6267 (High Sensitivity)	83.81	59.42	52.74	87.17	67.98	71.62
4485 (High Specificity)	57.83	85.38	68.13	78.93	75.72	71.61
5621 (High Sensitivity and Specificity)	73.49	73.08	59.60	83.61	73.22	73.28

[1]Where Transformed Total Functional Health Literacy Score is squared and on a scale from 0 to 10,000

Table 4-9 Estimated Regression Coefficients Used for Predicting Transformed Functional Health Literacy Score[1]

Model Term	Beta Coefficient	SE	t	P	95% Confidence Interval	
					Lower	Upper
Female Sex	332.08	95.41	3.48	0.001	145.01	519.14
Black Race	-2818.21	591.00	-4.7	0.000	-3976.98	-1659.44
Hispanic Race	-2048.23	436.88	-4.69	0.000	-2904.82	-1191.64
Some College	-644.45	186.92	-3.45	0.001	-1010.94	-277.95
HS Graduate	-1402.63	172.83	-8.12	0.000	-1741.49	-1063.76
Some HS	-2826.17	195.29	-14.47	0.000	-3209.07	-2443.27
Less than HS	-4888.72	227.45	-21.49	0.000	-5334.68	-4442.76
Age	-153.34	22.99	-6.67	0.000	-198.41	-108.27
Black Race*Some College	1086.76	729.52	1.49	0.136	-343.61	2517.14
Black Race*HS Graduate	577.78	656.19	0.88	0.379	-708.82	1864.39
Black Race*Some HS	1265.85	656.48	1.93	0.054	-21.31	2553.01
Black Race*Less than HS	1594.95	657.51	2.43	0.015	305.77	2884..14
Hispanic Race*Some College	-684.68	658.96	-1.04	0.299	-1976.71	607.34
Hispanic Race*HS Graduate	255.21	588.01	0.43	0.664	-897.70	1408.12
Hispanic Race*Some HS	1263.62	587.82	2.15	0.032	111.08	2416.17
Hispanic Race*Less than HS	2187.51	511.82	4.27	0.000	1183.98	3191.04
Some College*Age	-5.83	28.32	-0.21	0.837	-61.36	49.70
HS Graduate*Age	-27.91	26.50	-1.05	0.292	-79.87	24.05
Some HS*Age	-31.91	28.76	-1.11	0.267	-88.31	24.48
Less than HS*Age	65.68	28.84	2.28	0.023	9.14	122.23
Constant	7862.11	151.96	51.74	0.000	7564.17	8160.06

[1]n=3,209

Table 4-10 1992 National Adult Literacy Survey Demographic Characteristics

		N	(%)	Weighted (%)[1]
Sex				
	Male	779	36.33	44.08
	Female	1365	63.67	55.92
Race				
	White	1583	73.83	86.79
	Black	408	19.03	8.54
	Hispanic	153	7.14	4.67
Education				
	< HS[2]	608	28.36	27.03
	Some HS	415	19.36	20.89
	GED/HS Equiv/HS Graduate	495	23.09	25.51
	Some College/Technical or Trade School	375	17.49	15.49
	College Graduate	251	11.71	11.08
Family Income (in dollars)				
	<10,000	457	21.32	14.90
	10,000 – 14,999	235	10.96	11.22
	15,000 – 19,999	167	7.79	8.49
	20,000 – 24,999	126	5.88	6.56
	25,000 – 34,999	190	8.86	10.84
	35,000 – 49,999	116	5.41	6.96
	50,000 – 74,999	81	3.78	4.51
	≥75,000	55	2.57	3.34
	Missing	717	33.44	33.18
Functional Health Literacy (Estimated)				
	Inadequate	928	43.28	39.14
	Marginal	130	6.06	5.28
	Adequate	1086	50.65	55.58

[1]Estimated subpopulation size = 3907.84; [2]HS = High School

Table 4-11 Weighted Correlations Between the Estimate of Functional Health Literacy and Each Dimension of General Functional Literacy

	FHL[1]	Prose Literacy					Document Literacy					Quantitative Literacy				
		1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Prose																
1	0.64															
2	0.64	0.90														
3	0.62	0.90	0.90													
4	0.62	0.90	0.90	0.90												
5	0.62	0.90	0.90	0.91	0.91											
Document																
1	0.63	0.84	0.79	0.78	0.80	0.78										
2	0.62	0.77	0.83	0.77	0.79	0.77	0.90									
3	0.61	0.78	0.78	0.84	0.79	0.79	0.90	0.90								
4	0.62	0.77	0.77	0.76	0.84	0.77	0.90	0.90	0.90							
5	0.62	0.79	0.80	0.79	0.80	0.85	0.90	0.90	0.90	0.89						
Quantitative																
1	0.60	0.81	0.76	0.76	0.77	0.75	0.85	0.78	0.79	0.79	0.78					
2	0.60	0.76	0.80	0.75	0.76	0.75	0.79	0.84	0.79	0.79	0.78	0.90				
3	0.58	0.75	0.75	0.80	0.77	0.75	0.79	0.78	0.85	0.79	0.78	0.90	0.91			
4	0.60	0.76	0.75	0.76	0.82	0.75	0.80	0.79	0.79	0.86	0.79	0.90	0.91	0.91		
5	0.59	0.76	0.76	0.77	0.77	0.80	0.79	0.78	0.79	0.79	0.84	0.90	0.91	0.91	0.91	

[1]FHL = Functional Health Literacy; Estimated subpopulation size = 3907.84

Table 4-12 1996 Community Tracking Study Demographic Characteristics

		N	(%)	Weighted (%)[1]
Sex				
	Male	2957	42.79	40.71
	Female	3953	57.21	59.29
Race				
	White	6022	87.15	84.25
	Black	532	7.70	9.59
	Hispanic	356	5.15	6.16
Education				
	< HS[2]	884	12.79	18.85
	Some HS[2]	808	11.69	14.58
	GED/HS Equiv/HS[2] Graduate	2657	38.45	34.07
	Some College/Technical or Trade School	1184	17.13	17.49
	College Graduate	1377	19.93	15.00
Family Income (in dollars)				
	<10,000	1204	17.42	20.99
	10,000 – 14,999	712	10.30	11.56
	15,000 – 19,999	705	10.20	10.86
	20,000 – 24,999	677	9.80	9.77
	25,000 – 34,999	1211	17.53	16.77
	35,000 – 49,999	975	14.11	13.18
	50,000 – 74,999	841	12.17	10.36
	≥75,000	585	8.47	6.51
Usual Source of Care				
	No	396	5.73	5.89
	Yes	6501	94.08	94.11
	Missing	13	0.19	-
Insurance Type				
	Uninsured	58	0.84	0.95
	Medicaid Only	28	0.41	0.53
	Military Insurance	17	0.25	0.22
	Private – Direct Purchase	141	2.04	1.77
	Medicare HMO	137	16.45	15.04
	Medicare + Medigap or Other Public	3653	52.87	53.43
	Medicare Only	1876	27.15	28.06

Table 4-12 (Continued)

General Health Condition				
	Excellent	997	14.43	14.16
	Very Good	1924	27.84	26.71
	Good	2215	32.05	31.46
	Fair	1222	17.68	18.62
	Poor	552	7.99	9.06
Functional Health Literacy (Estimated)				
	Inadequate	1812	26.22	33.38
	Marginal	427	6.18	5.95
	Adequate	4671	67.60	60.67
Flu Shot within 12 months				
	No	2431	35.18	36.94
	Yes	4436	64.20	63.06
	Missing	43	0.62	-
Mammogram "Ever"[3]				
	No	722	18.26	20.10
	Yes	3199	80.93	79.90
	Missing	32	0.81	-
Mammogram within 2 years[3]				
	No	1334	33.75	36.19
	Yes	2587	65.44	63.81
	Missing	32	0.81	-
Mammogram within 1 year[3]				
	No	1960	49.58	51.72
	Yes	1961	49.61	48.28
	Missing	32	0.81	-

[1]Weighted Population Count = 33,623,164; [2]HS=High School; [3]Weighted Population Count (Females Only) = 19,935,667

Table 4-13 1996 Community Tracking Study Demographic Characteristics By Estimated Functional Health Literacy Category

		Inadequate (n=1812)	Inadequate/Marginal (n = 2239)	Adequate (n = 4671)
		Weighted %[1]	Weighted %[2]	Weighted %[3]
Sex				
	Male	42.31	41.77	40.02
	Female	57.69	58.23	59.98
Race				
	White	64.37	66.54	95.73
	Black	22.57	21.02	2.18
	Hispanic	13.06	12.44	2.09
Education				
	< HS[4]	56.48	47.93	0.00
	Some HS[4]	23.43	24.93	7.87
	GED/HS[4] Equiv/HS[4] Graduate	15.96	21.44	42.27
	Some College/Technical or Trade School	2.95	3.68	26.45
	College Graduate	1.18	2.02	23.41
Family Income (in dollars)				
	<10,000	35.13	33.52	12.87
	10,000 – 14,999	15.70	15.47	9.03
	15,000 – 19,999	12.86	12.32	9.91
	20,000 – 24,999	8.77	9.62	9.86
	25,000 – 34,999	11.32	12.04	19.83
	35,000 – 49,999	7.55	7.87	16.63
	50,000 – 74,999	5.61	5.86	13.27
	≥75,000	3.07	3.30	8.59

Table 4-13 (Continued)

Usual Source of Care				
	No	7.57	7.32	4.96
	Yes	92.43	92.68	95.04
Insurance Type				
	Uninsured	1.35	1.49	0.60
	Medicaid Only	1.16	0.98	0.24
	Military Insurance	0.37	0.31	0.17
	Private – Direct Purchase	0.97	1.03	2.24
	Medicare HMO	11.87	12.48	16.69
	Medicare + Medigap or Other Public	50.06	50.04	55.63
	Medicare Only	34.22	33.66	24.43
General Health Condition				
	Excellent	10.44	10.15	16.75
	Very Good	20.38	20.73	30.58
	Good	28.05	29.53	32.71
	Fair	26.25	25.35	14.25
	Poor	14.88	14.24	5.70
Flu Shot within 12 months				
	No	41.12	40.51	34.64
	Yes	58.88	59.49	65.36
Mammogram "Ever"[5,6,7]				
	No	30.76	29.22	14.43
	Yes	69.24	70.78	85.57
Mammogram within 2 years[5,6,7]				
	No	50.56	49.23	28.09
	Yes	49.44	50.77	71.91

Table 4-13 (Continued)

Mammogram within 1 year[5,6,7]				
	No	63.44	62.63	44.94
	Yes	36.56	37.37	55.06

[1]Weighted Population Count = 11,223,745; [2] Weighted Population Count = 13,225,044; [3]Weighted Population Count = 20,398,120; [4]HS=High School; [5]Weighted Population Count (Female Only) for Inadequate Category = 6,474,544; [6]Weighted Population Count (Female Only) for Inadequate/Marginal Category = 7,701,172; [7]Weighted Population Count (Female Only) for Adequate Category = 12,234,495

Table 4-14 Association Between Functional Health Literacy and Not Receiving a Flu Shot Within the Past 12 Months, Bivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.05	0.0005	0.95	0.93	0.98
Inadequate	0.27	0.0000	1.31	1.17	1.46
Marginal/Adequate	-	-	1.00	1.00	1.00
Inadequate/Marginal	0.25	0.0000	1.29	1.15	1.43
Adequate	-	-	1.00	1.00	1.00

[1]This continuous estimate represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-15 Association Between Functional Health Literacy and Not Ever Receiving a Mammogram, Bivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.25	0.0000	0.78	0.75	0.81
Inadequate	0.92	0.0000	2.52	2.10	3.02
Marginal/Adequate	-	-	1.00	1.00	1.00
Inadequate/Marginal	0.90	0.0000	2.45	2.07	2.89
Adequate	-	-	1.00	1.00	1.00

[1]This continuous estimate represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-16 Association Between Functional Health Literacy and Not Receiving a Mammogram Within the Past 2 Years, Bivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.25	0.0000	0.78	0.75	0.81
Inadequate	0.90	0.0000	2.46	2.13	2.85
Marginal/Adequate	-	-	1.00	1.00	1.00
Inadequate/Marginal	0.91	0.0000	2.48	2.19	2.81
Adequate	-	-	1.00	1.00	1.00

[1]This continuous estimate represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-17 Association Between Functional Health Literacy and Not Receiving a Mammogram Within the Past Year, Bivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.20	0.0000	0.82	0.79	0.85
Inadequate	0.71	0.0000	2.03	1.73	2.37
Marginal/Adequate	-	-	1.00	1.00	1.00
Inadequate/Marginal	0.72	0.0000	2.05	1.79	2.36
Adequate	-	-	1.00	1.00	1.00

[1]This continuous estimate represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-18 Association Between the Point Estimate of Functional Health Literacy and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.04	0.0052	0.96	0.93	0.99
Income (in thousands of dollars)					
<=25	0.05	0.4800	1.05	0.92	1.20
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.74	0.0165	2.10	1.15	3.86
Medicaid Only	0.49	0.4154	1.63	0.50	5.34
Military Insurance	1.28	0.0936	3.61	0.80	16.22
Private – Direct Purchase	0.37	0.0993	1.45	0.93	2.25
Medicare HMO	-0.41	0.0001	0.66	0.54	0.82
Medicare + Medigap or Other Public	-0.27	0.0002	0.76	0.66	0.88
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.94	0.0000	2.56	2.01	3.26
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.41	0.0052	1.50	1.13	2.00
Very Good	0.10	0.3844	1.11	0.88	1.40
Good	0.17	0.1708	1.19	0.93	1.53
Fair	-0.03	0.8440	0.97	0.75	1.26
Poor	-	-	1.00	1.00	1.00
Intercept	-0.32	0.0413	0.72	0.53	0.99
Model					
N	6701			Pseudo-R^2	0.0303
Weighted N	33,329,231			Model F value	38.91
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-19 Association Between the Upper 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.04	0.0055	0.96	0.93	0.99
Income (in thousands of dollars)					
<=25	0.05	0.4767	1.05	0.92	1.21
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.74	0.0163	2.10	1.15	3.86
Medicaid Only	0.49	0.4148	1.64	0.50	5.34
Military Insurance	1.29	0.0935	3.61	0.81	16.23
Private – Direct Purchase	0.37	0.0994	1.45	0.93	2.25
Medicare HMO	-0.41	0.0001	0.66	0.54	0.82
Medicare + Medigap or Other Public	-0.27	0.0002	0.76	0.66	0.88
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.94	0.0000	2.56	2.01	3.26
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.41	0.0053	1.50	1.13	2.00
Very Good	0.10	0.3873	1.11	0.88	1.40
Good	0.17	0.1720	1.19	0.93	1.53
Fair	-0.03	0.8430	0.97	0.75	1.26
Poor	-	-	1.00	1.00	1.00
Intercept	-0.10	0.6214	0.90	0.60	1.36
Model					
N	6701		Pseudo-R^2		0.0302
Weighted N	33,329,231		Model F value		38.81
			Model P-value		0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-20 Association Between the Lower 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.04	0.0049	0.96	0.93	0.99
Income (in thousands of dollars)					
<=25	0.05	0.4832	1.05	0.92	1.20
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.74	0.0166	2.10	1.14	3.85
Medicaid Only	0.49	0.4161	1.63	0.50	5.33
Military Insurance	1.28	0.0937	3.61	0.80	16.21
Private – Direct Purchase	0.37	0.0992	1.45	0.93	2.25
Medicare HMO	-0.41	0.0001	0.66	0.54	0.82
Medicare + Medigap or Other Public	-0.27	0.0002	0.76	0.66	0.88
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.94	0.0000	2.56	2.01	3.26
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.41	0.0051	1.50	1.13	2.00
Very Good	0.10	0.3816	1.11	0.88	1.40
Good	0.18	0.1696	1.19	0.93	1.53
Fair	-0.03	0.8449	0.97	0.75	1.26
Poor	-	-	1.00	1.00	1.00
Intercept	-0.55	0.0000	0.58	0.45	0.75
Model					
N	6701			Pseudo-R^2	0.0303
Weighted N	33,329,231			Model F value	39.01
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-21 Association Between the Inadequate Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate	0.25	0.0001	1.28	1.13	1.44
Marginal/Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.05	0.4555	1.05	0.92	1.20
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.75	0.0154	2.12	1.15	3.88
Medicaid Only	0.49	0.4222	1.63	0.50	5.35
Military Insurance	1.26	0.0903	3.54	0.82	15.29
Private – Direct Purchase	0.37	0.0959	1.45	0.94	2.25
Medicare HMO	-0.40	0.0001	0.67	0.54	0.82
Medicare + Medigap or Other Public	-0.27	0.0002	0.77	0.67	0.88
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.94	0.0000	2.56	2.01	3.26
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.41	0.0041	1.50	1.14	1.99
Very Good	0.11	0.3401	1.12	0.89	1.40
Good	0.18	0.1393	1.20	0.94	1.54
Fair	-0.02	0.8558	0.98	0.76	1.26
Poor	-	-	1.00	1.00	1.00
Intercept	-0.67	0.0000	0.51	0.39	0.66
Model					
N	6701			Pseudo-R^2	0.0314
Weighted N	33,329,231			Model F value	40.76
				Model P-value	0.0000

[1]Hosmer and Lemeshow Goodness of Fit Chi-square Statistic = 17.61 with 8 DF (p = 0.0243)

Table 4-22 Association Between the Inadequate/Marginal Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate/ Marginal	0.23	0.0003	1.26	1.11	1.43
Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.05	0.4818	1.05	0.92	1.20
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.73	0.0190	2.07	1.13	3.80
Medicaid Only	0.51	0.4053	1.66	0.50	5.45
Military Insurance	1.28	0.0869	3.59	0.83	15.54
Private – Direct Purchase	0.37	0.0982	1.45	0.93	2.25
Medicare HMO	-0.41	0.0001	0.67	0.54	0.82
Medicare + Medigap or Other Public	-0.26	0.0002	0.77	0.67	0.88
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.94	0.0000	2.56	2.01	3.26
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.41	0.0046	1.51	1.14	2.01
Very Good	0.11	0.3493	1.12	0.89	1.41
Good	0.18	0.1543	1.20	0.93	1.53
Fair	-0.02	0.8539	0.98	0.75	1.26
Poor	-	-	1.00	1.00	1.00
Intercept	-0.68	0.0000	0.51	0.39	0.67
Model					
N	6701		Pseudo-R^2		0.0313
Weighted N	33,329,231		Model F value		40.64
			Model P-value		0.0000

[1]Hosmer and Lemeshow Goodness of Fit Statistic = 22.49 with 8 DF (p = 0.0041)

Table 4-23 Association Between the Point Estimate of Functional Health Literacy and Not Ever Receiving a Mammogram, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.24	0.0000	0.79	0.75	0.83
Income (in thousands of dollars)					
<=25	0.05	0.7382	1.05	0.80	1.38
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.06	0.0088	2.90	1.31	6.43
Medicaid Only	0.62	0.2776	1.87	0.60	5.77
Military Insurance	1.24	0.0046	3.46	1.47	8.17
Private – Direct Purchase	-0.70	0.3192	0.50	0.13	1.97
Medicare HMO	-0.80	0.0000	0.45	0.31	0.66
Medicare + Medigap or Other Public	-0.19	0.0991	0.83	0.66	1.04
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.23	0.0000	3.42	2.37	4.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.23	0.2050	1.26	0.88	1.81
Very Good	0.04	0.8402	1.04	0.73	1.47
Good	-0.13	0.4958	0.88	0.61	1.27
Fair	-0.33	0.1016	0.72	0.49	1.07
Poor	-	-	1.00	1.00	1.00
Intercept	0.05	0.8594	1.05	0.62	1.77
Model					
N	3858			Pseudo-R^2	0.0798
Weighted N	19,721,229			Model F value	82.82
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-24 Association Between the Upper 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Ever Receiving a Mammogram, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.24	0.0000	0.79	0.75	0.83
Income (in thousands of dollars)					
<=25	0.05	0.7416	1.05	0.80	1.38
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.07	0.0085	2.91	1.31	6.45
Medicaid Only	0.63	0.2765	1.87	0.61	5.78
Military Insurance	1.24	0.0046	3.46	1.47	8.16
Private – Direct Purchase	-0.70	0.3199	0.50	0.13	1.97
Medicare HMO	-0.80	0.0000	0.45	0.31	0.66
Medicare + Medigap or Other Public	-0.19	0.0976	0.83	0.66	1.03
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.23	0.0000	3.42	2.37	4.95
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.23	0.2058	1.26	0.88	1.81
Very Good	0.04	0.8428	1.04	0.73	1.47
Good	-0.13	0.4943	0.88	0.61	1.27
Fair	-0.33	0.1012	0.72	0.49	1.07
Poor	-	-	1.00	1.00	1.00
Intercept	1.26	0.0009	3.54	1.68	7.43
Model					
N	3858			Pseudo-R^2	0.0797
Weighted N	19,721,229			Model F value	82.70
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-25 Association Between the Lower 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Ever Receiving a Mammogram, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.24	0.0000	0.79	0.75	0.83
Income (in thousands of dollars)					
<=25	0.05	0.7345	1.05	0.80	1.38
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.06	0.0091	2.89	1.30	6.42
Medicaid Only	0.62	0.2787	1.86	0.60	5.76
Military Insurance	1.24	0.0045	3.47	1.47	8.17
Private – Direct Purchase	-0.70	0.3185	0.50	0.13	1.97
Medicare HMO	-0.80	0.0000	0.45	0.31	0.65
Medicare + Medigap or Other Public	-0.19	0.1005	0.83	0.67	1.04
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.23	0.0000	3.42	2.37	4.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.23	0.2043	1.26	0.88	1.81
Very Good	0.04	0.8378	1.04	0.73	1.48
Good	-0.13	0.4972	0.88	0.61	1.27
Fair	-0.33	0.1020	0.72	0.49	1.07
Poor	-	-	1.00	1.00	1.00
Intercept	-1.16	0.0000	0.31	0.21	0.46
Model					
N	3858			Pseudo-R^2	0.0798
Weighted N	19,721,229			Model F value	82.93
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-26 Association Between the Inadequate Functional Health Literacy Estimate and Not Ever Receiving a Mammogram, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate	0.82	0.0000	2.27	1.85	2.79
Marginal/Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.14	0.2829	1.15	0.89	1.50
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.12	0.0032	3.08	1.46	6.50
Medicaid Only	0.75	0.2149	2.12	0.65	6.92
Military Insurance	1.13	0.0059	3.11	1.39	6.97
Private – Direct Purchase	-0.82	0.2331	0.44	0.12	1.69
Medicare HMO	-0.83	0.0000	0.44	0.30	0.64
Medicare + Medigap or Other Public	-0.20	0.0728	0.82	0.66	1.02
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.25	0.0000	3.48	2.45	4.95
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.10	0.5668	1.11	0.78	1.59
Very Good	-0.06	0.7220	0.94	0.66	1.33
Good	-0.20	0.2792	0.82	0.57	1.18
Fair	-0.36	0.0703	0.70	0.47	1.03
Poor	-	-	1.00	1.00	1.00
Intercept	-1.58	0.0000	0.21	0.14	0.30
Model					
N	3858			Pseudo-R^2	0.0710
Weighted N	19,721,229			Model F value	74.81
				Model P-value	0.0000

[1]Hosmer and Lemeshow Goodness of Fit Statistic = 5.99 with 8 DF (p = 0.6482)

Table 4-27 Association Between the Inadequate/Marginal Functional Health Literacy Estimate and Not Ever Receiving a Mammogram, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate/Marginal	0.79	0.0000	2.21	1.85	2.65
Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.13	0.3174	1.14	0.88	1.49
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.04	0.0094	2.83	1.29	6.21
Medicaid Only	0.81	0.1817	2.24	0.69	7.29
Military Insurance	1.18	0.0044	3.25	1.44	7.32
Private – Direct Purchase	-0.80	0.2413	0.45	0.12	1.72
Medicare HMO	-0.84	0.0000	0.43	0.29	0.64
Medicare + Medigap or Other Public	-0.20	0.0759	0.82	0.65	1.02
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.24	0.0000	3.47	2.43	4.95
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.13	0.4846	1.14	0.79	1.63
Very Good	-0.06	0.7230	0.94	0.66	1.34
Good	-0.22	0.2397	0.80	0.56	1.16
Fair	-0.35	0.0840	0.70	0.47	1.05
Poor	-	-	1.00	1.00	1.00
Intercept	1.62	0.0000	0.20	0.14	0.29
Model					
N	3858			Pseudo-R^2	0.0704
Weighted N	19,721,229			Model F value	76.33
				Model P-value	0.0000

[1]Hosmer and Lemeshow Goodness of Fit Statistic = 6.24 with 8 DF (p = 0.6204)

Table 4-28 Association Between the Point Estimate of Functional Health Literacy and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.06	0.0014	0.94	0.90	0.98
Income (in thousands of dollars)					
<=25	0.06	0.4914	1.06	0.89	1.27
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.85	0.0006	6.34	2.21	18.17
Medicaid Only	0.74	0.3175	2.10	0.49	9.05
Military Insurance	2.14	0.1214	8.50	0.57	127.55
Private – Direct Purchase	0.36	0.2291	1.44	0.80	2.60
Medicare HMO	-0.31	0.0063	0.73	0.59	0.92
Medicare + Medigap or Other Public	-0.15	0.0446	0.86	0.74	1.00
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.81	0.0000	2.24	1.71	2.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.33	0.0448	1.39	1.01	1.92
Very Good	0.07	0.6400	1.07	0.81	1.40
Good	0.19	0.2173	1.21	0.89	1.64
Fair	-0.14	0.3812	0.87	0.64	1.19
Poor	-	-	1.00	1.00	1.00
Intercept	-0.20	0.3231	0.82	0.55	1.22
Model					
N	3865			Pseudo-R^2	0.0328
Weighted N	19,745,011			Model F value	26.26
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-29 Association Between the Upper 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.06	0.0015	0.94	0.90	0.98
Income (in thousands of dollars)					
<=25	0.06	0.4917	1.06	0.89	1.27
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.85	0.0006	6.34	2.21	18.18
Medicaid Only	0.74	0.3170	2.11	0.49	9.06
Military Insurance	2.14	0.1215	8.50	0.57	127.53
Private – Direct Purchase	0.36	0.2291	1.44	0.80	2.60
Medicare HMO	-0.31	0.0063	0.73	0.59	0.92
Medicare + Medigap or Other Public	-0.15	0.0443	0.86	0.74	1.00
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.81	0.0000	2.24	1.71	2.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.33	0.0450	1.39	1.01	1.92
Very Good	0.07	0.6417	1.07	0.81	1.40
Good	0.19	0.2179	1.21	0.89	1.64
Fair	-0.14	0.3806	0.87	0.64	1.19
Poor	-	-	1.00	1.00	1.00
Intercept	0.13	0.6525	1.14	0.65	1.99
Model					
N	3865		Pseudo-R^2		0.0327
Weighted N	19,745,011		Model F value		26.24
			Model P-value		0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-30 Association Between the Lower 95% Confidence Boundary of the Functional Health Literacy Estimate and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Continuous[1]	-0.06	0.0014	0.94	0.90	0.98
Income (in thousands of dollars)					
<=25	0.06	0.4912	1.06	0.89	1.27
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.85	0.0006	6.33	2.21	18.16
Medicaid Only	0.74	0.3180	2.10	0.49	9.04
Military Insurance	2.14	0.1213	8.50	0.57	127.57
Private – Direct Purchase	0.36	0.2291	1.44	0.80	2.60
Medicare HMO	-0.31	0.0063	0.73	0.59	0.92
Medicare + Medigap or Other Public	-0.15	0.0450	0.86	0.74	1.00
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.81	0.0000	2.24	1.71	2.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.33	0.0446	1.39	1.01	1.92
Very Good	0.07	0.6384	1.07	0.81	1.40
Good	0.19	0.2167	1.21	0.89	1.64
Fair	-0.14	0.3817	0.87	0.64	1.19
Poor	-	-	1.00	1.00	1.00
Intercept	-0.53	0.0005	0.59	0.44	0.79
Model					
N	3865			Pseudo-R^2	0.0328
Weighted N	19,745,011			Model F value	26.27
				Model P-value	0.0000

[1]This continuous estimate of functional health literacy represents a 10 point incremental change on a 100-point functional health literacy scale.

Table 4-31 Association Between the Inadequate Functional Health Literacy Category and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate	0.31	0.0002	1.36	1.15	1.60
Marginal/Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.08	0.3777	1.08	0.91	1.28
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.87	0.0005	6.48	2.27	18.49
Medicaid Only	0.75	0.3101	2.12	0.50	9.06
Military Insurance	2.11	0.1226	8.26	0.57	120.39
Private – Direct Purchase	0.35	0.2519	1.41	0.78	2.55
Medicare HMO	-0.31	0.0079	0.74	0.59	0.92
Medicare + Medigap or Other Public	-0.15	0.0491	0.86	0.74	1.00
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.81	0.0000	2.25	1.71	2.96
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.32	0.0531	1.37	1.00	1.89
Very Good	0.06	0.6759	1.06	0.81	1.38
Good	0.19	0.2049	1.21	0.90	1.63
Fair	-0.14	0.3641	0.87	0.63	1.18
Poor	-	-	1.00	1.00	1.00
Intercept	0.69	0.000	0.50	0.38	0.67
Model					
N	3865			Pseudo-R^2	0.0336
Weighted N	19,745,011			Model F value	26.46
				Model P-value	0.0000

Table 4-32 Association Between the Inadequate/Marginal Functional Health Literacy Category and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate/Marginal	0.25	0.0007	1.28	1.11	1.48
Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.08	0.3306	1.09	0.92	1.28
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.83	0.0009	6.22	2.12	18.24
Medicaid Only	0.78	0.2931	2.19	0.51	9.44
Military Insurance	2.13	0.1207	8.40	0.57	123.47
Private – Direct Purchase	0.34	0.2643	1.40	0.78	2.53
Medicare HMO	-0.32	0.0062	0.73	0.58	0.91
Medicare + Medigap or Other Public	-0.16	0.0428	0.86	0.74	0.99
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	0.81	0.0000	2.25	1.71	2.96
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.31	0.0620	1.36	0.98	1.89
Very Good	0.05	0.7403	1.05	0.80	1.37
Good	0.18	0.2617	1.19	0.88	1.62
Fair	-0.15	0.3648	0.86	0.63	1.19
Poor	-	-	1.00	1.00	1.00
Intercept	0.68	0.000	0.51	0.38	0.69
Model					
N	3865			Pseudo-R^2	0.0324
Weighted N	19,745,011			Model F value	24.98
				Model P-value	0.0000

Table 4-33 Association Between the Inadequate Functional Health Literacy Estimate and Not Receiving a Mammogram Within the Past 2 Years, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate	0.79	0.0000	2.20	1.82	2.66
Marginal/Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.20	0.0363	1.22	1.01	1.48
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.71	0.1079	2.04	0.86	4.87
Medicaid Only	0.17	0.7857	1.18	0.36	3.91
Military Insurance	0.32	0.4144	1.37	0.64	2.93
Private – Direct Purchase	-0.51	0.2496	0.60	0.25	1.43
Medicare HMO	-0.73	0.0000	0.48	0.37	0.62
Medicare + Medigap or Other Public	-0.08	0.4920	0.92	0.73	1.16
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.26	0.0000	3.54	2.49	5.03
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	-0.26	0.2507	0.77	0.49	1.20
Very Good	-0.30	0.0438	0.74	0.55	0.99
Good	-0.31	0.0344	0.74	0.55	0.98
Fair	-0.44	0.0063	0.64	0.47	0.88
Poor	-	-	1.00	1.00	1.00
Intercept	0.63	0.0006	0.53	0.37	0.76
Model					
N	3858			Pseudo-R^2	0.08
Weighted N	19,721229			Model F value	40.46
				Model P-value	0.0000

Table 4-34 Association Between the Inadequate/Marginal Functional Health Literacy Estimate and Not Receiving a Mammogram Within the Past 2 years, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate/Marginal	0.80	0.0000	2.23	1.90	2.62
Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.18	0.0623	1.20	0.99	1.46
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.63	0.1803	1.88	0.75	4.75
Medicaid Only	0.22	0.7226	1.24	0.37	4.12
Military Insurance	0.36	0.3547	1.43	0.67	3.07
Private – Direct Purchase	-0.49	0.2729	0.61	0.25	1.47
Medicare HMO	-0.73	0.0000	0.48	0.38	0.62
Medicare + Medigap or Other Public	-0.08	0.5261	0.93	0.74	1.17
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.26	0.0000	3.53	2.47	5.05
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	-0.23	0.3289	0.80	0.51	1.26
Very Good	-0.29	0.0566	0.75	0.56	1.01
Good	-0.31	0.0340	0.73	0.55	0.98
Fair	-0.43	0.0089	0.65	0.47	0.90
Poor	-	-	1.00	1.00	1.00
Intercept	-0.68	0.0001	0.50	0.36	0.72
Model					
N	3858			Pseudo-R^2	0.082490
Weighted N	19,721,229			Model F value	42.30
				Model P-value	0.0000

Table 4-35 Association Between the Inadequate Functional Health Literacy Estimate and Not Receiving a Mammogram Within the Past Year, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate	-0.59	0.0000	1.81	1.52	2.16
Marginal/Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	-0.28	0.0009	1.33	0.54	3.27
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	-0.28	0.5370	1.33	0.54	3.27
Medicaid Only	-0.28	0.6442	1.32	0.41	4.29
Military Insurance	0.21	0.6039	0.81	0.37	1.78
Private – Direct Purchase	0.45	0.1815	0.64	0.33	1.23
Medicare HMO	0.50	0.0001	0.61	0.47	0.78
Medicare + Medigap or Other Public	0.05	0.6017	0.95	0.80	1.14
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	-1.04	0.0000	2.84	1.88	4.29
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.23	0.2120	0.80	0.56	1.14
Very Good	0.28	0.0928	0.76	0.55	1.05
Good	0.18	0.2031	0.84	0.63	1.10
Fair	0.39	0.0057	0.68	0.51	0.89
Poor	-	-	1.00	1.00	1.00
Intercept	-0.02	0.8858	0.98	0.72	1.33
Model					
N	3858			Pseudo-R^2	0.054165
Weighted N	19,721,229			Model F value	9.69
				Model P-value	0.0000

Table 4-36 Association Between the Inadequate/Marginal Functional Health Literacy Estimate and Not Receiving a Mammogram Within the Past Year, Multivariate Logistic Regression

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Literacy					
Inadequate/Marginal	0.61	0.0000	1.84	1.58	2.15
Adequate	-	-	1.00	1.00	1.00
Income (in thousands of dollars)					
<=25	0.27	0.0020	1.30	1.10	1.54
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.22	0.6431	1.25	0.49	3.22
Medicaid Only	0.31	0.6017	1.37	0.42	4.45
Military Insurance	-0.18	0.6596	0.84	0.38	1.84
Private – Direct Purchase	-0.43	0.2041	0.65	0.33	1.27
Medicare HMO	-0.50	0.0001	0.61	0.47	0.78
Medicare + Medigap or Other Public	-0.04	0.6525	0.96	0.80	1.15
Medicare Only	-	-	1.00	1.00	1.00
Usual Source of Care					
No	1.04	0.0000	2.83	1.86	4.30
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	-0.19	0.2859	0.82	0.58	1.18
Very Good	-0.26	0.1143	0.77	0.56	1.06
Good	-0.17	0.2142	0.84	0.64	1.11
Fair	-0.38	0.0074	0.68	0.52	0.90
Poor	-	-	1.00	1.00	1.00
Intercept	-0.07	0.6547	0.93	0.69	1.27
Model					
N	3858			Pseudo-R^2	0.056336
Weighted N	19,721,229			Model F value	10.88
				Model P-value	0.0000

Table 4-37 Association Between the Independent Predictors of Functional Health Literacy and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Sex					
Female	0.10	0.1642	1.11	0.96	1.28
Male	-	-	1.00	1.00	1.00
Race					
Black	0.64	0.0000	1.91	1.53	2.38
Hispanic	0.32	0.3246	1.37	0.73	2.57
White	-	-	1.00	1.00	1.00
Education					
Less than HS[2]	0.55	0.0000	1.74	1.38	2.19
Some HS	0.46	0.0000	1.59	1.30	1.93
HS Graduate/Equiv.	0.35	0.0000	1.43	1.21	1.67
Some College	0.13	0.1726	1.14	0.94	1.37
College Graduate	-	-	1.00	1.00	1.00
Age (yearly increments)	-0.03	0.0000	0.97	0.96	0.98
Income (in thousands of dollars)					
<=25	-0.03	0.7159	0.97	0.85	1.12
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	0.53	0.1077	1.70	0.89	3.26
Medicaid Only	0.26	0.6370	1.30	0.44	3.86
Military Insurance	0.98	0.1709	2.66	0.66	10.79
Private – Direct Purchase	0.32	0.1394	1.38	0.90	2.12
Medicare HMO	-0.39	0.0002	0.68	0.55	0.83
Medicare + Medigap or Other Public	-0.22	0.0021	0.80	0.70	0.92
Medicare Only	-	-	1.00	1.00	1.00

Table 4-37 (Continued)

Usual Source of Care					
No	0.92	0.0000	2.51	1.98	3.17
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.45	0.0020	1.57	1.18	2.10
Very Good	0.12	0.3058	1.13	0.90	1.41
Good	0.17	0.1828	1.18	0.92	1.52
Fair	-0.07	0.5989	0.93	0.72	1.21
Poor	-	-	1.00	1.00	1.00
Intercept	-1.02	0.0000	0.36	0.26	0.49
Model					
N	6701			Pseudo-R^2	0.0546
Weighted N	33,329,231			Model F value	35.37
				Model P-value	0.0000

[1]Hosmer and Lemeshow Goodness of Fit Statistic = 11.61 with 8 DF (p = 0.1693)
[2]HS = High School

Table 4-38 Association between the Independent Predictors of Functional Health Literacy and Not Ever Receiving a Mammogram, Multivariate Logistic Regression[1]

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Sex					
Female	-	-	-	-	-
Male	-	-	-	-	-
Race					
Black	0.37	0.0123	1.44	1.08	1.92
Hispanic	-0.12	0.7645	0.89	0.42	1.90
White	-	-	1.00	1.00	1.00
Education					
Less than HS[2]	1.05	0.0000	2.84	1.95	4.16
Some HS	0.81	0.0000	2.26	1.55	3.28
HS Graduate/Equiv.	0.45	0.0118	1.57	1.10	2.22
Some College	0.11	0.5734	1.12	0.75	1.67
College Graduate	-	-	1.00	1.00	1.00
Age (yearly increments)	0.05	0.0000	1.05	1.03	1.07
Income (in thousands of dollars)					
<=25	0.03	0.8316	1.03	0.79	1.35
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.20	0.0041	3.33	1.46	7.55
Medicaid Only	0.76	0.2041	2.13	0.66	6.84
Military Insurance	1.16	0.0064	3.18	1.38	7.30
Private – Direct Purchase	-0.62	0.3764	0.54	0.14	2.13
Medicare HMO	-0.79	0.0000	0.45	0.31	0.66
Medicare + Medigap or Other Public	-0.20	0.0902	0.82	0.66	1.03
Medicare Only	-	-	1.00	1.00	1.00

Table 4-38 (Continued)

Usual Source of Care					
No	1.25	0.0000	3.49	2.43	5.01
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.21	0.2681	1.23	0.85	1.77
Very Good	0.00	0.9830	1.00	0.70	1.43
Good	-0.15	0.4139	0.86	0.59	1.24
Fair	-0.35	0.0832	0.71	0.48	1.05
Poor	-	-	1.00	1.00	1.00
Intercept	-1.88	0.0000	0.15	0.09	0.25
Model					
N	3858			Pseudo-R^2	0.0836
Weighted N	19,721,229			Model F value	63.25
				Model P-value	0.0000

[1]Hosmer and Lemeshow Goodness of Fit Statistic = 7.90 with 8 DF (p = 0.4429)
[2]HS = High School

Table 4-39 Association between the Independent Predictors of Functional Health Literacy and Not Receiving a Flu Shot Within the Past 12 Months, Multivariate Logistic Regression (Female Only)

Variable	Coefficient	p-value	OR	OR 95% CI	
				Lower	Upper
Sex					
Female	-	-	-	-	-
Male	-	-	-	-	-
Race					
Black	0.64	0.0001	1.89	1.37	2.61
Hispanic	0.07	0.7814	1.07	0.67	1.70
White	-	-	1.00	1.00	1.00
Education					
Less than HS	0.84	0.0000	2.32	1.66	3.25
Some HS	0.60	0.0000	1.83	1.39	2.40
HS Graduate/Equiv.	0.53	0.0000	1.70	1.33	2.17
Some College	0.23	0.1231	1.26	0.94	1.68
College Graduate	-	-	1.00	1.00	1.00
Age (yearly increments)	-0.03	0.0000	0.97	0.96	0.98
Income (in thousands of dollars)					
<=25	0.00	0.9558	1.00	0.84	1.18
>25	-	-	1.00	1.00	1.00
Insurance					
Uninsured	1.74	0.0015	5.68	1.95	16.59
Medicaid Only	0.62	0.3826	1.86	0.46	7.44
Military Insurance	1.85	0.1387	6.35	0.55	73.43
Private – Direct Purchase	0.34	0.2680	1.41	0.77	2.57
Medicare HMO	-0.29	0.0161	0.75	0.59	0.95
Medicare + Medigap or Other Public	-0.11	0.1458	0.89	0.77	2.57
Medicare Only	-	-	1.00	1.00	1.00

Table 4-39 (Continued)

Usual Source of Care					
No	0.82	0.0000	2.26	1.74	2.94
Yes	-	-	1.00	1.00	1.00
General Health Condition					
Excellent	0.40	0.0170	1.50	1.08	2.09
Very Good	0.11	0.4359	1.12	0.85	1.47
Good	0.22	0.1579	1.25	0.92	1.70
Fair	-0.15	0.3541	0.86	0.62	1.19
Poor	-	-	1.00	1.00	1.00
Intercept	-1.15	0.0000	0.32	0.22	0.45
Model					
N	3865			Pseudo-R^2	0.0576
Weighted N	19,745,011			Model F value	23.37
				Model P-value	0.0000

Table 4-40 1996 Community Tracking Study Demographic Characteristics By Estimated Functional Health Literacy Category and HMO Participation

		Inadequate		Inadequate /Marginal		Adequate	
		Weighted %		Weighted %		Weighted %	
		HMO[1] (n = 232)	Non-HMO[2] (n = 1509)	HMO[3] (n = 306)	Non-HMO[4] (n = 1852)	HMO[5] (n = 831)	Non-HMO[6] (n = 3677)
Sex							
	Male	51.05	41.27	50.06	40.74	42.30	39.04
	Female	48.95	58.73	49.94	59.26	57.70	60.96
Race							
	White	54.89	67.22	57.61	69.57	94.52	96.54
	Black	20.07	22.31	18.68	20.58	2.31	2.03
	Hispanic	25.05	10.47	23.72	9.85	3.18	1.43
Education							
	< HS[7]	44.70	57.64	36.07	49.26	0.00	0.00
	Some HS[7]	25.87	23.33	27.52	24.78	5.74	8.48
	GED/HS[7] Equiv/HS[7] Graduate	22.98	15.10	28.32	20.70	44.46	41.78
	Some College/Technical or Trade School	4.40	2.82	4.72	3.52	26.25	26.55
	College Graduate	2.05	1.12	3.37	1.75	23.55	23.19

Table 4-40 (Continued)

Family Income (in dollars)							
	<10,000	25.22	36.59	24.39	34.85	13.01	12.86
	10,000 – 14,999	16.55	15.87	16.55	15.40	9.28	9.14
	15,000 – 19,999	14.76	12.36	13.71	11.98	9.00	10.01
	20,000 – 24,999	8.65	8.93	10.67	9.68	10.24	9.89
	25,000 – 34,999	16.05	10.97	14.77	11.97	21.88	19.52
	35,000 – 49,999	8.09	7.44	9.42	7.64	16.47	16.80
	50,000 – 74,999	7.49	4.87	6.62	5.31	12.28	13.22
	≥75,000	3.20	2.97	3.88	3.18	7.85	8.55
Usual Source of Care							
	No	6.86	7.08	6.02	6.86	3.81	4.94
	Yes	93.14	92.92	93.98	93.14	96.19	95.06
Insurance Type							
	Uninsured	0.00	0.00	0.00	0.00	0.00	0.00
	Medicaid Only	0.00	0.00	0.00	0.00	0.00	0.00
	Military Insurance	0.00	0.00	0.00	0.00	0.00	0.00
	Private – Direct Purchase	0.00	0.00	0.00	0.00	0.00	0.00
	Medicare HMO	100.00	0.00	100.00	0.00	100.00	0.00
	Medicare + Medigap or Other Public	0.00	59.39	0.00	59.79	0.00	69.49
	Medicare Only	0.00	40.61	0.00	40.21	0.00	30.51
General Health Condition							
	Excellent	11.79	10.20	12.13	9.84	15.13	16.64
	Very Good	18.35	20.73	19.30	20.90	35.33	29.77
	Good	36.11	27.13	36.15	28.90	33.49	32.71
	Fair	23.11	26.25	22.55	25.44	12.09	14.68
	Poor	10.64	15.68	9.87	14.93	3.96	6.21

Table 4-40 (Continued)

Flu Shot within 12 months							
	No	34.67	41.09	35.57	40.30	29.61	34.98
	Yes	65.33	58.91	64.43	59.70	70.39	65.02
Mammogram "Ever"[8]							
	No	18.07	31.19	15.65	29.94	9.02	15.31
	Yes	81.93	68.81	84.35	70.06	90.98	84.69
Mammogram within 2 years[8]							
	No	33.56	52.16	31.57	51.17	18.76	29.71
	Yes	66.44	47.84	68.43	48.83	81.24	70.29
Mammogram with 1 year[8]							
	No	48.93	65.00	51.07	64.11	35.75	46.62
	Yes	51.07	35.00	48.93	35.89	64.25	53.38
Mean Age (in years)		77.70	77.22	77.20	77.14	71.07	71.28

[1]Weighted Population Count = 1,332,196; [2] Weighted Population Count = 9,459,249; [3]Weighted Population Count = 1,650,894; [4]Weighted Population Count = 11,068,803; [5]Weighted Population Count = 3,404,686; [6]Weighted Population Count = 16,330,191; [7]HS=High School; [8]Weighted population counts are reduced accordingly to represent female-only population

Table 4-41 Bivariate Associations between Functional Health Literacy and Not Receiving a Flu Shot or Mammogram by HMO Participation

	Overall Sample (n = 6701)[1]	Medicare HMO (n = 1137)[1]	Non HMO (n = 5529)[1]
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Inadequate Functional Health Literacy			
Flu Shot within 12 months	1.31 (1.17 – 1.46)	1.21 (0.88 – 1.68)	1.29 (1.15 – 1.45)
Mammography Ever	2.52 (2.10 – 3.02)	2.28 (1.04 – 5.02)	2.38 (1.94 – 2.92)
Mammography within past 1 year	2.03 (1.73 – 2.37)	1.59 (1.06 – 2.37)	2.03 (1.69 – 2.44)
Mammography within past 2 years	2.46 (2.13 – 2.85)	2.13 (1.25 – 3.63)	2.41 (2.04 – 2.85)
Inadequate/Marginal Functional Health Literacy			
Flu Shot within 12 months	1.29 (1.15 – 1.43)	1.31 (0.94 – 1.83)	1.25 (1.11 – 1.42)
Mammography Ever	2.45 (2.07 – 2.89)	1.87 (0.88 – 3.97)	2.36 (1.96 – 2.85)
Mammography within past 1 year	2.05 (1.79 – 2.36)	1.88 (1.30 – 2.72)	2.05 (1.75 – 2.39)
Mammography within past 2 years	2.48 (2.19 – 2.81)	2.00 (1.23 – 3.25)	2.48 (2.15 – 2.85)

[1]Medicare HMO and Non-HMO sample sizes do not sum to the overall sample size as only respondents reporting Medicare or Medicare plus Medigap or other public insurance were include in the subgroup analysis.

Table 4-42 Multivariate[1,2] Associations between Functional Health Literacy and Not Receiving a Flu Shot or Mammogram by HMO Participation

	Overall Sample (n = 6701)[3]	Medicare HMO (n = 1137)[3]	Non HMO (n = 5529)[3]
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Inadequate Functional Health Literacy			
Flu Shot within 12 mos.	1.28 (1.13 – 1.44)	1.15 (0.79 – 1.68)	1.31 (1.14 – 1.50)
Mammography Ever	2.27 (1.85 – 2.79)	1.73 (0.77 – 3.90)	2.34 (1.92 – 2.86)
Mammography within past 1 yr	1.81 (1.52 – 2.16)	1.43 (0.91 – 2.23)	1.90 (1.58 – 2.28)
Mammography within past 2 yrs	2.20 (1.82 – 2.66)	1.89 (1.05 – 3.42)	2.27 (1.89 – 2.72)
Inadequate/Marginal Functional Health Literacy			
Flu Shot within 12 mos.	1.26 (1.11 – 1.43)	1.27 (0.83 – 1.94)	1.27 (1.10 – 1.47)
Mammography Ever	2.21 (1.85 – 2.65)	1.50 (0.71 – 3.18)	2.34 (1.97 – 2.79)
Mammography within past 1 yr	1.84 (1.58 – 2.15)	1.77 (1.17 – 2.66)	1.90 (1.63 – 2.23)
Mammography within past 2 yrs	2.23 (1.90 – 2.62)	1.86 (1.08 – 3.19)	2.34 (2.01 – 2.73)

[1]For the overall sample, model covariates include income, insurance status, usual source of care and general health status.
[2]For the Medicare HMO and Non-HMO samples, model covariates include income, usual source of care and general health status.
[3]Medicare HMO and Non-HMO sample sizes do not sum to the overall sample size as only respondents reporting Medicare only or Medicare plus Medigap or other public insurance were include in the subgroup analysis.

5. CHAPTER 5 -DISCUSSION

The research contained herein contributes to the body of health literacy literature in a number of important ways. It is the first to develop a model derived from commonly collected demographic variables to estimate functional health literacy. Second, it expands the current knowledge about the prevalence of inadequate and marginal functional health literacy in the elderly from a restricted regional sample of Medicare managed care enrollees to a nationally representative population-based estimate. It provides further evidence of construct validity of the health literacy construct through demonstrated positive associations with general functional literacy. Finally, this research confirms the significant, direct relationship between inadequate and marginal functional health literacy and preventive health services utilization in a nationally representative sample of elderly $\geq$ 65 years of age.

5.1. ESTIMATING FUNCTIONAL HEALTH LITERACY

Building on previous research (Reder, 1997; Sentell, 2003), this study used standard multivariate regression modeling and associated diagnostic procedures to develop a model to estimate functional health literacy from a constellation of observed demographic and functional health literacy variables. This study represents the first attempt to model functional health literacy from a common collection of demographic characteristics (i.e., sex, race, education, and age). The estimated model explained 36.5% of the variance in functional health literacy. Correctly identifying 73% of individuals with inadequate or marginal functional health literacy, the model demonstrated fair to good diagnostic properties. Although the population prevalence of inadequate or marginal functional health literacy is lower than the prevalence of adequate functional health literacy in the elderly, the model did not trade sensitivity for specificity to enhance diagnostic accuracy. In fact, the model correctly identified 73% of those with inadequate or marginal functional health literacy as well as 73% of those who had adequate functional health literacy.

This reported research was not the first attempt to model the literacy construct. For example, the 1992 NALS data have been used to estimate general functional literacy proficiencies for population subgroups in small census areas using demographic, occupational and educational characteristics (Reder, 1997). The precedent for modeling general functional literacy to assess relationships with health status and health care utilization has been established (Sentell, 2003). Using a set of demographic and socioeconomic predictor variables from the 1992 NALS dataset, a model that explained 56% of the variation in general functional literacy was estimated (Sentell, 2003). The model was subsequently used to generate individual estimates of general functional literacy in the 1996 Medical Expenditure Panel Survey dataset to test their relationship with various aspects of health status and health care utilization. In this modeling approach, general functional literacy was considered as one dimension represented by an average of all reported plausible values for each dimension of general functional literacy (i.e., prose, document, and quantitative literacy). Although highly correlated, the three unique dimensions of general functional literacy represent diverse sets of skills. Combining the three general functional literacy dimensions into one alters their specification and clouds the distinct definition of each dimension. Also, the accuracy of estimating general functional literacy in individuals must be viewed with caution. Imputation error was not accounted for in this research (Sentell, 2003). Plausible literacy values reported in the 1992 NALS dataset represent imputed estimates of literacy based on a set of background conditioning variables rather than observed measurements (Kirsch et al., 2001). Both sampling error and imputation error must be accounted for when estimating general functional literacy (Mislevy, 1991; Mislevy, Johnson, & Muraki, 1992). Plausible values do not represent individually observed test scores and are, therefore, biased estimates of individual literacy proficiency (Kirsch, et al., 2001). The plausible values, however, do represent valid, unbiased estimates of population literacy proficiency. For this reason, one must question using the 1992 NALS to estimate individual literacy proficiency in other datasets.

5.2. EXPANDING THE GENERALIZABILITY OF FUNCTIONAL HEALTH LITERACY ESTIMATES

There has been no nationally representative study of functional health literacy in the United States. Thus, the knowledge of the prevalence of inadequate or marginal functional health literacy has been based primarily on two large studies of functional health literacy that were conducted in purposive, non-random samples of distinct population subgroups: (1) adult patients who used urban, public hospitals (Williams, et al., 1995) and (2) Medicare managed care enrollees (MHLS) (Gazmararian, et al., 1999).

Using a valid predictive model, this research estimated the national prevalence of inadequate, marginal and adequate functional health literacy for those $\geq$ 65 years of age to be approximately 39%, 5% and 56%, respectively. These national estimates of the prevalence of inadequate and marginal functional health literacy were much higher than the prevalence of inadequate and marginal functional health literacy in the MHLS data, which reported approximately 36% of respondents with inadequate or marginal functional health literacy (Gazmararian, et al., 1999). The 1992 NALS had a slightly older sample and a larger proportion of respondents with less than a high school education than the MHLS. Thus, these two factors are suspected of increasing the proportion of respondents with inadequate or marginal functional health literacy since they are significantly associated with decreased functional health literacy.

This research also adds confidence that the estimates of functional health literacy describe an underlying literacy construct. The moderate to strong positive correlations (i.e., $r \geq 0.58$) between the synthetic estimate of functional health literacy and the each dimension of general functional literacy provides supporting evidence of its construct validity. Until now, there has been no assessment of the association between functional health literacy and general functional literacy reported in the published literature.

5.3. FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE UTILIZATION IN THE ELDERLY

Using nationally representative data from 1996 CTS, this study estimated the prevalence of inadequate or marginal functional health literacy to be 39%. This estimate was slightly higher than what was observed in the MHLS.

Consistent with other national estimates of flu shot utilization in 1996, 63% of the White, Black and Hispanic elderly population $\geq$ 65 years of age received a flu shot in 1996. Prior national estimates of flu shot utilization conducted during comparable time periods were 64% (Greene, et al., 2001) and 68% (Carrasquillo, et al., 2001) using the 1996 Medicare Current Beneficiary Survey and 1996 Medical Expenditure Panel Survey, respectively.

It was expected that the national estimates of flu shot and mammogram utilization in this study would vary slightly from previous research since the current study included in its sample a small portion of individuals who were uninsured or insured only by Medicaid, the military, or private insurance whereas prior research included only Medicare beneficiaries. In addition, one prior study included minority groups other than Blacks or Hispanics (Greene, et al., 2001) whereas the current study only included Black and Hispanic minority groups due to inadequate sample sizes of the “other” minority groups .

This research estimated the national prevalence of mammogram within the past year to be 48% and within the past two years to be 64%. Nearly 80% of females were estimated to have ever had a mammography screening examination. These estimates were also comparable to prior research which calculated the prevalence of mammography utilization within the past year to be 43% (Greene, et al., 2001) and within the past two years to be 67% (Carrasquillo, et al., 2001).

A significant relationship was found between the synthetic estimate of functional health literacy and preventive health care utilization in the White, Black and Hispanic population $\geq$ 65 years of age after controlling for the effects of income, insurance coverage, having a usual source of care, and self-reported general health status. To improve confidence in the point estimate of functional health literacy, the upper and lower 95% confidence boundaries of the estimate were calculated. The direction and statistical significance of the relationships between the upper and lower boundaries of synthetic estimate of functional health literacy and preventive health care utilization remained consistent with those of the point estimate, further enhancing confidence in the estimate.

Preventive health care utilization varied by functional health literacy category. Those estimated to have inadequate or marginal functional health literacy had significantly higher odds of not receiving a flu shot within the past 12 months after controlling for the effects of income, insurance coverage, having a usual source of care, and self-reported general health status when compared to those individuals with adequate functional health literacy.

The relationship between functional health literacy and flu shot use for the population subgroup of elderly females did not differ from the population estimates that included both males and females. A similar relationship was found between inadequate or marginal functional and not receiving a flu shot within the past 12 months for the female-only population sub-group eliminating the concern of a sex effect .

Females $\geq$65 years of age estimated to have inadequate or marginal functional health literacy were less likely to have ever received a mammogram after controlling for the effects of income, insurance coverage, having a usual source of care, and self-reported general health status. This same relationship persisted even after changing the specification of mammogram utilization to within the past one or two years.

The findings from this study corroborate earlier work that found significant relationships between functional health literacy and having ever received a flu shot or a mammogram within the past two years in a Medicare managed care sample of beneficiaries 65 to 80 years of age (Scott, et al., 2002). In post-hoc analysis, the current study sample was restricted to include only 65 to 80-year old respondents to be similar to the sample used in previous research (Scott et al., 2002). Restricting the current study sample to 65 to 80 year olds did not influence the findings of this research. That is, individuals with inadequate or marginal functional health literacy had significantly higher odds of not obtaining preventive health care compared to those with adequate functional health literacy.

5.4. INSURANCE TYPE AND THE RELATIONSHIP BETWEEN FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE UTILIZATION

A number of research studies have explored the effect of managed care health insurance on preventive health care utilization. A literature review of published studies between 1990 and 1998 concluded that "…it is unclear whether managed care enrollees are more or less likely than other enrollees are to obtain preventive services." (Phillips, Fernyak, Potosky, Halpin-Schauffler, & Egorin, 2000). The authors noted that there were no differences between Medicare managed care enrollees and enrollees in non-managed care plans although sample sizes were too small to identify differences. More recently published research specific to the elderly population has suggested that participation in a Medicare HMO is associated with higher likelihood of having a flu shot during the prior winter as well as having received a mammography screening examination within the previous year (Greene, et al., 2001). Another study confirmed that Medicare HMO participation was associated with increased likelihood of having a mammography screening examination within the past two years, but found no relationship between Medicare HMO participation and receipt of a flu shot within the past year (Carrasquillo, et al., 2001). Because the only published study examining the relationship between functional health literacy and preventive health care utilization was performed in a sample of just Medicare managed care enrollees (Scott, et al., 2002), questions remain about whether Medicare HMO participation influences the functional health literacy – preventive health care utilization relationship.

The results of the current research suggest that an association between functional health literacy and preventive health care utilization persists regardless of Medicare HMO participation. To examine the effect of Medicare HMO participation on the relationship between functional health literacy and preventive health care utilization, the 1996 CTS sample was stratified by Medicare HMO enrollment. In contrast with the statistically significant findings when using the overall sample as well as the non-HMO subgroup, this research did not find a significant relationship between the synthetic estimate of functional health literacy and receipt of a flu shot within the past 12 months in the Medicare HMO subgroup. Although not statistically significant, examination of the descriptive data revealed a consistent trend in which a higher proportion of respondents with inadequate or marginal functional health literacy in the Medicare HMO sample reported not receiving a flu shot within the past 12 months compared to the proportion of respondents with adequate functional health literacy in the Medicare HMO sample who reported not receiving a flu shot within the past 12 months. With a sample size of 1,137 respondents in the Medicare HMO subgroup, the power to detect a statistically significant difference was only 0.44. While not statistically significant, the absolute difference in the proportion of respondents who did not receive a flu shot within the past 12 months in the inadequate or marginal functional health literacy group was 5.96% higher than the adequate functional health literacy group. Considering the overall size of the population 65 years of age or older, the national consequences of this difference could result in substantial morbidity and mortality.

There was, however, a significant relationship between functional health literacy and not receiving a mammogram within the past two years. Those respondents estimated to have inadequate or marginal functional health literacy had odds of not receiving a mammogram within the past one or two years that were significantly higher than those individuals with adequate functional health literacy, regardless of Medicare HMO or non-HMO participation. Compared to ever having a mammogram, it is believed that mammogram within the recent past (i.e., one or two years) is the most appropriate specification of the mammography screening experience when evaluating the Medicare HMO participation effect since Medicare enrollees can transition between HMO and non-HMO plans within short periods of time. Caution must be used when interpreting mammography utilization in the elderly as recommendations for mammography screening differ for women less than 70 years of age compared to women 70 years of age or older (US Preventive Services Task Force, 1996). Restricting the sample to women between 65 and 70 years of age in this study would significantly reduce power for hypothesis testing.

5.5. PREDICTORS OF FUNCTIONAL HEALTH LITERACY AND PREVENTIVE HEALTH CARE UTILIZATION

As expected, by comparing the pseudo-R^2 values, this research confirmed that models describing the relationship between the independent predictors of functional health literacy (i.e., sex, race, education and age) and preventive health care utilization had greater explanatory power than models which described the relationship between a synthetic estimate of functional health literacy, derived from the variables sex, race, education, and age; and preventive health care utilization. Additionally, the independent predictors of functional health literacy demonstrated improved model fit over the synthetic estimate of functional health literacy with respect to estimating not receiving a flu shot within the past 12 months. However, the synthetic estimate of functional health literacy had slightly better model fit compared to its independent predictors with respect to never having a mammogram. One may ask, “What does a model using a synthetic estimate of functional health literacy add over a model simply using its independent predictors?" The answer is conceptual, supported in this empirical body of work and described as follows.

Confirming previous work (Greene, et al., 2001; Carrasquillo, et al., 2001), the data from the 1996 CTS suggest there are race, education and age differences with respect to the dimensions of preventive care utilization in the elderly used in the study. The current study demonstrated elderly Blacks, as well as those with a high school education or less and who are younger in age had significantly higher odds of not receiving a flu shot within the past 12 months. Elderly females who were Black, had a high school education or lower and were older had significantly higher odds of not ever receiving a mammogram. However, when considering only recent mammography use (i.e., within the past two years), only education and age differences persisted. These data identified no relationship between sex and receipt of a flu shot within the past 12 months. While the direction of the education and race relationships with respect to preventive health care utilization remain consistent regardless of preventive health care measure used, the direction of the age relationship with preventive health care use changes with it being positively associated with flu shot and negatively associated with mammography screening.

It is difficult to interpret and provide solutions to mitigate these differences in preventive health care utilization that are a function of immutable demographic characteristics. An individual cannot change their race, education or age. Inherent systemic discrimination or lack of cultural competence that may fuel these disparities may also take many years to resolve.

One hypothetical mechanism by which disparities may operate is through poor literacy skills. In this research, the synthetic estimate of functional health literacy, based on the restricted weights of sex, race, age and education, remained a significant predictor of preventive health care utilization. The direction of the association between functional health literacy and preventive health care utilization remained consistent, regardless of the dimension of preventive care considered in analyses. Because the synthetic functional health literacy estimate represents the weighted relationships of sex, race, education and age variables that are associated with functional health literacy, it supports the hypothesis that functional health literacy may in fact contribute to sex, race, education and age-related differences in preventive health care utilization.

In contrast to focusing on immutable demographic characteristics which cannot be changed, efforts can be directed toward improving functional health literacy skills and methods designed to facilitate communication with those who have inadequate or marginal functional health literacy skills. Improving functional health literacy skills and improving the management of those with inadequate or marginal functional health literacy skills should ultimately empower those at greatest risk for health care disparities allow them to participate in proposing solutions that address demographic disparities in care. Fixing the person and fixing the system are both valid approaches – the author is not recommending one approach over the other.

5.6. POLICY, PRACTICE, AND RESEARCH IMPLICATIONS

This research has important policy, practice and research implications. In terms of public policy, it provides the first national estimate of the prevalence of inadequate and marginal functional health literacy and the significance of its relationship with preventive health care utilization. If we are to improve prevention activities, programs must be constructed in a way so that all people, regardless of functional health literacy level, can understand and use them. Shifting the focus of assessment from immutable demographic characteristics, this research suggests that interventions that address functional health literacy may potentially reduce disparities.

It is important to think beyond the policy level in assessing the implications of this research. There is an absence of instruments to efficiently collect health literacy data in large populations. To target educational materials and interventions based on literacy level; those in charge of managing population health need practical methods to identify individuals at greatest risk of inadequate or marginal functional health literacy. Moving from a “one size fits all” approach, health system administrators, health insurers and public health providers can use the modeling approach presented here to efficiently identify those at highest risk for inadequate or marginal functional health literacy and in greatest need of alternative educational interventions. Many health systems use self-report risk assessment surveys to identify patients at-risk for repeat hospitalization. Interventions are then targeted to those who score above a predetermined threshold. In contrast with risk assessment surveys which can easily collected through mail surveys, health literacy data must be generated through in-person administration. Thus, a model that can be used to generate a synthetic estimate of functional health literacy can be used to more efficiently target health promotion and outreach efforts. Furthermore, the technique for generating synthetic estimates of functional health literacy can be used to estimate functional health literacy in other large national datasets to study its role in health care use, satisfaction, and quality.

Finally, this study sets the stage for future research. Given the magnitude of the national prevalence of inadequate and marginal functional health literacy, interventional strategies must be designed to overcome functional health literacy barriers. Subsequent to identifying those at greatest risk, researchers can use qualitative research to explore the world of those individuals identified to have inadequate or marginal functional health literacy (Morse & Field, 1995). Using phenomenological and ethnographic techniques, researchers can learn from those with inadequate or marginal functional health literacy what it is like to experience the health system with such a burden. From this perspective, interventions that most effectively address the realities of the experience of those with poor functional health literacy skills can be designed and tested.

5.7. LIMITATIONS

Culture represents "…the shared ideas, meanings and values acquired by individuals as members of a society (Nielson-Bohlman et al, 2004)." Culture shapes and individual's perception, comprehension and understanding of health communication and, in turn, influences their functional health literacy (Nielson-Bohlman et al, 2004). The functional health literacy model developed in this research is culturally-naïve′ as it represents only a partial estimate of functional health literacy. The model is limited by the explanatory power of the four predictor variables considered (i.e., sex, race, education, and age). While there are other language, cultural, societal, education and health system factors that may improve the prediction of functional health literacy, this research was purposefully limited to explanatory variables common in health services data sets that have been measured in a consistent manner. If primary data are collected in future research with the goal to generate functional health literacy models, variables that represent these additional factors associated with functional health literacy that are common to large national data sets should be collected and used in modeling to improve explanatory power. As noted, collection of health literacy data using an instrument such as the S-TOHFLA requires in-person administration, and would significantly increase the cost of most surveys.

When testing the relationship between the synthetic estimate of functional health literacy and preventive health care utilization, multivariate models cannot simultaneously control for the additional effects of sex, race, education and age that are independent of functional health literacy due to anticipated variable collinearity. In fact, this happened in previous research which tested the relationship between a synthetic estimate of general functional literacy and preventive health care utilization (Sentell, 2003). Including the independent predictors of general functional literacy in the model with the synthetic estimate of general functional literacy mitigated the relationship between literacy and preventive health care utilization.

Data for all variables used in this research represent point estimates. Thus, the temporal relationships between predictor variables and functional health literacy as well as estimates of functional health literacy, covariates and measures of preventive health care utilization cannot be assessed. Thus, causal relationships between the synthetic estimate of functional health literacy and preventive health care utilization cannot be established from this research. The secular trend in the relationship between the synthetic estimates of functional health literacy and preventive health care utilization is also not known. Additional studies should be conducted in the 1998 Community Tracking Study data to assess these trends.

All data for model development and hypothesis testing were determined from self-report and cannot be objectively verified with claims data or medical records. While potentially subject to response bias, it is assumed that respondents accurately recalled and truthfully reported their flu shot and mammography screening experience.

Due to sample size limitations, only White, Black and Hispanic respondents are represented in this research. These three racial/ethnic groups represent the overwhelming majority of the population of the United States (US Census Bureau, 1990; US Census Bureau, 2000). With respect to the 1996 CTS respondents who were $\geq$ 65 years of age, the “other” racial/ethnic groups were not represented in sufficiently large numbers to generate stable, representative estimates. In addition, grouping the “other” racial/ethnic groups as one to obtain sufficient sample size precludes meaningful interpretation of the findings due to the large ethnic diversity of the “other” race/ethnic group. In contrast, all Hispanic respondents were grouped together. Although the effect of cultural differences among different Hispanic sub-groups on functional health literacy was not controlled, the functional health literacy model was derived from functional health literacy data collected both in Spanish and English (Gazmararian, et. al., 1999). Thus, it is believed that the language effect for Spanish-speaking and non-Spanish-speaking Hispanics would be minimized. It is also assumed that the Hispanic subgroups were more homogeneous than the racial/ethnic mix of the “other” race category. Thus, the cultural differences across the Hispanics subgroups would be much less than would be expected in the “other” race category.

5.8. CONCLUSION

Functional health literacy is an essential skill in optimizing health care utilization. In summary, this body of work has proposed, developed and validated a model for estimating functional health literacy. At the national level, it has confirmed a significant positive relationship between functional health literacy and preventive health care utilization in the elderly. Race, education and age-related disparities in preventive health care utilization may, in part, be mediated through functional health literacy. As we move to equalize health care access, utilization and quality for all, functional health literacy must be considered part of the solution if we are to empower those in greatest need.

APPENDIX A

DATA USE AGREEMENT

DATA USE AGREEMENT

LIMITED DATA SET POLICY

Emory University has in place a HIPAA policy regarding the use of Limited Data Sets for research, public health and health care operations purposes. Under this policy, the Emory Covered Component, which consists of all units of the Robert Woodruff Health Sciences Center, the Student Health Service, and the University Counseling Center, can provide a Limited Data Set to a researcher or other appropriate individual for purposes of research, public health or health care operations. The Limited Data Set consists of health information has been stripped of all of the following identifiers:

- Names.
- Addresses, including any email, web URL and postal addresses, except zip codes and names of towns, cities and states.
- Numerical identifiers (including telephone numbers; fax numbers; email addresses; IP addresses; social security numbers; medical record numbers; health plan beneficiary numbers; account numbers; certificate/license numbers; vehicle identification and serial numbers, including license plate numbers; device identifiers and serial numbers).
- Biometric identifiers (including finger and voice prints).
- Full-face photographic images.

A Limited Data Set may contain the following information: (a) dates and ages; (b) gender; (c) race; (d) ethnicity; (e) marital status; (f) town, city and state of residence; (g) Zip Codes; and (h) a unique identifying number, characteristic or code.

AETNA MEMBER LIMITED DATA SET: EMORY OBLIGATIONS

The Limited Data Set being provided under this agreement is derived from Aetna (previously Prudential) member Supporting Data. As a condition of providing this Limited Data Set to you, Emory University is required to make you aware of the nature of the supporting data, and the obligations it has to Aetna with regard to the Supporting Data. By signing this agreement, the recipient of the Limited Data Set agrees to fully support and comply with Emory's efforts to fulfill these obligations.

Description of Supporting Data:

Original dataset is from the Prudential Medicare health literacy study conducted in four locations (Cleveland, Houston, Tampa and Ft. Lauderdale/Miami). The total sample includes data from 3,260 new Medicare Managed Care enrollees. Data were collected in 1997.

Emory Obligations to Aetna:

- to protect any and all Supporting Data in a Limited Data Set from unauthorized use or disclosure with at least the same degree of care Emory uses to protect its own confidential information of a similar nature;
- to use the Supporting Data in a Limited Data Set only for the purpose(s) expressly set forth in, and in accordance with, the terms of the Agreement and this Amendment;
- not to record, copy, or reproduce any Supporting Data in a Limited Data Set in any form except to the extent necessary to fulfill its obligations under the Agreement and this Amendment;

- not to disclose to or otherwise permit any third person or entity access to any Supporting Data in a Limited Data Set except with USQA's prior written consent, which may be withheld in USQA's sole discretion, or specifically as indicated in an Attachment hereto;

- to limit disclosure of Supporting Data in a Limited Data Set to those parties who are necessary for and involved in Emory's performance of its obligations under the Agreement and this Amendment;

- to ensure that any parties who receive or obtain Supporting Data in a Limited Data Set are advised of the nature of the Supporting Data and of the obligations Emory has undertaken with respect to such Supporting Data under the Agreement and this Amendment;

- to use appropriate safeguards to prevent use and disclosure of the information other than as provided for by the Agreement and this Amendment; and

- not to identify or make any efforts to identify the individuals who are the subjects of the Supporting Data in a Limited Data Set or to contact or make any effort to contact such individuals.

- Emory shall report to USQA any use or disclosure of the information not provided for by this Section 3 of which it becomes aware as soon as reasonably possible, but in no event more than ten (10) business days after Emory becomes aware of such use or disclosure.

- Upon termination of the Agreement between Emory and USQA, Emory shall return or destroy all data transferred from USQA or any Aetna entity to Emory, including but not limited to Supporting Data except as otherwise provided below. This provision shall apply to Supporting Data that is in the possession of subcontractors or agents of Emory. Emory shall retain no copies of the Supporting Data.

- In the event that Emory reasonably determines that returning or destroying all data transferred from USQA or any Aetna entity to Emory, including but not limited to Supporting Data, is infeasible, Emory shall provide to USQA notification of the conditions that make return or destruction infeasible. Upon mutual agreement of the parties that return or destruction of all data transferred from USQA or any Aetna entity to Emory, including but not limited to Supporting Data, is infeasible, Emory shall extend the protection of the Agreement and this Amendment to such data to those purposes that make the return or destruction infeasible, for so long as Emory maintains such data.

DATA USE AGREEMENT

In order to obtain a Limited Data Set, a researcher or other appropriate person requesting the Limited Data Set (the "Requestor") must complete and sign the following Data Use Agreement:

Emory Covered Component Unit from Whom Limited Data Set is Requested: Emory Center on Health Outcomes and Quality, Rollins School of Public Health, Department of Health Policy and Management

Name & Title of Requestor: Michael J. Miller, DrPH candidate, and Howard B. Degenholtz, PhD, Assistant Professor (academic advisor)

Address & Phone No. of Requestor: Michael J. Miller, Center for Bioethics and Health Law, University of Pittsburgh, Medical Arts Building, Suite 300, 3708 Fifth Avenue, Pittsburgh, PA 15213. Telephone: 412-647-5702

Entity by Whom Requestor is Employed: University of Pittsburgh

The undersigned Requestor hereby requests that the Emory Covered Entity provide it with the Limited Data Set described below for the uses and purposes described below. The Requestor agrees and affirms that all information requested to be provided in the Limited Data Set, and all uses and purposes for which the Limited Data Set is requested, are permitted by and are in accordance with the Limited Data Set policy described above.

(1) Description of Limited Data Set Requested: Health literacy measure/score (continuous variable); age (continuous variable); race/ethnic origin; education level; income; gender

---

(2) The Limited Data Set is being requested for the following purpose(s):

__X___ **Research.** Briefly describe: This limited data set will be used to develop a predictive model of health literacy that can be applied to other publicly available datasets.

_____**Public health purposes.** Briefly describe:________________________________

_____**Health care operations.** Briefly describe:________________________________

---

(3) Description of Persons who will be Permitted to Use or Receive the Limited Data Set (e.g., PI and research staff; specific study sponsor, etc.): Michael J. Miller, PI, and advisors and staff at the University of Pittsburgh as necessary.

By signing below, the Requestor agrees that he/she will not, and will ensure that his or her staff:

(a) Will not, use or further disclose the information contained in the Limited Data Set other than as permitted in this Data Use Agreement or as required by law;

(b) Will use appropriate safeguards to prevent the use or disclosure of the information contained in the Limited Data Set other than as permitted in the Data Use Agreement;

(c) Will report to the Emory Covered Component any use or disclosure of the information contained in the Limited Data Set that is not permitted by this Data Use Agreement of which it becomes aware. Such reports can be made to the Emory University Privacy Officer, Office of Research Compliance, Ste. 510, 1784 N. Decatur Rd., Atlanta, GA 30322

(d) Will ensure that any of its agents or subcontractors to whom it provides the Limited Data Set agrees in writing to the same restrictions and conditions that apply to the Requestor. The Requestor may do this by providing its agents and subcontractors with a copy of this Data Use Agreement and having them agree in writing that they have received and reviewed the Agreement and agree to abide by its terms (see Subcontractor/Agent Signature Block below).

(e) Will not identify the information or contact the individuals who are the subject of the information.

Requestor:

Signature: Michael J. Miller

Signature: Howard Degenhoff

Date: 11/4/2003

Approved by Emory Covered Entity:

Signature:

Title: Assis't Dean of Administration

Date: 12/5/03

Acknowledgement and Agreement of Requestor's Agents & Subcontractors:

The undersigned subcontractor/agent of the Requestor who will be receiving access to the Limited Data Set described herein agrees that it has received a copy of and reviewed this Data Use Agreement governing its use of the Limited Data Set and that it will ensure that it and its employees and agents abide by its terms.

Name of Subcontractor/Agent:____________________________ Date:_________

Authorized Signature:____

Name and Title of Authorized Signatory:__________________________________

APPENDIX B

INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

University of Pittsburgh
Institutional Review Board

Exempt and Expedited Reviews
Christopher M. Ryan, Ph.D., Vice Chair

Multiple Project Assurance: M-1259

3500 Fifth Avenue
Suite 105
Pittsburgh, PA 15213
Phone: 412.383.1480
Fax: 412.383.1146
e-mail: irbexempt@msx.upmc.edu

TO: Michael J. Miller

FROM: Christopher M. Ryan, Ph.D., Vice Chair

DATE: April 2, 2004

PROTOCOL: The Relationship Between a Synthetic Estimate of Functional Health Literacy and Preventive Health Care Use in a National Sample of Elderly

IRB Number: 0403128

The above-referenced protocol has been reviewed by the University of Pittsburgh Institutional Review Board. Based on the information provided in the IRB protocol, this project meets all the necessary criteria for an exemption, and is hereby designated as "exempt" under section 45 CFR 46.101(b)(4).

The regulations of the University of Pittsburgh IRB require that exempt protocols be re-reviewed every three years. If you wish to continue the research after that time, a new application must be submitted.

- If any modifications are made to this project, please submit an 'exempt modification' form to the IRB.
- Please advise the IRB when your project has been completed so that it may be officially terminated in the IRB database.
- This research study may be audited by the University of Pittsburgh Research Conduct and Compliance Office.

Approval Date: 04/01/2004
Renewal Date: 04/01/2007

CR:ky

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