Published in final edited form as:

Cancer Epidemiol. 2012 June ; 36(3): 270–275. doi:10.1016/j.canep.2011.10.001.

Different effects of multiple health status indicators on breast and colorectal cancer screening in a nationally-representative US sample

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Abstract

Objective—To examine the independent associations between multiple health status indicators and breast and colorectal cancer screening (CRCS) in a national US sample.

Study Design and Setting—Analysis of cross-sectional data from the 2005 National Health Interview Survey (NHIS) involved 5115 men and 7100 women aged 50 years and older.

Measures—Health status indicators included: self-reported perceived health status, number of chronic conditions, and functional limitation due to a chronic condition. Individuals were considered adherent to CRCS guidelines if they reported having a home-based fecal occult blood test in the past year or endoscopy in the past 10 years. Women were adherent to breast cancer screening guidelines if they reported having a mammogram in the previous 2 years. Statistical analyses were conducted using SUDAAN software to account for the complex sampling of the NHIS survey. Logistic regression was used to examine associations between each of the health status indicators and screening adherence for CRCS and mammography and to calculate estimated screening rates.

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Conflict of Interest Statement: The authors have no conflicts of interest to disclose.

Results—The three health status indicators were independently and differentially associated with screening adherence. Poor perceived health was associated with lower mammography among women, whereas a greater number of chronic conditions were consistently associated with greater screening. In adjusted analyses, functional limitation was only significantly associated with greater CRCS among women.

Conclusions—Our analyses included three common indicators of health status and provide new evidence of their complex associations with cancer screening. Future studies must examine the mechanisms by which these indicators influence screening recommendations and adherence among older adults over time.

Keywords

health status indicators; cancer screening; mammography, colorectal cancer screening

Introduction

An increasing number of adults in the United States are living with one or more chronic health conditions [1]. Among 45–64 year olds, 68% have at least one chronic condition, as do 90% of those aged 65 years and older [1]. As the life expectancy of adults in the United States continues to increase and chronic health conditions, such as diabetes, manifest themselves at earlier ages and can be better controlled with improved treatments, people will be living with chronic conditions and related impairment for a greater proportion of their lives [2,3]. This may have serious implications for cancer prevention and control efforts over the lifespan. Greater understanding of the impact of chronic conditions on the continuum of cancer care is needed to optimize strategies for improving screening, diagnosis, treatment and long-term survival [4].

Both breast and colorectal cancer (CRC) can be detected through evidence-based screening tests and when diagnosed at an early, localized stage, the prognosis for each of these cancers is excellent [5]. Despite the availability of such screening tests, in the United States in 2005, only 71.8% of women aged 50–64 years and 63.8% of women aged 65 years and older had a mammogram within the past two years [6] and only 50.0% of adults aged 50 years and older were adherent to CRC screening (CRCS) recommendations [7]. Numerous studies have identified correlates of cancer screening adherence for breast cancer and CRC [8–11].

A growing literature has reported associations between health status and cancer screening but to date, findings have been equivocal. Multiple studies have found that patients with chronic conditions, functional limitations, or poor perceived health status are less adherent to cancer screening recommendations [12–22]. Other studies have shown no association between cancer screening rates and chronic health conditions [23–26] or self-reported health [9,27]. Still others have shown that CRCS adherence is greater among those with more chronic conditions [28] or poorer self-reported health [7] and that women with severe physical limitations are more likely to utilize mammography screening [29]. Inconsistencies in the results of prior studies may be due to multiple factors including the use of different indicators of health status across studies, the examination of different screening behaviors across diverse populations, and differential inclusion of covariates in statistical analyses. Studies that have included multiple health status indicators have typically conducted separate analyses to examine the association of each indicator with cancer screening adherence. Thus, the extent to which different health status indicators may be uniquely associated with cancer screening is unknown. Different health status indicators may capture unique aspects of health that can then differentially influence screening behavior. For example, poor health status may indicate reduced life expectancy, thereby making cancer

screening a low priority. Patients with multiple health conditions may consider cancer screening an additional burden or competing demand and thus be less likely to screen. Alternatively, they may have greater access to screening through multiple regular doctor visits and therefore be more likely to screen. Finally, persons with functional limitations may experience practical barriers to completing screening test preparation or even getting to the screening facility. Further, prior studies have focused on screening for a single type of cancer. Thus, it is unclear whether any observed associations with health status indicators may be consistent across different cancer screening tests. Given the different modalities of breast and CRC screening tests, health status indicators may be differentially associated with these tests (e.g. a person with poor health status may be able to attend a mammography clinic but unable to tolerate the preparation regimen or sedation involved with colonoscopy).

The objective of the current study was to examine the independent associations between three commonly used health status indicators—perceived health status, number of chronic health conditions (as a measure of chronic disease burden), and the presence of a functional limitation due to a chronic condition—and breast and CRC screening. Findings from this study may help identify specific population subgroups that are under- or over-screened for cancer based on health status and inform clinical and public health initiatives on using health status indicators to target cancer screening efforts for those most likely to benefit. We sought to answer two main research questions: 1) is each of the health status indicators independently associated with cancer screening behavior after controlling for each other and other correlates of breast and CRC screening; and 2) are observed associations similar across health status indicators and cancer screening type?

Methods

Procedure

The study data are drawn from the 2005 National Health Interview Survey (NHIS), an annual health survey of civilian, non-institutionalized adults in the United States. Participants were interviewed in their own homes by U.S. Census Bureau interviewers. The NHIS employs a multistage, clustered, cross-sectional design, including state-level stratification, and oversampling of Hispanic and black individuals, and post-stratification adjustments for age, sex, and race/ethnicity based on U.S. Census Bureau population statistics. Further details regarding the 2005 NHIS are available elsewhere [30]. The 2005 NHIS is the most recent year for which the primary variables of interest for the current study were available.

Participants

There were a total of 31,428 respondents to the Sample Adult module of the 2005 NHIS (69% response rate). We excluded from all analyses individuals who were under the age of 50 (n=17, 948), men who were missing data regarding receipt of CRCS (n=521), and women who were missing data regarding receipt of colorectal and breast cancer screenings (n=669). Men who reported a history of CRC (n=75) and women who reported a history of CRC (n=89) or breast cancer (n=343) were excluded from respective analyses for CRC and breast cancer screening. This left an available sample size of 5115 men and 7100 women.

Measures

Outcome variables

Colorectal and breast cancer screening: Participants reported their use of home-based fecal occult blood test (FOBT), flexible sigmoidoscopy, and colonoscopy. Individuals were considered adherent to recommended guidelines for CRCS if they reported having a home-

based FOBT in the past year or either form of endoscopy in the past 10 years (the NHIS response options cannot identify sigmoidoscopy use within the recommended 5 year interval) [31]. Women reported on prior receipt of mammography. Adherence to breast cancer screening was based on 2002 U.S. Preventive Services Task Force (USPSTF) guidelines [32], and we categorized women as adherent to mammography screening if they reported having a mammogram in the 2 years prior to the survey. These definitions of adherence to cancer screening tests were applied regardless of the reported reason for testing as has been done previously [33].

Independent variables

Health status indicators: A single item (“How would you rate your health—would you say it is excellent, very good, good, fair, or poor?”) assessed participants' self-reported overall health and three categories (*poor/fair, good, very good/excellent*), based on the distribution of self-reported health in the study population, were included in analysis. Participants indicated whether they had any functional limitation (yes/no), which was defined as any difficulty with one or more functional activities, including walking a quarter of a mile, standing or sitting for extended periods, or carrying a full bag of groceries, due to a chronic medical condition. We also created an index of the number of chronic health conditions by totaling each participant's reported history of the following: diabetes; cancer (excluding non-melanoma skin cancer); a stomach, duodenal, or peptic ulcer; current asthma; coronary heart disease; angina; myocardial infarction; hypertension; stroke; chronic obstructive pulmonary disease; arthritis. The total number of chronic conditions was categorized as 0, 1, 2, or 3 or more conditions due to the distribution of observed responses. Inclusion of these conditions in the index was based on other chronic condition indices [34,35] and availability of specific conditions in the dataset.

Covariates—The following covariates were included in the analysis based on prior studies of correlates of breast and CRC screening.

Demographics: Participants reported their age, sex, race/ethnicity, education level, and marital status.

Healthcare access and utilization: Participants indicated the number of visits to a doctor or other healthcare provider in the previous year, where they usually receive preventive healthcare (doctor's office/HMO; clinic or health center; no usual source of preventive care), and whether they had any public or private healthcare insurance coverage.

Behavioral risk factors: Participants indicated their height and weight, from which body mass index (BMI) was calculated and categorized as not overweight/obese (BMI < 25.0 kg/m²), overweight (BMI from 25.0–29.9 kg/m²), or obese (BMI ≥ 30.0 kg/m²) [36]. Participants answered questions about their previous and current cigarette use and were categorized as current, former, or never smokers [37].

Perceived cancer risk: Participants reported their perceived risk of getting CRC (*less likely, about as likely, more likely, or don't know*) compared to an average individual of the same age and sex. Women reported their perceived risk of getting breast cancer (*less likely, about as likely, more likely, or don't know*) compared to an average women of the same age.

Statistical Analyses

All statistical analyses were conducted using SUDAAN software (version 10; Research Triangle Institute, Research Triangle Park, NC) to account for the complex sampling of the NHIS survey. We used logistic regression analyses to examine the unadjusted and adjusted

associations between each of the health status indicators and screening adherence for CRCS (separately for men and women) and mammography (for women). Adjusted analyses examined the unique associations between the health status indicators and screening after controlling for each other and other covariates. Previous studies have indicated that correlates of CRCS may differ for men and women [8,38], so we considered men and women separately. The three health status variables were moderately associated with each other (Pearson r s from .41 to .46, p s < .001), suggesting that although correlated they are distinct conceptually and unlikely to be interchangeable. Thus, they were included in our adjusted models simultaneously. Adjusted odds ratios (aOR) and 95% confidence intervals (95% CI) are presented. Only individuals with complete data for all relevant covariates were included in each adjusted analysis. Logistic regression analysis also was used to estimate screening rates (also referred to as predicted marginals) for unadjusted and adjusted models. Adjusted screening rates can be interpreted as the screening rate for each group adjusted for all other variables in the model. As sensitivity analyses, we repeated all of the adjusted analyses with the missing data for each covariate included as a separate category. All percentages reported in the Results section are weighted and all sample sizes are unweighted. Due to the large sample size, a more conservative $p < 0.01$ was used to determine statistical significance for all analyses.

Results

Frequencies for the study covariates and the health status indicators for men and women are shown in Table 1. The median age was 61 years for men and 62 years for women. Twenty percent of the sample was from non-white racial/ethnic groups, 29.3% of men and 21.4% of women were college graduates, and 77.5% of men and 57.0% of women were married or partnered. Almost half of the participants rated their health status as very good or excellent, 42.9% of men and 55.8% of women reported having a functional limitation caused by a chronic condition, and more than 20% of men and 20% of women reported having three or more chronic conditions (mean number of conditions was 1.45 for men and 1.60 for women). Individuals reporting worse overall health were more likely to have a functional limitation and a greater number of chronic health conditions. Individuals who reported having a functional limitation had more chronic conditions than those with no functional limitations.

Associations Between Health Status Indicators and Colorectal Cancer Screening

Among both men and women, approximately one in two individuals was adherent to CRCS (Table 2). In unadjusted analyses, self-reported health was not associated with CRCS for either men or women, but both men and women were more likely to report CRCS if they had a functional limitation due to a chronic condition or a greater number of chronic health conditions. In the adjusted analyses among men, self-reported health remained not significantly associated with CRCS ($p = 0.029$). Having a functional limitation was no longer associated with CRCS among men in the adjusted analyses, but screening remained higher among men with a greater number of chronic health conditions. In the adjusted analyses for women, the results were consistent with the unadjusted analyses: self-reported health was not associated with CRCS, but higher rates of CRCS were found among women with a functional limitation or a greater number of chronic health conditions.

We were interested in further investigating the interrelationships between self-reported health status and number of chronic conditions because we believed that persons with a greater number of conditions and poor health status would likely have lower screening rates than persons with a greater number of conditions and excellent health status. To determine whether an interaction between self-reported health status and number of chronic conditions may explain the difference in the association between self-reported health status and CRCS

in unadjusted and adjusted models among men, we included an interaction term in adjusted models. The interaction term was statistically significant at $p=0.003$, but there were no clear and consistent patterns in the estimated rates of reported CRC test use except that men with poor/fair health generally had lower rates than men with very good/excellent health and that screening rates increased with higher numbers of health conditions. There was no evidence of an interaction between self-reported health status and number of chronic health conditions for CRCs among women ($p=0.276$). For both men and women, the results of the sensitivity analyses were consistent with the adjusted analyses reported here.

Associations Between Health Status Indicators and Mammography Screening

Two-thirds of women reported having a mammogram within the past two years (Table 3). In the unadjusted analyses, all three health indicators were significantly associated with mammography use. Women were less likely to report having a mammogram in the past two years if they reported poor/fair overall health, had a functional impairment, or had no chronic health conditions compared to women with one or two chronic conditions. In the adjusted analyses, the associations between mammography screening and self-reported health remained statistically significant, but number of chronic health conditions ($p=0.017$) and functional limitation ($p=0.041$) were no longer significantly associated with mammography adherence at our significance level of 0.01. There was no evidence of an interaction between self-reported health status and number of chronic health conditions for mammography screening among women ($p=0.874$). The results of the sensitivity analysis were consistent with the adjusted analyses reported here, except that the association between chronic health conditions and mammography was statistically significant ($p=0.004$).

Discussion

Our findings provide new evidence regarding the complex relationship between health status indicators and cancer screening. Methodologic differences across relevant prior studies makes comparison of the existing literature difficult and results have been equivocal. Studies vary in the inclusion and definition of different health status indicators, the type of screening tests studied, underlying population characteristics, and the array of covariates included. Additionally, to our knowledge, no prior study has examined the independent associations of three different health status indicators with cancer screening in the same multivariable model. We sought to address limitations of previous work and advance the study of the impact of chronic health conditions on cancer screening by considering the association of three of the most commonly used indicators of health status simultaneously across two different cancer screening tests in a national sample of older adults.

Our finding that, across sex and screening type, poor self-reported health appears to be associated with reduced likelihood of screening is consistent with previous studies that have considered the association of short life expectancy with cancer screening behavior [13,16,17]. It is reasonable that if a patient has a short life expectancy, the benefit of screening tests is questionable and physicians may not encourage patients to seek preventive cancer screening [39]. Over-screening of persons who are unlikely to benefit may add significant burden to the individual as well as to the health system overall [14]. We might expect that individuals with functional limitations may get screened less often due to patients' reduced abilities to physically access screening resources however we did not find this. Our finding of no association between functional limitations and mammography is generally supported by previous studies [12,19,20,24,25] However, two studies that were able to separate out severity or type of impairments reported reduced likelihood of mammography among women with major mobility problems [22] or social but not physical limitations [29], indicating that the severity or nature of existing functional limitations may impact screening behavior more so than the mere presence of a limitation. With regard to

CRCS, our finding of increased CRCS among women with functional limitations is supported in part by findings by Heflin (2002) that decreased function was associated with increased FOBT use but not by other studies with more specific measures of functional limitations [15,17,20]. Further exploration of our finding of increased odds of CRCS among women with functional limitations is warranted to identify additional correlates or mechanisms. A greater number of existing chronic conditions may influence cancer screening behaviors in two different ways by acting as competing demands to a person's health resources (both emotional and financial) or by reducing life expectancy; therefore, cancer prevention practices may receive less attention by patients and their physicians [39]. However, we found that people with chronic conditions appeared to be more likely to get mammography and CRCS even after controlling for self-reported health. Though we might expect this to be due to an increased number of doctor visits for those with multiple health conditions and therefore greater opportunity to receive screening recommendations, controlling for the number of doctor visits in the past year did not explain our findings. Other factors such as better self-management behaviors or greater self-efficacy for health promotion behaviors among people with multiple conditions might provide an explanation but could not be addressed in this study [20]. Our results may differ from other studies that have investigated the relationship between health status and cancer screening behaviors because we included persons 50 years of age or older who may have fewer chronic health conditions, better self-reported health status, and better overall life expectancy than previously reported samples. We were able to control for the confounding effects of a variety of relevant demographic, behavioral and healthcare access and utilization variables. Additionally, our study included people who access medical care in a variety of settings (i.e. community clinics, private physician offices, the Veterans' Administration) and through a variety of payment mechanisms. Our findings suggest that though the indicators may be overlapping and measuring some conceptually similar aspects of health, each has its own independent contribution to understanding the influence of comorbidity and health status on cancer screening behaviors. Thus, more than one mechanism or pathway of influence may be supported. The findings also suggest that it should not be assumed that health status indicators influence screening behaviors in the same direction or through the same mechanisms, and that researchers take these nuances into account when including health status variables in their studies.

There are limitations of our study. The NHIS data are cross-sectional so we cannot infer causality from our analyses. Also, we are unable to adequately distinguish screening from diagnostic mammograms or CRC tests or tests that people had for reasons other than screening and therefore may have overestimated rates of CRC and breast cancer screening. However, we excluded persons who had a diagnosis of CRC or breast cancer from the respective analyses and it has been suggested that having a cancer screening test within the recommended timeframe ultimately means that the person has been screened for cancer even if the initial reason for the test was something else [33]. Additionally, our use of a 10-year time frame for receipt of endoscopy for CRCS may lead to overestimation of CRCS adherence, although this is mitigated by the fact that sigmoidoscopy is an infrequently used form of CRCS [8]. We did not have information about disease severity or duration for the included health conditions and we might expect that persons with more severe conditions have shorter life expectancy and would be less likely to receive preventive cancer screenings. Also, despite the numerous confounding variables that we were able to control for, socioeconomic status was only partially controlled for through variables such as education and health insurance coverage and thus there may be residual confounding. Despite these limitations, we were able to take a novel approach to investigate the relationship of both breast cancer and CRC screening with three different health status indicators simultaneously in a national sample of men and women aged 50 years and older while controlling for numerous relevant covariates.

In conclusion, findings from this study indicate that three of the most commonly used health status indicators are independently and differentially associated with colorectal and breast cancer screening. This is a new and important finding in studying health status and cancer screening behaviors. Future studies of longitudinal data may be able to explore potential mediators and moderators of the associations between these health status indicators and cancer screening. Routinely capturing information on self-reported health status, prevalent health conditions, and functional limitation in cancer surveillance systems will improve our ability to study the important determinants of cancer screening adherence. Additionally, qualitative work with older adults who are not adherent to current screening guidelines is needed to further explore the differential impact of these health status indicators on adherence to cancer screening guidelines. Such knowledge will be important for better targeting of messages to promote cancer screening and to encourage patient-provider interactions regarding the need for cancer screening. Ultimately, an understanding of how and in what contexts health status influences cancer screening behaviors is needed to improve cancer screening rates among those for whom health status serves as a barrier to cancer screening utilization.

Acknowledgments

Dr. Deshpande is supported by a National Cancer Institute Cancer Center Support Grant (P30 CA91842 ; T. Eberlein, PI); Dr. McQueen is funded by an American Cancer Society Mentored Research Scholar Grant (CPPB-113766); and Dr. Coups is supported by grant K07CA133100 from the National Cancer Institute.

References

- [1]. Anderson, G.; Johns Hopkins University. Chronic conditions: making the case for ongoing care. 2007. Available from: http://www.fightchronicdisease.org/news/pfcd/documents/ChronicCareChartbook_FINAL.pdf
- [2]. Anderson G, Horvath J. The growing burden of chronic disease in America. Public Health Rep. 2004; 119:263–270. [PubMed: 15158105]
- [3]. Anderson, G.; Horvath, J. Chronic conditions: Making the case for ongoing care. John Hopkins University; Baltimore, MD: 2002.
- [4]. Geraci JM, Escalante CP, Freeman JL, Goodwin JS. Comorbid disease and cancer: the need for more relevant conceptual models in health services research. J Clin Oncol. 2005; 23(30):7399–7403. [PubMed: 16234509]
- [5]. Cokkinides, V.; Bandi, P.; Siegel, R.; Ward, EM.; Thun, MJ. Cancer prevention & early detection facts & figures 2008. American Cancer Society; Atlanta, GA: 2007.
- [6]. American Cancer Society. Breast cancer facts & figures 2009–2010. American Cancer Society; Atlanta, GA: 2009.
- [7]. Shapiro JA, Seeff LC, Thompson TD, Nadel MR, Klabunde CN, Vernon SW. Colorectal Cancer Test Use from the 2005 National Health Interview Survey. Cancer Epidemiol Biomarkers Prev. 2008; 17(7):1623–1630. [PubMed: 18628413]
- [8]. Meissner HI, Breen NL, Klabunde CN, Vernon SW. Patterns of colorectal cancer screening uptake among men and women in the US. Cancer Epidemiol Biomarkers Prev. 2006; 15:389–394. [PubMed: 16492934]
- [9]. Seeff LC, Nadel MR, Klabunde CN, Thompson TD, Shapiro JA, Vernon SW, et al. Patterns and predictors of colorectal cancer test use in the adult US population: results from the 2000 National Health Interview Survey. Cancer. 2004; 100(10):2093–2103. [PubMed: 15139050]
- [10]. Rakowski W, Meissner H, Vernon SW, Breen N, Rimer B, Clark MA. Correlates of repeat and recent mammography for women ages 45 to 75 in the 2002 to 2003 Health Information National Trends Survey (HINTS 2003). Cancer Epidemiol Biomarkers Prev. 2006; 15(11):2093–2101. [PubMed: 17119033]

- [11]. Rakowski W, Wyn R, Breen N, Meissner H, Clark MA. Prevalence and correlates of recent and repeat mammography among California women ages 55–79. *Cancer Epidemiol.* 2010; 34(2): 168–177. [PubMed: 20303844]
- [12]. Heflin MT, Oddone EZ, Pieper CF, Burchett BM, Cohen HJ. The effect of comorbid illness on receipt of cancer screening by older people. *J Am Geriatr Soc.* 2002; 50(10):1651–8. [PubMed: 12366618]
- [13]. Bynum JP, Braunstein JB, Sharkey P, Haddad K. The influence of health status, age, and race on screening mammography in elderly women. *Arch Intern Med.* 2005; 165:2083–2088. [PubMed: 16216997]
- [14]. Meissner HI, Tiro JA, Haggstrom D, Lu-Yao G, Breen N. Does patient health and hysterectomy status influence cervical cancer screening in older women? *J Gen Intern Med.* 2008; 23(11): 1822–1828. [PubMed: 18784967]
- [15]. Sultan S, Conway J, Edelman D, Dudley T, Provenzale D. Colorectal cancer screening in young patients with poor health and severe comorbidity. *Arch Intern Med.* 2006; 166(20):2209–2214. [PubMed: 17101938]
- [16]. Kiefe CI, Funkhouser E, Fouad MN, May DS. Chronic disease as a barrier to breast and cervical cancer screening. *J Gen Intern Med.* 1998; 13(6):357–365. [PubMed: 9669564]
- [17]. Walter LC, Lindquist K, Nugent S, Shult T, Lee SJ, Casadel MA, et al. Impact of age and comorbidity on colorectal cancer screening among older veterans. *Ann Int Med.* 2009; 150:465–473. [PubMed: 19349631]
- [18]. Blustein J, Weiss LJ. The use of mammography by women aged 75 and older: factors related to health, functioning, and age. *J Am Geriatr Soc.* 1998; 46(8):941–946. [PubMed: 9706880]
- [19]. Nosek MA, Howland CA. Breast and cervical cancer screening among women with physical disabilities. *Arch Phys Med Rehabil.* 1997; 78(12 Suppl 5):S39–44. [PubMed: 9422006]
- [20]. Ramirez A, Farmer GC, Grant D, Papachristou T. Disability and preventive cancer screening: results from the 2001 California Health Interview Survey. *Am J Public Health.* 2005; 95(11): 2057–2064. [PubMed: 16195509]
- [21]. Schootman M, Jeffe DB. Identifying factors associated with disability-related differences in breast cancer screening (United States). *Cancer Causes Control.* 2003; 14:97–107. [PubMed: 12749715]
- [22]. Iezzoni LI, McCarthy EP, Davis RB, Siebens H. Mobility impairments and use of screening and preventive services. *Am J Public Health.* 2000; 90(6):955–961. [PubMed: 10846515]
- [23]. Fisher DA, Galanko J, Dudley TK, Shaheen NJ. Impact of comorbidity on colorectal cancer screening in the veterans healthcare system. *Clin Gastroenterol Hepatol.* 2007; 5:991–996. [PubMed: 17627900]
- [24]. Walter LC, Lindquist K, Covinsky KE. Relationship between health status and use of screening mammography and papanicolaou smears among women older than 70 years of age. *Ann Intern Med.* 2004; 140(9):681–689. [PubMed: 15126251]
- [25]. Burack RC, Gurney JG, McDaniel AM. Health status and mammography use among older women. *J Gen Intern Med.* 1998; 13(6):366–372. [PubMed: 9669565]
- [26]. Diab ME, Johnston MV. Relationships between level of disability and receipt of preventive health services. *Arch Phys Med Rehabil.* 2004; 85(5):749–757. [PubMed: 15129399]
- [27]. Liang S, Phillips KA, Nagamine M, Ladabaum U, Haas JS. Rates and predictors of colorectal cancer screening. *Prev Chronic Dis.* 2006; 3(4):1–13.
- [28]. Klabunde CN, Schenck AP, Davis WW. Barriers to colorectal cancer screening among medicare consumers. *Am J Prev Med.* 2006; 30(4):313–319. [PubMed: 16530618]
- [29]. Ahmed NU, Smith GL, Haber G, Belcon MC. Are women with functional limitations at high risk of underutilization of mammography screening? *Womens Health Issues.* 2009; 19(1):79–87. [PubMed: 19111790]
- [30]. National Center for Health Statistics (NCHS). NHIS survey description. NCHS, Centers for Disease Control and Prevention; Hyattsville, MD: Available at: http://www.cdc.gov/nchs/about/major/nhis/quest_data_related_1997_forward.htm.

- [31]. Vernon SW, Meissner HI, Klabunde CN, Rimer BK, Ahnen DJ, Bastani R, et al. Measures for ascertaining use of colorectal cancer screening in behavioral, health services, and epidemiologic research. *Cancer Epidemiol Biomarkers Prev.* 2004; 13:898–905. [PubMed: 15184243]
- [32]. U. S. Preventive Services Task Force. Screening for breast cancer: recommendations and rationale. *Ann Intern Med.* 2002; 137:344–346. [PubMed: 12204019]
- [33]. Klabunde CN, Cronin KA, Breen N, Waldron WR, Ambs AH, Nadel MR. Trends in colorectal cancer test use among vulnerable populations in the United States. *Cancer Epidemiol Biomarkers and Prev.* 2011; 20(8):1611–1621.
- [34]. Katz JN, Chang LC, Sangha O, Fosse IAH, Bates DW. Can comorbidity be measured by questionnaire rather than medical record review? *Med Care.* 1996; 34(1):73–84. [PubMed: 8551813]
- [35]. Charlson ME, Pompei P, Ales KL, et al. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis.* 1987; 40:373–383. [PubMed: 3558716]
- [36]. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults [NIH Publication No. 98-4083]: National Heart Lung and Blood Institute. 1998.
- [37]. National Center for Health Statistics. [Accessed June 15, 2009] National Health Interview Survey (NHIS): Glossary of terms. Available at: http://www.cdc.gov/nchs/nhis/tobacco/tobacco_glossary.htm
- [38]. McQueen A, Vernon SW, Meissner HI, Klabunde CN, Rakowski W. Are there gender differences in colorectal cancer test use prevalence and correlates. *Cancer Epidemiol Biomarkers Prev.* 2006; 15(4):782–791. [PubMed: 16614124]
- [39]. Fleming ST, Pursley HG, Newman B, Pavlov D, Chen K. Comorbidity as a predictor of stage of illness for patients with breast cancer. *Med Care.* 2005; 43(2):132–40. [PubMed: 15655426]

Table 1

Frequencies for Study Variables Stratified by Sex, 2005 National Health Interview Survey

	Men n=5,115 %	Women n=7,100 %
Age (years)		
50–64	62.7	57.1
65–75	23.4	23.6
76	13.9	19.3
Missing (n)	0	0
Race/ethnicity		
Non-Hispanic white	79.8	79.4
Non-Hispanic black	9.0	9.8
Non-Hispanic other	3.8	3.3
Hispanic	7.4	7.5
Missing (n)	0	0
Education level		
Some high school or less	17.3	19.1
High school graduate	29.2	34.1
Some college	24.2	25.3
College graduate	29.3	21.4
Missing (n)	51	63
Marital status		
Married/partnered	77.5	57.0
Not married/partnered	22.5	43.0
Missing (n)	16	25
Body mass index		
Not overweight/obese	27.3	39.5
Overweight	45.7	32.6
Obese	27.0	27.8
Missing (n)	50	317
Smoking status		
Current smoker	17.8	13.7
Former smoker	43.1	26.6
Never smoker	39.1	59.7
Missing (n)	9	12
Perceived colorectal cancer risk compared to other people		
Less likely	38.2	40.4
As likely	47.0	42.4
More likely	7.0	8.7
Don't know	7.9	8.5

	Men n=5,115 %	Women n=7,100 %
Missing (n)	18	37
Perceived breast cancer risk compared to other people		
Less likely	–	38.0
As likely	–	42.9
More likely	–	11.5
Don't know	–	7.6
Missing (n)	–	38
Number of past year doctor visits		
0	13.4	8.2
1	15.2	11.7
2–3	24.7	24.7
4–7	26.5	28.2
8	20.3	27.2
Missing (n)	14	55
Source of preventive care		
Doctor's office or HMO	75.3	81.2
Another location	18.2	15.1
Nowhere	6.4	3.6
Missing (n)	4	1
Health insurance coverage		
Private insurance	70.7	68.8
Public insurance	21.5	23.7
No insurance	7.8	7.5
Missing (n)	7	11
Overall self-reported health		
Poor/fair	19.5	21.4
Good	30.8	31.7
Very good/excellent	49.7	46.9
Missing (n)	2	0
Functional limitation caused by chronic condition		
Yes	42.9	55.8
No	57.1	44.2
Missing (n)	41	78
Number of chronic health conditions		
0	32.7	26.3
1	28.0	28.6
2	18.8	22.5
> 3	20.5	22.6
Missing (n)	7	2

Note. All percentages are weighted. HMO = health maintenance organization. Data Source: National Center for Health Statistics (2006).

Table 2

Adjusted Odds Ratios and Unadjusted and Adjusted Screening Estimates Examining Health Status Indicators of Colorectal Cancer Screening, Stratified by Sex, 2005 National Health Interview Survey

	Men			Women		
	aOR (95% CI)	Unadjusted Screening Rate, % (SE)	Adjusted Screening Rate, % (SE)	aOR (95% CI)	Unadjusted Screening Rate, % (SE)	Adjusted Screening Rate, % (SE)
Full sample	—	50.4 (0.9)	—	—	48.6 (0.8)	—
Overall self-reported health						
Poor/fair	0.74 (0.59–0.92)	52.2 (1.9)	46.4 (1.9)	0.84 (0.68–1.03)	46.8 (1.4)	47.4 (1.7)
Good	0.89 (0.75–1.06)	50.8 (1.5)	50.2 (1.4)	0.91 (0.78–1.05)	48.0 (1.3)	49.0 (1.3)
Very good/excellent	Ref	49.5 (1.2)	52.6 (1.2)	Ref	49.7 (1.1)	51.0 (1.2)
Functional limitation caused by chronic condition						
Yes	1.09 (0.92–1.29)	56.4 ^{**} (1.3)	51.7 (1.4)	1.29 (1.09–1.52)	52.1 ^{**} (1.0)	51.9 (1.1)
No	Ref	45.9 (1.1)	49.9 (1.2)	Ref [*]	44.3 (1.2)	46.7 (1.3)
Number of chronic health conditions						
0	Ref ^{**}	36.7 ^{**} (1.4)	43.9 (1.6)	Ref ^{**}	36.9 ^{**} (1.4)	44.2 (1.6)
1	1.43 (1.19–1.72)	51.5 (1.5)	51.5 (1.5)	1.39 (1.17–1.66)	51.2 (1.4)	51.0 (1.3)
2	1.61 (1.29–2.00)	58.2 (1.8)	53.9 (1.7)	1.34 (1.10–1.63)	52.8 (1.5)	50.2 (1.4)
3	1.79 (1.39–2.30)	63.8 (1.7)	56.2 (1.9)	1.55 (1.25–1.94)	55.0 (1.4)	53.3 (1.6)

Note. aOR = adjusted odds ratio. For the adjusted analysis among men, n=4927. For the adjusted analysis among women, n=6257. All percentages are weighted. Data Source: National Center for Health Statistics (2006).

[†] Adjusted screening rates are predicted marginals obtained from a multiple logistic regression analysis. The adjusted analyses controlled for age, race/ethnicity, education level, marital status, body mass index, smoking status, perceived colorectal cancer risk compared to others, number of past year doctor visits, source of preventive care, health insurance coverage, and additionally for women, adherence to mammography.

* $p < .01$

^{**} $p < .001$, for the association between the variable and adherence to colorectal cancer screening (defined as receipt of a home-based fecal occult blood test in the past year or flexible sigmoidoscopy/colonoscopy in the past 10 years).

Table 3

Adjusted Odds Ratios and Unadjusted and Adjusted Screening Estimates Examining Health Status Indicators of Mammography Screening Among Women, 2005 National Health Interview Survey

	aOR (95% CI)	Unadjusted Screening Rate, % (SE)	Adjusted Screening Rate [†] , % (SE)
Overall self-reported health			
Poor/fair	0.57 (0.46–0.71)	58.9 ^{**} (1.5)	61.5 (1.6)
Good	0.74 (0.62–0.89)	65.5 (1.3)	66.6 (1.3)
Very good/excellent	Ref ^{**}	72.7 (1.0)	71.9 (1.1)
Functional limitation caused by chronic condition			
Yes	0.84 (0.72–0.99)	65.6 ^{**} (1.0)	66.6 (1.0)
No	Ref	69.9 (1.0)	69.6 (1.1)
Number of chronic health conditions			
0	Ref	64.2 ^{**} (1.3)	64.5 (1.6)
1	1.20 (0.99–1.45)	70.1 (1.2)	67.8 (1.2)
2	1.43 (1.15–1.79)	71.4 (1.3)	70.9 (1.3)
3	1.26 (0.98–1.61)	64.6 (1.5)	68.7 (1.4)

Note. aOR = adjusted odds ratio. For the adjusted analysis, n=6128. All percentages are weighted. Data Source: National Center for Health Statistics (2006).

[†] Adjusted screening rates are predicted marginals obtained from a multiple logistic regression analysis. The adjusted analysis controlled for age, race/ethnicity, education level, marital status, body mass index, smoking status, perceived breast cancer risk compared to others, number of past year doctor visits, source of preventive care, and health insurance coverage.

^{**} $p < .001$, for the association between the variable and adherence to mammography (defined as receipt of a mammogram in the past two years).