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An Assessment of Health Insurance Features as Predictors of Colorectal Cancer Screening

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An Assessment of Health Insurance Features as Predictors of Colorectal Cancer Screening

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Thesis

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Dedication

In memory of my caring grandmothers who influenced me in so many ways and passed after prolonged fights with colorectal cancer

Carol Courten

And

Julia Woersching

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Abstract

Health insurance design influences whether a person will receive health services, including colorectal cancer (CRC) screening, although how insurance design influences utilization is not fully explained. By disaggregating types of insurance into discrete organizational and financial features, specific influential factors may be identifiable.

This study evaluated insurance features as predictors of CRC screening using data from the 2009, 2010, and 2011 Medical Expenditure Panel Survey. Studied insurance features included three organizational features: whether a person's insurance defined a provider network (DPN), used gatekeeping, and restricted coverage to a DPN; and two financial features: whether a person had a Flexible Spending Account (FSA) and categories of cost-sharing experience during the survey year. The primary outcome studied was whether a person was up-to-date with United States (US) Preventive Services Task Force (USPSTF)-

recommended CRC screening. In sensitivity analyses, any previous-year CRC screening was evaluated as an alternative outcome to assess if insurance features more strongly affected short-term screening than longer-term USPSTF screening. Multivariate logistic regression models were devised to separately evaluate each insurance feature. In smaller samples of the Western US, secondary analyses evaluated if insurance features differentially affected CRC screening among Hispanic versus non-Hispanic whites.

In the logistic models of the full US samples, organizational insurance features did not significantly predict the USPSTF outcome. A significant, >3% point, increase in any previous-year CRC screening was predicted by having two features, gatekeeping and coverage restricted to a DPN. The third organizational feature, having coverage restricted to a DPN, had a non-significant positive effect.

In the Western US analyses, each organizational feature predicted a more favorable change in screening likelihood for Western Hispanic whites than non-Hispanic whites suggesting a possible effect of reducing disparate CRC screening among Hispanics.

For the financial features in the full and Western US analyses, having a FSA had a large positive effect in unadjusted models, although the effect did not remain significant in fully-adjusted models. Cost-sharing categories predicted substantial variation in screening likelihood, which was largely mitigated in fully-adjusted models. Further research is needed using causal study designs and datasets with richer detail about insurance design.

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List of Acronyms

ACA	Patient Protection and Affordable Care Act
AHRQ	Agency for Healthcare Research and Quality
AIAN	American Indians/Alaskan Natives
ARSMA-II	Acculturation Rating Scale for Mexican Americans-II
BRFSS	Behavioral Risk Factor Surveillance Survey
CAHPS	Consumer Assessment of Healthcare Providers and Systems surveys
CAPI	computer-assisted personal interviewing
CDC	Centers for Disease Control and Prevention
CHIP	Children's Health Insurance Plan
CRC	colorectal cancer
CSHCN	children with special health care needs
CT	computed tomography
DCBE	double-contrast barium enema
DPN	defined provider network
EARTH	Education Towards Research and Health Study
FFS	fee-for-service
FOBT	fecal occult blood test
FSA	flexible spending account
FSIG	flexible sigmoidoscopy
HEDIS	Healthcare Effectiveness Data and Information Set
HDHP/SO	high-deductible health plan with a savings option
HIPA	MEPS Health Insurance Plan Abstraction file (available only for 1996)
HMO	health maintenance organization
MA	Medicare Advantage

MCBS	Medicare Current Beneficiary Survey
MCO	Managed Care Organization
MEPS-HC	Medical Expenditure Panel Survey – Household Component
MMC	Medicare Managed Care
NCHS	National Center for Health Statistics
NCQA	National Committee for Quality Assurance
NHIS	National Health Interview Survey
PCSA	Primary Care Service Area
PCP	primary care physician
PPO	preferred provider organization
SCOPE	Supporting Colorectal Cancer Outcomes Through Participatory Enhancements study
SEER	Surveillance, Epidemiology, and End Results
SES	socioeconomic status
USPSTF	United States Preventive Services Task Force

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Chapter 1

Introduction

Colorectal cancer (CRC) is one of the largest US cancer burdens. In 2013, there were an estimated 142,820 new CRC cases and 50,830 CRC deaths making it the second leading cause of cancer death for men and women combined (Surveillance, Epidemiology, and End Results Program 2013). An average-risk individual has a 4.8% risk of being diagnosed with CRC at some point in their lifetime. CRC incidence and mortality have generally declined continuously since the mid-1980s (Edwards 2009), although use of CRC screening still lags behind other highly effective cancer screening tests (Klabunde 2012).

CRC screening is highly effective and cost-effective at reducing CRC incidence and mortality (Whitlock 2008; Maciosek 2010; Maciosek 2006). From 1975-2000, CRC screening explained 53% of the observed decline in CRC mortality, while changes in risk factors explained 35% of the decline and improvements in treatment explained 12% (Edwards 2009). The US Preventive Services Task Force (USPSTF) recommends that average risk adults aged 50-75 receive CRC screening by any of three strategies: 1) colonoscopy every ten years, 2) flexible sigmoidoscopy (FSIG) every five years with high-sensitivity fecal occult blood test (FOBT) every three years, or 3) annual FOBT (US Preventive Services Task Force 2008), which is generally consistent with other prominent guidelines (Rex 2009; McFarland 2008)). While CRC screening use increased recently from 54% up-to-date with recommended screening in 2002 to 65% up-to-date in 2012 (Klabunde 2013), CRC screening use remains low relative to screened percentages for other highly effective cancer screening tests, notably 72.4% for mammography for breast cancer screening and 83.0% for pap smears for cervical cancer screening (Klabunde 2012).

The likelihood of being up-to-date with CRC screening varies depending on many factors including age, sex/gender, race, Hispanic ethnicity, education, income, having health insurance and having a usual source of health care (Shapiro 2012). Improving the health of all groups and eliminating disparities/achieving health equity are overarching goals of the US government's HealthyPeople campaign (Healthy People 2013). For the first time in 2012, equivalent percentages of whites (65.9%) and blacks (63.1%) were up-to-date with CRC screening in the Behavioral Risk Factor Surveillance Survey (BRFSS) (Klabunde 2013) the Centers for Disease Control and Prevention (CDC). Also for the first time, CRC screening use did not significantly differ between Asians/Pacific Islanders (63.2%) and whites or blacks. Screening differences persist though between Hispanics (53.1%), American Indians/Alaskan Natives (AIANs) (54.5%) and non-Hispanics (66.4%).

Many factors contribute to racial/ethnic CRC screening differences. In multiple studies, lower use of CRC screening among Hispanics has been largely or entirely mitigated statistically after adjusting for lower socioeconomic status (SES) and worse health care access (Gonzales 2012; Cokkinides 2011). Other factors include whether a physician recommended CRC screening (Yepes-Rios 2006; Jo 2008; Kelly 2007; Cronan 2008), immigration status and time lived in the US (Shih 2008), and geographic area-level poverty (Lian 2008). For receiving colonoscopy specifically, an intuitive, but non-obvious, factor found to strongly influence whether underserved individuals followed through with a scheduled colonoscopy was having a "next of kin" (spouse, family, or friend) available as a chaperone after the procedure because of the sedation (Anderson 2011).

Many approaches can be considered in the effort to increase CRC screening use nationally and reduce inequities. Screening promotion can use culturally appropriate messages to target particular groups, and other policy and practice

reforms can address the underlying fundamental social causes of inequities. Demographic and socioeconomic factors that are the root causes of inequities are not easy to modify, so health care system factors, such as organizational and financial factors that can influence preventive services use, may be a more suitable focus for strategies aiming to increase screening among vulnerable populations and may be more amenable to policy action. It has been noted that health insurance may be particularly well suited for influencing preventive services use because of insurer's organizational and financial connections to both providers and patients (Tye 2004).

The National Committee for Quality Assurance's (NCQA) produces the Healthcare Effectiveness Data and Information Set (HEDIS) that measures health plan performance on CRC screening as the percentage of adults aged 50-75 who are up-to-date with appropriate screening. Since the early 2000s, HEDIS CRC screening performance has steadily improved within each Health Maintenance Organizations (HMOs) and Preferred Provider Organizations (PPOs) (the two predominant types of health insurance) in the commercial and Medicare markets (National Committee for Quality Assurance 2013). In 2012, the HEDIS CRC screening performance measure indicated that HMOs have consistently achieved higher CRC screening rates than PPOs in the commercial and Medicare markets since the measures began reporting on all health plan types in 2005. HEDIS performance shows that the gap in CRC screening use between HMOs and PPOs has narrowed with a jump in CRC screening use among PPOs from 2010 to 2011, 47.6 to 54.6% for commercial PPOs and 41.0 to 55.2% for Medicare PPOs.

Variation in CRC screening use across types of health insurance has limited implications if there are not meaningful distinctions between health insurance types. Insurers exert influence on utilization in multiple ways and insurance characteristics may vary within a type of insurance as much as between types

(McGlynn 1998). Deconstructing health insurance types into discrete features is a means to more finely examine the effects of insurance characteristics on being up-to-date with recommended CRC screening.

By deconstructing health insurance types into discrete features, the features fit in Andersen and colleagues' frequently used Behavioral Model of Health Services Use as enabling factors (Andersen 1968; Andersen 1995; Andersen and Davidson 2007; Andersen 2008; Aday, Andersen, and Fleming 1980). In the Behavioral Model, individual and contextual characteristics act as predisposing, enabling and need factors that influence health behaviors and ultimately outcomes. Factors that stimulate or inhibit use vary depending on the particular service (Andersen 1995). For instance, an inpatient stay for a life-threatening illness would be primarily explained by need-based factors, while whether the whether a person obtains a discretionary preventive service, such as CRC screening, depends more on predisposing factors such as awareness of the service and health beliefs about obtaining needed services, and on enabling factors, such as being financially able to obtain the service and being having time away from work or other life demands to obtain the service. While it may be impossible to detect differences in the enabling effect of different health insurance types, constituent insurance features may act as enabling factors that influence a person's ability to obtain CRC screening. For instance, copay amount would be expected to influence ability-to-pay for CRC screening, and organizational features might enable an insurer to influence providers to recommend CRC screening.

A dataset that would permit evaluating insurance feature effects on CRC screening likelihood is the Medical Expenditure Panel Survey (MEPS) produced by the Agency for Healthcare Research and Quality (AHRQ) (Agency for Healthcare Research and Quality 2010). In addition to a survey component inquiring about a variety of personal characteristics and health behaviors, MEPS

collects information on medical events, payments and sources of payments. MEPS's unique combination of information includes CRC screening status, some insurance features, and a large set of potentially relevant covariates encompassing predisposing, enabling and need factors.

MEPS has been used with conceptual guidance from the Behavioral Model to evaluate whether insurance characteristics predicted recent screening mammography (Tye 2004). Primarily using data from the 1996 MEPS, Tye et al. assigned organizational and financial health insurance characteristics as individual enabling factors and assessed their influence on mammography use. Tye et al. created hypotheses for the effects of health insurance characteristics' by drawing on two main theoretical premises or "causal pathways": 1) if a health insurance characteristic increases the insurer's capacity to manage information flows, the health insurer will be better able to communicate to providers and patients about appropriate screening mammography (Galbraith 1973) and 2) if a health insurance characteristic reduces the effective "price" of screening mammography to enrollees, demand will increase (Manning 1987). The study found that mammography use did not differ depending on a woman's health insurance plan being labeled managed care or indemnity, although more specific health plan characteristics did predict use including that having insurance that defined a provider network and that used gatekeeping were found to predict greater likelihood of recent mammography (Tye 2004). Additional health plan characteristics, restricting out-of-network coverage, use of cost containment strategies, enrollee cost sharing, and breadth of benefit coverage were not found to influence mammography use.

This study adapted Tye et al.'s approach to accomplish the objective of assessing insurance features as predictors of CRC screening. To accomplish the objective, cross-sectional analyses were conducted of pooled data from the years 2009, 2010, and 2011 of MEPS data. The conceptual framework based on

the Behavioral Model of Health Services Use and Tye et al.'s causal pathways informed specification of analyses using available measures in MEPS.

As previously noted, CRC screening use is known to be inequitable for Hispanics (Klabunde 2013) and for Hispanics in New Mexico as compared to whites (Gonzales 2012). Within Hispanics, variation in CRC screening use has been identified between different states and regions of the country (Pollack 2006) and based on nation of origin (Gorin and Heck 2005). Those patterns reveal lower CRC screening among Western US Hispanics and among the prevalent Hispanic subgroups in the West of Mexican and Central American origin. In Gonzales et al.'s study of the BRFSS data for New Mexico, having health insurance was associated with a higher prevalence of up-to-date CRC screening rates for non-Hispanics than for Hispanics by ~20% points for both men and women. Uninsured non-Hispanic white men and women had screening rates ~8% points less than uninsured Hispanic men and women, respectively, while insured non-Hispanic white men and women had CRC screening rates that were 12% and 14% greater than insured Hispanic men and women, respectively. Exploring insurance feature effects may provide evidence to support a greater benefit to CRC screening rates from having insurance among non-Hispanic whites than Hispanics. Because geographic identification of MEPS respondents is limited to census regions, this subanalysis examined Hispanic and non-Hispanic whites in the Western US census region. To explore differential insurance feature effects between non-Hispanic whites and Hispanic whites in the Western US, the subanalysis repeated the full population analysis with the addition of a mediating effect for insurance features by Hispanic ethnicity.

The influences of insurance features studied here has a potential to inform health insurance administration and health policy to increase CRC screening use, reduce inequities, reduce CRC incidence and mortality, and support the study of insurance feature effects on utilization of other health services.

Specific Aims and Hypotheses

Aim 1. ***Evaluate the association between insurance features and likelihood of being up-to-date with USPSTF-recommended CRC screening.***

Hypothesis: Higher CRC screening likelihood is predicted by insurance features that indicate an insurer had greater capacity to communicate about appropriate CRC screening messages to providers and enrollees or by insurance features that indicate enrollees experienced lower cost-sharing.

Aim 2. ***Evaluate the association between insurance features and likelihood of being up-to-date with USPSTF-recommended CRC screening among Western US Hispanic and non-Hispanic whites.***

Hypothesis: Aim 1's hypothesized benefits of increased CRC screening use due to insurance features will be smaller for Western Hispanic whites in comparison to non-Hispanic whites.

Chapter 2

Literature Review

This chapter provides an overview and synthesis of knowledge on topics relevant to this study. Four content areas were reviewed: 1) CRC Overview: the population health burden is summarized including incidence, prevalence, mortality, trends, treatments, and costs; 2) CRCS Trends and Predictors: recent estimates and trends in CRC screening use are summarized. A formal literature search was performed to broadly assess factors that predict CRC screening that will inform covariate specification for multivariate analyses. Specific issues for Aim 2 are addressed relating to assessing the CRC screening inequity between non-Hispanic and Hispanic whites in the Western US; 3) Theoretical Framework: Use of the Behavioral Model of Health Services Use in this study adapted from Tye et al. is explained; 4) Health Insurance Effects: current enrollment in types of insurance across the major sources of payment is detailed. How different insurance types generally affect health services use and CRC screening in particular is examined. A formal literature search was conducted to identify evidence regarding the effects of health insurance features on health services utilization.

Colorectal Cancer Overview

An estimated 1,154,481 people had CRC in the US in 2013 (Surveillance, Epidemiology, and End Results Program 2013). Incidence was 45.0 cases of CRC per 100,000 persons, which constitutes 8.6% of all new cancer diagnoses. The CRC mortality rate was 16.4 per 100,000 persons, which constitutes 8.8% of

all cancer deaths. For men and women separately, CRC is the third leading cause of cancer and third deadliest cancer after lung and prostate cancer and lung and breast cancer, respectively. CRC incidence and mortality have been declining since the mid-1980s (Edwards 2009) and have each fallen by nearly 3% per year over the last ten years (Surveillance, Epidemiology, and End Results Program 2013).

The CRC burden disproportionately affects some groups. CRC risk increases with older age: the median age at diagnosis is 69, and those aged 65-74 and 75-84 each make up 24% of new cases (Surveillance, Epidemiology, and End Results Program 2013). The median age at death is 74 with those aged 75-84 making up the largest share, 28.2% followed by those aged 65-74, 21.9% of deaths, and those aged 85 and older, 20.8%. Men in comparison to women consistently have higher CRC incidence (50.6 vs. 38.2 per 100,000) and mortality (19.6 vs. 13.9 per 100,000). African American men and women have the highest CRC incidence and death rates of all racial and ethnic groups by 1.5-2 times the population average. In comparison to the full population rates, whites have slightly lower incidence and mortality rates that are just less; non-Hispanics of all races have slightly higher incidence and mortality rates; and Asians/Pacific Islanders, Hispanics, and AIANs generally have lower CRC incidence and mortality by 10-20%, except AIAN women have a 15% higher mortality rate than the full population.

CRC risk factors include several medical history factors: a family history of CRC or other hereditary colorectal conditions; a history of ulcerative colitis or Crohn's disease; a personal history of colorectal, ovarian, or breast cancer; or a personal history of polyps (National Cancer Institute 2013a). Lifestyle risk factors include lack of regular physical activity, a diet low in fruit and vegetables or a low-fiber and high-fat diet, obesity, excessive alcohol consumption, and cigarette smoking. Several medications have been evaluated for CRC prevention effects: although

evidence is mixed, long-term aspirin use has been found to reduce CRC risk; evidence is insufficient to conclude if non-aspirin non-steroidal anti-inflammatory drugs decrease CRC incidence; evidence is mixed or unsupportive regarding vitamin supplements including vitamin E, antioxidant vitamins, folic acid supplements, and statin use. Associational benefits of calcium supplements have been found although the evidence is inconclusive.

From 2003-2009, five-year survival for new cases was 64.9%. There are six standard treatments for CRC: surgery by local excision within the colon or resection of the colon with anastomosis or colostomy; chemotherapy; radiation therapy; radiofrequency ablation; cryosurgery; and targeted therapy with monocolonal antibodies or angiogenesis inhibitors (National Cancer Institute 2013b). The five-year survival rate is much higher for persons whose cancers are detected at an earlier stage, greater than 90% for local stage cancers vs. ~10% for distant cancers. The strong rationale for routine CRC screening is due to earlier detection (Edwards 2009). In 2010, annual medical expenditures for CRC were estimated to be $14.1 billion and were projected to rise to $17.4 billion in 2020 (in 2010$) in analyses accounting for only changes in the US population, with a range of estimates from $14.4 billion to $20.4 billion in different scenarios varying incidence, survival, and cost assumptions (Mariotto 2011).

Predictors of Colorectal Cancer Screening

A formal literature search was conducted to identify studies evaluating CRC screening predictors other than health insurance features. A PubMed search was conducted on 06/03/2013 covering the previous ten years. The search terms contained three components: 1) National Cancer Institute's "Cancer Topic Search" for "Digestive System Cancer: Screening and Prevention" modified to

exclude non-colorectal cancers (Appendix) (National Cancer Institute), 2) the U.S. National Library of Medicine's health disparities search terms (U.S. National Library of Medicine) and 3) any of three words to identify predictors: (predictor* OR factor* OR determinant*). The search strategy yielded 131 search results, and 43 articles were reviewed. The most current, original findings from US settings on unique CRC screening predictors, quantitative and qualitative, were reviewed to inform the specification of control variables in this study's analyses. Evidence from additional applicable sources are included where appropriate notably an extensive 2010 systematic review of CRC screening use and quality that was conducted on behalf of AHRQ (Holden 2010a).

Changes in CRC screening Use Over Time

Repeated measures over time using national health surveys including the National Health Interview Survey (NHIS) and BRFSS show that CRC screening use has continuously increased over time from the late 1980s to the present (Klabunde 2013; Cokkinides 2011; Miranda 2012; Shavers 2010; Klabunde 2011; Bandi 2012; Soneji 2012; Rim 2011; Holden 2010b). In the CRC screening eligible population of 50-75 year old average-risk persons, nation-wide 65.1% were up-to-date with USPSTF-recommended CRC screening strategy in a recent estimate from the 2012 BRFSS (Klabunde 2013). From 2000-2008, the percentage of the population aged 50-75 that was up-to-date with any recommended CRC screening strategy increased by 15.9% point (38.6 to 54.5%) (Klabunde 2011).

Medicare Policies influencing Trends of Different CRC screening Techniques

CRCS trends by screening technique from the early 2000s to the present are a continuation of trends relating to Medicare policy changes for CRC screening around the turn of the millennium (Gross 2006). Beginning in January 1998, Medicare was required by Congress to pay for FOBT, FSIG, double-contrast

barium enema (DCBE) screening, and colonoscopy for high-risk persons according to American Cancer Society recommendations. Coverage was later expanded to require Medicare to reimburse screening colonoscopy every 10 years for all persons as of July 1, 2001, no longer for just those at high-risk. In a trend analysis of number of procedures received per 100,000 Medicare beneficiaries from 1991-2003, it was demonstrated that a switch occurred from more FSIG use in the early period from 1991-7 to more colonoscopy use after the first policy change in 1998 (Gross 2006). FSIG peaked at 691.9 procedures per calendar-year quarter per 100,000 beneficiaries in 1999-2000 before declining to 267.5 in 2002-2003. Colonoscopy use increased from 284.6 procedures per calendar-year quarter per 100,000 beneficiaries in 1996-1997 to 1918.9 procedures in 2002-2003, an increase by a factor of greater than six. Colonoscopy use superseded FSIG as the predominant screening technique, even before the universal colonoscopy coverage expansion in July 2001.

Provider Opinion

Besides reimbursement policy, provider opinion has contributed to the trends in CRC screening use by different techniques. In the 2006-2007 National Survey of Primary Care Physicians' Recommendations and Practices for Breast, Cervical, Colorectal, and Lung Cancer Screening (Klabunde 2009), 95.3% of primary care physicians (PCPs) perceived colonoscopy to be effective in reducing mortality, while only 22.6% of PCPs perceived computed tomography (CT) colonography to be effective, and less than 20% of PCPs perceived to be effective each of FOBT, FSIG, DCBE, and fecal DNA testing. Comparing the techniques that PCPs said that they would recommend in that survey to the previous 1999-2000 survey, the percentage of PCPs recommending FOBT declined from 95% to 80%, while the percentage of PCPs recommending each FSIG and colonoscopy more than switched with a decline for FSIG from 78 to 26% and an increase for colonoscopy from 38 to 95%.

CRCS Trends within Racial/Ethnic Groups

Major racial/ethnic groups, African Americans, Hispanics, Asians and non-Hispanic whites have generally experienced increasing CRC screening use consistent with trends in the general population over the same period (Shavers 2010; Klabunde 2011; Bandi 2012; Soneji 2012). The magnitude of trends varies though: Hispanics have not increased screening use as much as other major racial/ethnic groups (i.e. disparities have widened) due to a smaller increase in colonoscopy use, although at the same time Hispanics have also had smaller declines in FOBT and FSIG (Klabunde 2011; Bandi 2012).

CRC screening adoption has varied among Hispanic subethnicities as well: using pooled MEPS data from 2000-2007 (Miranda 2012), CRC screening use trends were studied for Hispanic subethnicities, blacks and whites aged 50 and older. Puerto Ricans, Cubans, blacks, and whites experienced a similar ≥10% points gain in combined use of FOBT and/or endoscopy from 2000-2007, although CRC screening use was essentially flat for Mexicans and declined among "Other Latinos". These trends are relevant to this study's second Aim because Mexican and Central Americans are heavily represented in the Western US while Puerto Ricans and Cubans are concentrated in the Eastern US (Ennis 2012).

CRCS Trends by Other Factors

Inequities have also widened relating to other factors, particularly social status and SES factors: from 2000-2008, smaller gains in CRC screening use were experienced by those with less income and education, by the disabled, and by immigrants (Klabunde 2011; Rim 2011). Inequities widened for those with deficient health care access including those lacking health insurance (Rim 2011), those having no physician visits in the previous year, and those without a usual source of care (Klabunde 2011). Among the insured, CRC screening disparities relating to age subgroups and insurance types have shifted over time (Klabunde

2011). Among the insured 50-64 age group, the disparity between the publicly (historically inequitable) and privately insured widened slightly by 5% points. In the insured 65-75 age group, the CRC screening gap narrowed by more than 5% points for those having basic Medicare without supplemental insurance (historically inequitable) in comparison to those with Medicare HMO coverage or Medicare with private supplemental insurance.

Changes in CRC Screening Over Time Summary

In the context of Medicare's CRC screening reimbursement expansions in 1998 and 2001 (Gross 2006), and a shift in provider opinions to favor colonoscopy more and favor FSIG and FOBT less (Klabunde 2009), colonoscopy became the strongly preferred CRC screening strategy type by the early 2000s. Declining FSIG and FOBT use has been more than replaced by increasing colonoscopy use such that overall CRC screening use consistent with recommendations increased from 38.6% in 2000 to 54.5% in 2008 (Klabunde 2011) and most recently has been estimated to be 65.1% in 2012 (Klabunde 2013). These gains have been experienced broadly, although CRC screening use has notably not increased as much among Hispanics resulting in a widening disparity in comparison to non-Hispanic whites (Klabunde 2011) and some Hispanic subgroups (Miranda 2012). Inequities have also widened among those of lower socioeconomic and social status and those with poorer health care access (Klabunde 2011; Rim 2011).

Predisposing Factors

Demographics

Age

As age increases above from the recommended start age, 50, CRC screening use increases (Shapiro 2012; Cokkinides 2011; Miranda 2012) until plateauing at

70-75 years and gradually declining thereafter (Soneji 2012; Mobley 2010; O'Malley 2005). In the 50-59, 60-69, and 70-75 age groups in the 2010 NHIS, 50.0, 65.8 and 68.2%, respectively, were estimated to be up-to-date with CRC screening by any of the USPSTF-recommended strategies (Shapiro 2012). In the 50-59, 60-69, and 70-75 age groups in the 2010 BRFSS, 55.1, 72.9 and 76.9%, respectively, were estimated to be up-to-date with CRC screening by any of the USPSTF-recommended strategies (Joseph 2012). The discrepancy between the estimates from the NHIS and BRFSS is due to survey administration differences and different response rates: NHIS has a higher response rate, and since non-responders are less likely to be screened, NHIS has less non-response bias than BRFSS, so the NHIS is less likely to overestimate screening rates (Holden 2010b).

Explanations for the Association with Increasing Age

Many explanations have been proposed for the positive association between increasing age and CRC screening use including greater awareness of CRC and CRC screening, elevated concern about CRC, more diagnostic testing for other gastrointestinal issues, more positive FOBT tests with increasing age that prompt endoscopy (Ioannou 2003), poorer health that prompts health care system encounters increasing the likelihood of a CRC screening provider recommendation, and the removal of health insurance coverage barriers for the uninsured/underinsured once they receive Medicare at age 65 (although CRC screening use increases substantially in the 50-64 year olds age group prior to Medicare eligibility) (Hudson 2012).

Sex/Gender

Men and women are similarly likely to receive CRC screening with many studies finding no difference in CRC screening use (Cokkinides 2011; Soneji 2012; Carcaise-Edinboro and Bradley 2008), although some, mostly larger studies,

have found that women have a small, independently significant, lower likelihood of CRC screening use (Miranda 2012; Shavers 2010; Rim 2011; Ioannou 2003; Homayoon 2013). Recent estimates though suggest that if there has historically been a small gender gap, it may have recently reversed: in the 2010 BRFSS, women had significantly higher CRC screening use than men (65.0 vs. 63.9) (Joseph 2012), and in the 2012 BRFSS, women had further gains in CRC screening use since 2010, while use did not change among men, 66.2% vs. 63.9% (Klabunde 2013). No literature was found pertaining to CRC screening use among any non-heteronormative genders.

Explanations for Gender Disparities

Explanations for gender differences in CRC screening use include differences in physician recommendation patterns and differential attitudes and beliefs about CRC screening. In the Supporting Colorectal Cancer Outcomes Through Participatory Enhancements (SCOPE) study, a predominantly white, insured, and higher SES sample visiting primary care practices in New Jersey between 2006 and 2008 (Hudson 2012), men were recommended to receive CRC screening significantly more often than women, although men and women did not differ in their likelihood of adhering to a recommendation. Another study though did not find gender significantly predicted receiving a recommendation for FOBT, FSIG, colonoscopy, any endoscopy, or any CRC screening among black and white, North and South Carolina Medicare beneficiaries (Klabunde 2006). In a study assessing attitudes and beliefs associated with CRC screening use, it was found that women were more likely than men to report agreement with attitudes and beliefs that were associated with lower likelihood of being up-to-date with endoscopy use (Farraye 2004) including being more frightened or embarrassed about having a FSIG exam, considering having a FSIG to be very inconvenient with one's daily schedule, being more willing to have a FSIG if the endoscopist was the same gender as the respondent, and being less likely to agree that

having an FSIG every five years after the age of 50 is important for general health.

Race

Estimates from the 2012 BRFSS indicate that differences in CRC screening use are not significant between whites, 65.9% up-to-date with recommended screening; blacks, 65.5%; and Asians/Pacific Islanders, 63.2%; although screening is still inequitable among AIANs, 54.5% (Klabunde 2013). Those estimates are a change from estimates two years earlier in the 2010 BRFSS and 2010 NHIS, which indicated that CRC screening use among Asians was lower than whites and blacks (Shapiro 2012; Joseph 2012).

Hispanic Ethnicity

In recent 2012 BRFSS estimates, Hispanics' CRC screening use lagged non-Hispanics, 53.1% vs. 66.4% (Klabunde 2013). Among Hispanics, CRC screening use varies depending on multiple factors, which suggest higher risk of CRC screening underuse among Western US Hispanics that are the focus of Aim 2. In a multivariate analysis of the 2000 NHIS examining two CRC screening techniques separately (Gorin and Heck 2005), CRC screening use varied across Hispanic subgroups: Puerto Ricans and Central/South Americans had half the odds of Mexican Americans (OR: 0.50 (0.28-0.89) and 0.42 (0.21-0.85), respectively) of having received any endoscopy in the past five years, although for the second technique considered, no Hispanic subgroups had significantly different FOBT use within the previous year than Mexican Americans. It may not have been possible to detect differences between Mexican Americans and each Cubans and Dominican Americans because of small sample sizes for those subgroups. In another study examining Hispanic subgroups, which used combined data from 2001-2005 MEPS and 2000-2004 NHIS (Jerant 2008), Hispanics of Mexican or Dominican origin had larger disparities in comparison to

non-Hispanic whites than Hispanics of Cuban or Puerto Rican origin vs. non-Hispanic whites. CRC screening use among Hispanics varies across geographic areas as well. A state-level analysis of the 2002 BRFSS (Pollack 2006) found that Hispanics in Northeastern states (Massachusetts, New Jersey and New York) had greater CRC screening use within recommended time intervals than Hispanics in Western States (Arizona, California, Colorado, and New Mexico).

Explanations for Inequitable CRC screening use Among Hispanics

Evidence indicates many factors contribute to Hispanic CRC screening disparities. In multiple studies, lower SES among Hispanics than non-Hispanics/whites has been attributed as a cause of CRC screening underuse among Hispanics. SES measures that have been studied include income, employment, education, and health care access factors. Addressing these factors, which have been labeled fundamental social causes of disease, has been theorized to be sine qua non for eliminating health inequities (Link and Phelan 1995).

In a study assessing CRC screening use among Latino subgroups (Miranda 2012), all subgroups had unadjusted disparities in CRC screening use compared to non-Hispanic whites when only adjusting for age and sex. In a model that adjusted for education, income, and insurance, only Mexicans and "Other Latinos" still had inequitable CRC screening use while Cubans and Puerto Ricans did not have significantly different CRC screening use from non-Hispanic whites. In analyses of the 2006 New Mexico BRFSS stratified by sex (Gonzales 2012), New Mexico Hispanic women had inequitable CRC screening use versus white women (OR: 0.55 (0.44-0.70)) that was not statistically eliminated after controlling for several blocks of covariates including survey language, demographics, SES, clinical factors, lifestyle factors, preventive services utilization factors, or a full model including all the aforementioned covariate blocks. Controlling for socioeconomic factors (health care coverage, current

employment status, annual household income and high school-level education) most noticeably, partially statistically mitigated the disparity for Hispanic women (OR: 0.73 (0.56-0.97). Gonzales et al. noted that New Mexican Hispanic women in their sample were less likely to have health care coverage and were more likely to report being low income (<$25,000), being unemployed or having less than a high school education. Therefore residual differences remain between New Mexican Hispanic and non-Hispanic white women that explain the statistical difference. For New Mexico Hispanic men in contrast, most of the blocks did statistically eliminate inequitable CRC screening use in comparison to non-Hispanic white men except for demographic, clinical and lifestyle factors. In addition to SES, cultural factors including nation of origin, acculturation factors and health beliefs/psychosocial factors have also been shown to contribute to Hispanic CRC screening inequities, which are discussed in a subsequent sections. While Hispanics have lower CRC incidence and mortality than non-Hispanics (Surveillance, Epidemiology, and End Results Program 2013) as was noted earlier, Hispanics may have excess CRC risk due to lifestyle factors that increases the need for CRC screening in the Hispanic population including higher rates of obesity and lower use of other cancer screening tests than non-Hispanics whites, although Hispanics have favorably lower rates of smoking and frequent alcohol consumption (Cokkinides 2012).

Barriers to CRC screening Among Hispanic Men

Although screening rates indicate that CRC screening use has historically been inequitable among Hispanic women in comparison to men (Gorin and Heck 2005; Crawley 2008), unique barriers to CRC screening use for Hispanic men have been noted. In focus group responses of low income/education Hispanics mostly of Mexican-birth who were living in U.S. cities along the Texas-Mexico border (Fernandez 2008), the concept of machismo was identified as a barrier to CRC screening among men, that CRC screening is a violation to manhood. One man

was even quoted as jokingly saying that men avoid CRC screening because they think, “I may die, but I’ll die a virgin”. In this study, participants also expressed the opinion that women visit the doctor more often than men and are inherently more inclined to accept CRC screening. In an exploratory qualitative study of attitudes and beliefs about CRC screening among New Mexico Hispanic subpopulations (Getrich 2012), the importance of machismo notably differed for two particular subgroups: 1) Hispanos (Hispanics who trace their ancestry from late-16th century Spanish colonists) concentrated in northern New Mexico and 2) first-generation Mexicans concentrated in southern New Mexico. For first-generation Mexicans, perceptions about receiving colonoscopy included that it was an affront to heterosexual manhood and/or would negatively affect a man’s reputation in the community. These privacy and stigma concerns were not held by Hispanos possibly because of a tighter knit community going back many generations and the absence of recent immigration enforcement threats, which is an issue for southern New Mexico first-generation Mexican communities.

Geography

CRCS use varies over geographic regions and depending on population density. Arkansas had the lowest proportion of its population up-to-date with recommended CRC screening in 2012, 55.7%, while Massachusetts had the highest proportion, 76.3% (Klabunde 2013). Among US census regions the Northeast had higher predicted recommended CRC screening use than the Midwest and South, but not the West in multivariate analyses of a combined sample of the 2000, 2003, 2005, and 2008 NHIS (Klabunde 2011). Studies have consistently found a disparity in CRC screening use for persons living in rural areas in comparison to their urban counterparts (Shih 2008; Carcaise-Edinboro and Bradley 2008; Homayoon 2013; Schumacher 2008).

Acculturation

Some evidence supports an association between CRC screening use and acculturation (acculturation measures, immigration status, and spoken language) and cultural factors (factors potentially related to traditional lifestyle for Native Americans). For measures of Hispanic acculturation evaluated in two studies, CRC screening use was not significantly predicted by either the Acculturation Rating Scale for Mexican Americans-II (ARSMA-II) (Yepes-Rios 2006) or the Marin and Marin Short Acculturation Scale (Shah 2006). Across immigration status categories, CRC screening use was found to vary. Foreign-born persons who had been in the US for 15 or more years or for ten or fewer years were less likely to have ever received CRC screening than US-born non-Hispanic whites, OR: 0.58 (0.51-0.67) and OR: 0.46 (0.29-0.71), in analyses of the 2000 NHIS (Shih 2008). No difference was found for foreign-born persons residing in the US for 10-14 years, OR: 0.85 (CI: 0.49-1.46), although the 10-14 years group had a small sample. Spoken language has been assessed as a CRC screening predictor in multiple ways. In two small studies, measures of English speaking proficiency did not predict CRC screening use (Anderson 2011; Homayoon 2013). In two larger studies, language spoken at home did predict CRC screening use, among Native Americans (Schumacher 2008) and in a nationally representative sample comparing English and Spanish speakers in the 2004 MEPS (Carcaise-Edinboro and Bradley 2008). Survey language was found to significantly predict CRC screening use in one larger study of Latinos and non-Latinos in 23 states offering the 2006 BRFSS in Spanish (Diaz 2008). Factors potentially related to traditional lifestyle (use of traditional medicines, advice from traditional healer, identity with tribal tradition, identity with non-Native culture and participation in traditional events) did not predict CRC screening use, in the large Education Towards Research and Health (EARTH) Study that surveyed 11,358 Native Americans from Alaska and the Navajo Nation (Schumacher 2008).

Health Beliefs

Three studies are highlighted that examined health belief/psychosocial factors as a determinant of CRC screening use. In a survey of 158 European Americans, African Americans and Mexican Americans recruited in public settings in three zip codes in San Diego selected based on racial representation and median income below $50,000 (Cronan 2008), greater perceived efficacy of screening predicted greater likelihood of being up-to-date with recommended CRC screening; perceived vulnerability also positively predicted screening, but did not reach statistical significance; while self-efficacy for screening and perceived barriers were not significant (Cronan 2008). After having sequentially controlled other covariates in three earlier models, the addition of psychological factors in the full, final model statistically eliminated the CRC screening disparity between European and Mexican Americans.

CRCS psychosocial factors were studied at a community health center in the University of Kansas Medical center in a sample that was majority aged 40-49 (52.9%), African American (69.3%), low-income (70.6% <$1200/month), unmarried (85%), and had low health care access (44.4% uninsured) (Greiner 2005). In the subset of the sample aged 50 and older, cancer fatalism significantly predicted returning the FOBT card that had been provided during survey administration, and not having any FOBT barriers was positively predictive and nearly reached statistical significance (particular psychosocial factors derived for the study from focus group responses), OR: 2.72 (CI:0.95-7.81). FOBT card return did not depend on CRC screening test preference; trust in health care providers; or having endoscopy barriers.

Differences between population and provider beliefs about CRC screening in New Mexico were assessed using a primary survey of PCPs in 2006 and the 2004 New Mexico BRFSS CRC screening module (Hoffman 2011). Population and provider beliefs were dissonant: physicians attributed patient barriers as

primarily at fault for CRC screening underuse, while the population attributed not receiving a physician recommendation as the leading barrier.

Preventive Services Utilization

History of receiving preventive services is a proxy for being health-aware and, therefore, for being more likely to receive other preventive services. Other cancer screenings have strongly predicted CRC screening use including recent receipt of mammography (Gonzalez 2012), recent receipt of pap smears (Schumacher 2008) and for Hispanics having received other non-CRC cancer screening tests (Gorin and Heck 2005). A study found that having received an influenza or pneumonia vaccine predicted being up-to-date with CRC screening (Klabunde 2007). Whether a person takes preventive medications including a multivitamin or aspirin did not predict CRC screening in two studies (Anderson 2011; Ioannou 2003).

Patient-Provider Communication

In multiple forms, better patient-provider communication predicts CRC screening use. Reporting “sometimes”, “usually” , or “always” vs. “never” in response to questions in the Consumer Assessment of Healthcare Providers and Systems (CAHPS) survey about how often health care encounters in several ways were satisfying predicted a higher likelihood of ever having received CRC screening (Carcaise-Edinboro and Bradley 2008). Provider recommendation has repeatedly strongly predicted CRC screening use (Yepes-Rios 2006; Jo 2008; Kelly 2007; Cronan 2008). Perceived medical discrimination strongly negatively predicted being up-to-date with recommended CRC screening with generally stronger effects for men than women among African Americans, AIANs, Asians and Latinos (Crawley 2008).

Health Status

Evidence is mixed regarding whether worse health predicts CRC screening: worse health predicted CRC screening for measures of perceived health status (Cokkinides 2011; Shih 2008; Gorin and Heck 2005; Ioannou 2003) and for having chronic conditions (Klabunde 2006; Schumacher 2008). Other studies though did not find that worse perceived health status or having chronic or comorbid conditions predicted CRC screening (Lian 2008; Anderson 2011; O'Malley 2005; Hudson 2012; Homayoon 2013; Schumacher 2008; Gonzalez 2012). Worse health status may predict CRC screening use because persons in poorer health have more health care encounters during which a provider could prompt them to obtain CRC screening.

Need-Based Factors

Any CRC risk factor is a potential CRC screening predictor because by affecting a person's CRC risk, risk factors are need-based factors for CRC screening in the Behavioral Model of Health Services Use since higher risk implies a stronger recommendation to receive CRC screening.

Medical History

Family history of CRC or any cancer predicted CRC screening use in two large studies (Schumacher 2008; Murff 2008). One study has evaluated differences in CRC screening likelihood between African Americans and whites who had a family CRC history (Murff 2008). Whites had a higher odds of having received colonoscopy in the past five or ten years, and comparing high and low family history risk level, whites had an even greater advantage compared to African Americans in the high risk subpopulation (having a first degree relative who was younger than 50 years when diagnosed with CRC or having multiple first degree relatives) than in the lesser risk subpopulation (having only one first degree relative diagnosed at age 50 or later). CRC-related symptoms, personal CRC history or irritable bowel disease, strongly predicted recent endoscopy use

(Mobley 2010), although such use is presumably for diagnostic rather than screening purposes, which should exclude those individuals from an evaluation of CRC screening predictors. Breast cancer survivors had a small increased probability of recent endoscopy, as well (Mobley 2010).

Lifestyle Factors

Evidence on the association between lifestyle factors and CRC screening use is generally mixed. There have been equivocal findings regarding whether tobacco use negatively predicts CRC screening (Hudson 2012; Homayoon 2013), does not predict CRC screening (Lian 2008; Anderson 2011; Gorin and Heck 2005; Schumacher 2008), or is a protective factor (Soneji 2012). Multiple studies found that former smokers are more likely to have received CRC screening than never smokers (Ioannou 2003; Schumacher 2008; Wong and Coups 2011; Brennenstuhl 2010); that finding may be explained by successful quitters being more health-aware otherwise and motivated to obtain recommended CRC screening to reduce their CRC risk. In one study of individuals visiting primary care practices in New Jersey, non-smokers had greater odds of receiving a CRC screening recommendation, OR: 1.876 (1.24-2.84), and even greater odds of adhering to a recommendation, OR: 2.59 (1.52-4.43) (Hudson 2012). Evidence is also mixed for alcohol use: one study found heavy drinking (2+ drinks/day for men; 1+ drinks/day for women) predicted endoscopy use (Lian 2008) and one study did not find an effect for alcohol consumption (2+ drinks/day) on CRC screening use for men who had been recently screened for prostate cancer (Wong and Coups 2011). A low-fat diet to prevent heart disease predicted CRC screening in one study (Ioannou 2003). Evidence is mixed that greater physical activity predicts increased CRC screening (Ioannou 2003; Wong and Coups 2011) or did not affect it (Lian 2008). Evidence is mixed that obesity predicts increased CRC screening use (Lian 2008; Soneji 2012; Hudson 2012), decreased use (for compliance with a free scheduled colonoscopy in a low-

income underserved population) (Anderson 2011), or does not predict use (Homayoon 2013; Schumacher 2008).

Enabling Factors

Socioeconomic Status

In the Behavioral Model of Health Services Use, individual and community SES influence a person's ability to pay for and access health services. Individual SES has been theorized to act as a fundamental social cause of disease by determining access to resources that influence health (Link and Phelan 1995). Multiple individual measures of SES predict CRC screening. Increasing household income consistently predicts greater use of CRC screening (Shapiro 2012; Cokkinides 2011; Shih 2008; Lian 2008; Miranda 2012; Shavers 2010; Soneji 2012; O'Malley 2005; Joseph 2012; Ioannou 2003; Carcaise-Edinboro and Bradley 2008; Homayoon 2013; Schumacher 2008). Higher educational attainment is also consistently positively predictive (Shapiro 2012; Cronan 2008; Shih 2008; Lian 2008; Pollack 2006; Miranda 2012; Soneji 2012; O'Malley 2005; Joseph 2012; Carcaise-Edinboro and Bradley 2008; Homayoon 2013). A combined income and education criteria (less than a 12th grade education and/or annual income of less than $15,000) was used to dichotomize low vs. high SES in one study, which also predicted CRC screening use (Diaz 2008). Employment status has mixed evidence from multiple studies (Yepes-Rios 2006; Ioannou 2003; Homayoon 2013) including that unemployment or retirement (multivariate adjusted including age 65+ vs. 50-64) positively predicts CRC screening in comparison to being employed (Lian 2008; Ioannou 2003). The employed may be less likely to receive CRC screening because they are unable to leave work to obtain CRC screening. Respondent's ability to pay was measured in one study as whether they stated that cost had prevented a doctor's visit in the previous year, which did not significantly predict CRC screening use (Wong and Coups 2011).

Contextual-level SES effects may also be relevant CRC screening predictors, although evidence is limited. Medicare beneficiaries living in communities with generally poorer elderly were less likely in six states and more likely in two states to have recently received endoscopy (Mobley 2010). In another assessment of a community-level SES effect on CRC screening, greater area-level poverty predicted lower CRC screening use after controlling for six sets of individual-level covariates, and CRC screening use was found to vary across smaller ZIP5 area codes, but not ZIP3 areas (Lian 2008).

Health Care Access

Greater health care access strongly predicts CRC screening use. Having a usual source of care consistently strongly predicts CRC screening use (Shapiro 2012; Shih 2008; Shih 2008; Pollack 2006; Shavers 2010; Klabunde 2006), as well as having a usual PCP (Jo 2008; Lian 2008; Wong and Coups 2011), having a longer history with one's current PCP (Farraye 2004), and having health insurance vs. not (Shapiro 2012; Shih 2008; Lian 2008; Pollack 2006; Miranda 2012; Shavers 2010; Soneji 2012; Joseph 2012; Ioannou 2003; Carcaise-Edinboro and Bradley 2008; Fernandez 2008; Gonzalez 2012; Wong and Coups 2011). Insurance further predicts CRC screening depending on source of coverage: both those under 65 with private insurance and those aged ≥65 with Medicare plus a private supplemental tended to have higher CRC screening use than their only publically insured age-specific counterparts, although source of coverage was not independently significant after adjusting for individual-level covariates (Shapiro 2012).

At the contextual level, living in a state with a greater privately insured portion of the 50-64 year old population was positively associated with CRC screening use, although did not independently predict use in multivariate analyses (Cokkinides 2011). In the same study, states with a mandate requiring comprehensive private insurance coverage for CRC screening procedures that had been in effect

for one or more years predicted endoscopy in the previous year in comparison to states without a mandate or a mandate for less than one year. Provider density was found to influence CRC screening use (Soneji 2012): increasing gastroenterologist density positively predicted greater CRC screening use, while increasing PCP density negatively predicted CRC screening use, although the authors commented that positive effects for PCP density might have been masked by other factors including collinearity with gastroenterologist density. In a sample of 272,077 Medicare beneficiaries in 11 states covered by the Surveillance, Epidemiology, and End Results (SEER) Medicare cancer registry who survived from 2000-2005, effects of each gastroenterologist, oncologist, and nurse density on endoscopy use were mixed across states (Mobley 2010). Effects were also mixed for density of endoscopy facilities. More difficult transportation conditions generally had a negative influence on the probability of receiving endoscopy in some states including having moved to a different zip code, experiencing greater commuter intensity, and, to a lesser extent, a respondent's distance to an endoscopy provider (Mobley 2010).

Health Care Utilization

Health care utilization is an indication of opportunities to receive a CRC screening recommendation and of a patient's willingness to encounter the health care system. A greater number of recent doctor visits strongly predicted CRC screening use in two studies (O'Malley 2005; Homayoon 2013). Having a check-up or preventive visit in the last year vs. further in the past also positively predicted CRC screening use (Lian 2008; Ioannou 2003; Klabunde 2006; Wong and Coups 2011).

Social Ties

Indicators of greater social ties usually predict CRC screening use include being married or partnered in comparison to not being married (Cokkinides 2011; Shih

2008; Gorin and Heck 2005; Shavers 2010; Soneji 2012; Hudson 2012; Homayoon 2013; Klabunde 2006; Wong and Coups 2011); and having an available next of kin, which predicted 4-5 times greater odds of underserved individuals following through with a scheduled free colonoscopy appointment (Anderson 2011). The authors noted that since colonoscopy has become the overwhelming screening technique of choice, the large majority of patients have a logistical need for another person to drive them home from the encounter because of the sedation.

Summary of Colorectal Cancer Screening Predictors

A large variety of factors predicts CRC screening use encompassing predisposing, enabling and need factors from the Behavioral Model of Health Services Use. Overall, CRC screening has increased substantially in the last 15 years from less than half of the US population up-to-date with recommended CRC screening then to nearly two-thirds up-to-date now. Those gains are due to increasing colonoscopy use, and despite declining FSIG and FOBT use, that can be attributed to Medicare colonoscopy reimbursement expansions in 1998 and 2001 that lowered financial barriers for colonoscopy and to a shift in provider opinions favoring colonoscopy.

Amid substantial overall gains in CRC screening use, gains have occurred broadly with some inequities closing pertaining to predisposing factors, particularly racial inequities, such that screening rates among whites, blacks, and Asians are now similar, although inequities persist for AIANs and Hispanics. CRC screening use varies according to other demographic factors generally increasing with age, varying substantially across states, and generally being lower in rural areas, although men and women are similarly likely to be screened. For minority groups with large immigrant populations, other predisposing factors salient to CRC screening use include acculturation, such as lower CRC screening use found among persons born outside the US and among persons

less comfortable speaking or using English. Some studies have found that positive health beliefs and attitudes predict CRC screening use, and that health beliefs are relevant to disparities including racial and ethnic minorities and for barriers to screening for women. Additional predisposing factors that influence CRC screening use include having a history of receiving other preventive services, such as other cancer screenings and immunizations, and having better patient-provider communication including whether minorities perceive medical discrimination. Evidence is mixed that worse health status predicts CRC screening use.

Need-based factors for CRC screening are indicators of increased CRC risk, i.e. a person is at higher CRC risk that CRC screening potentially would detect. Some need-based factors pertain to medical history including hereditary or health status-related risks. Family history of CRC or having CRC-related symptoms have each strongly predicted likelihood of CRC screening. Other need-based factors relate to lifestyle risk factors for CRC. Tobacco use generally predicts CRC screening underuse, although multiple studies have found that former smokers are more likely to have received screening than never smokers are. Evidence is mixed for associations between CRC screening and obesity, physical activity, alcohol consumption and having a healthy diet.

Important enabling factors for CRC screening include SES, health care access, health care utilization, and social ties. Higher SES generally predicts higher CRC screening use, often approximated by single-measure proxies such as household income or education, although less community-level poverty generally also predicts CRC screening. An exception to higher SES predicting CRC screening use is the greater likelihood of having received CRC screening among the unemployed and retired in comparison to the employed, plausibly because of having more free time to seek CRC screening. Many facets of greater health care access predict CRC screening use especially having health insurance,

having a usual source of care, having a usual PCP, and having a longer history with one's current PCP. Effects were mixed for the impact of greater provider density in a community including of gastroenterologists, oncologists, and nurses, as well as for the density of endoscopy facilities. Living somewhere with more difficult transportation conditions was negatively predictive. A persons' recent health care utilization history suggests the amount of opportunity they have had to receive a CRC screening recommendation and willingness/lack of barriers to encounter the health care system. Having a greater number of recent doctor visits or having had a more recent checkup strongly predicts CRC screening. Last, more close social ties generally increases CRC screening use with benefits to screening use for being married or partnered vs. otherwise and having an available next of kin to chaperone the patient from a colonoscopy appointment.

Theoretical Framework

The theoretical framework for this study adapts the framework of Tye et al.'s evaluation of health plan characteristics as predictors of breast cancer screening mammography (Tye 2004; Tye 2002). Tye et al. began with the commonly used Behavioral Model of Health Services Use developed by Andersen, Aday and colleagues (Andersen 1968; Andersen 1995; Andersen and Davidson 2007; Andersen 2008; Aday, Andersen, and Fleming 1980). In the Behavioral Model, an individual's use of health services is influenced by individual and contextual characteristics that act as either predisposing, enabling or need factors. Predisposing factors are innate qualities that influence propensity to obtain a service; enabling factors influence capability to obtain a service; and need factors indicate perceived need (by the individual) or technical need (based on expert judgment of the clinician or from evidence-based guidelines) for a service

(Andersen 1995). Health services utilization contributes to health outcomes, and the experience from receiving health services and their outcomes provides feedback that recursively influences a person's individual and contextual characteristics and ultimately future health services use.

Tye et al. conducted a literature review to determine organizational and financial characteristics of health plans that fit in Anderson's behavioral model as individual, enabling factors. Although insurance features could be considered contextual, health plan characteristics were placed at the individual level because the dataset for their analyses, MEPS, identifies individuals as having certain health plan characteristics. Several health plan characteristics were classified as having either an organizational or a financial effect. Tye et al. chose not to use general health plan categories and/or dichotomous comparisons, such as managed care vs. indemnity or managed care typologies (e.g. fee-for-service (FFS), PPOs, HMOs, and point of service (POS)). The broad nature of plan typologies complicates assessing their effects: the meaning of effects is obscured by plans within a category varying in their essential features and plans in different categories sharing features. In addition, although meaningful differences in service use may be distinguishable by plan type, the specific feature responsible may be unclear. Instead of using general categories, Tye et al. decided to assess a set of health plan characteristics as others had done previously (Conrad 1998; Gold and Hurley 1997; Weiner and de Lissovoy 1993). Tye et al.'s set of health plan characteristics consisted of eight features: whether a plan has a defined network of providers; whether coverage for care is restricted to a network; whether enrollees are required to have a primary care gatekeeper; the copayment for a physician visit; the deductible amount; the coinsurance rate; breadth of benefit coverage (medical, dental, vision, and prescription drugs); and whether a respondent's health plan used cost containment strategies (e.g. utilization management; derived from the 1996 MEPS Health Insurance Plan Abstraction (HIPA) file).

Tye et al. proposed hypotheses for effects of the health plan characteristics on utilization of screening mammography, which was informed by causal pathways derived from two organizational and economic theories. Information-Processing Theory (Galbraith 1973) was drawn on to propose that organizational characteristics affect a health plan's capacity to coordinate and process information flows. The theory proposes that increasing information processing capacity enables a health plan to increase awareness of cancer screening guidelines among providers and patients, which will increase demand for screening. Financial characteristics were proposed to influence screening by affecting the out-of-pocket price of mammography, which relates inversely to demand for screening according to the law of demand from economics and empirical evidence (Broyles and Rosko 1988), and has been demonstrated empirically, most notably, by the RAND Health Insurance Experiment (Manning 1987). Using the 1996 MEPS and the adapted Behavioral Model framework, Tye et al. devised multivariate logistic regression models with a control variable set of predisposing and enabling factors. Repeated Regressions were conducted to evaluate each health plan characteristic separately because multicollinearity between characteristics and missing data for plan characteristics prohibited testing all characteristics in one model.

This study followed Tye et al.'s theoretical framework and study design to evaluate insurance features as predictors of CRC screening. Insurance features were parameterized as discrete organizational and financial features that act as individual enabling factors, in contrast to categorizations of health plan labels, typologies, or dichotomous comparisons. The insurance features and covariates included in multivariate logistic regression analyses were decided based on evidence from the literature reviews of insurance and non-insurance CRC screening predictors and by available data in MEPS. Hypotheses for specific insurance features are proposed in the methods following Tye et al.'s causal

pathways. The Aim 2 analysis for Western Hispanic and non-Hispanic whites was derived from the Aim 1 analyses.

Health Insurance Effects Review

Overview of Health Insurance in the US

Americans obtain health insurance from private and/or public sources, although a large portion of the population remains uninsured; an estimated 47.3 million, 18%, of the nonelderly population (<65 years) were uninsured in 2012 (Kaiser Commission on Medicaid and the Uninsured 2013). Nearly all the elderly (65+ years) population receives Medicare as a guaranteed entitlement, although nearly 640,000 elderly (<2%) remained uninsured in 2012 (Kaiser Commission on Medicaid and the Uninsured 2013). Including all elderly and nonelderly recipients, Medicare insured over 50 million Americans in 2012, 8 million (17%) of whom were nonelderly persons with permanent disabilities (The Henry J. Kaiser Family Foundation 2012). In the nonelderly population (aged <65), 266.9 million in 2012 (of the total 312 million 2012 population), the majority, 55.7% had employer-sponsored insurance personally or from a spouse or parent; the second largest portion of the nonelderly, 20.8%, had Medicaid or other public insurance including the Children's Health Insurance Plan (CHIP), Medicare, and military-related coverage; and a small minority, 5.8% had private, non-group insurance. Considering the extent that being insured actually makes health care affordable, 31.7 million insured nonelderly persons qualified as underinsured in 2012 (defined as a "household that spent 10% or more of income on medical care (excluding premiums) or 5% or more if income under 200% poverty") and were at risk for not being able to afford needed health care. In total, at least 79

million Americans were at risk for not being able to afford needed care in 2012 due to being uninsured or underinsured (Schoen 2014).

Population insurance coverage is undergoing a seismic shift due to the full rollout of the Patient Protection and Affordable Care Act's (ACA) major provisions in 2014 with uncertain long-term outcomes. During the period from October 1 2013 to May 1 2014, an estimated 20 million Americans gained coverage or have enrolled in a new insurance offering (Blumenthal and Collins 2014) including an estimated 8.0 million who obtained insurance through the ACA's state-based individual marketplaces, 6.0 million who enrolled in Medicaid or CHIP, 5.0 million who obtained insurance directly from an insurer, and 1.0 million young adults aged 19-26 who gained coverage from their parent's policy. In the most rigorous calculation to date, researchers have estimated that 57% of enrollees on the individual marketplaces were previously uninsured, although other survey estimates ranged from 24-87% (Kliff 2014), so the precise portion of enrollees who were previously uninsured is unknown. New coverage due to ACA provisions though undoubtedly represents a substantial reduction of the uninsured of at least several millions and possibly more than ten million, which is likely to increase in coming years (Blumenthal and Collins 2014). As noted, the ways by which the ACA increases the number of insured persons is by easing enrollment in extant insurance options, rather than introducing fundamentally new models or entirely replacing existing options. Within and across those options, insurance features vary, which constrains the interactions and responsibilities of and between individual enrollees, providers and payers and ultimately influences enrollees health services utilization including for preventive services such as CRC screening. In the three largest sources of health insurance coverage, employer-sponsored insurance, Medicare and Medicaid, patterns and trends of enrollment in different types of insurance provide an

indication of the evolving nature of the insurance constraints influencing enrollees' utilization including for CRC screening.

Employer-sponsored insurance

In 2013, nearly half of the US population, 149 million nonelderly people, obtained coverage from employer-sponsored insurance offerings (The Kaiser Family Foundation and Health Research & Educational Trust 2013). Enrollment by types of plans has substantially evolved since the intense public focus and state-level regulatory backlash against managed care in the 1990s (Kronebusch 2009). In 2000, the proportion of covered workers with conventional FFS coverage was 8% after a steep decline in the previous decade from 73% in 1988, to 46% in 1993, and 27% in 1996 (The Kaiser Family Foundation and Health Research & Educational Trust 2013). By 2009, the proportion of persons with employer-sponsored FFS plans dropped below 1%. The proportion of workers in HMO plans was 14% in 2013 a decline by half from 29% in 2000 (down from a high of 31% in 1996), and Point-of-Service (POS) plans (a hybrid HMO-FFS plan with a network of providers with lower cost-sharing like an HMO provider and the option to see non-network providers with higher cost-sharing (Office of Personnel Management)) have also considerably diminished from a peak of 24% in 1999 to 9% in 2013. Enrollment has increased for two plan types: PPOs are the majority plan type of covered workers in 2013 (57%) up from 42% in 2000, although the peak PPO share was 61% in 2005; and high-deductible health plans with a savings option (HDHP/SO) have a 20% share that has risen from a 4% share when they were first included in the report for the year 2006 (in the Kaiser Family Foundation report, the HDHP/SO category refers to the federal legal designation of such plans, although all HDHP/SOs have an underlying PPO, HMO, POS, or conventional FFS plan). The trends suggest that employers wanting to offer the most comprehensive and unrestrictive coverage or employees desiring such coverage opt for PPOs that have an option of network providers at somewhat

lower cost, but are less restrictive about access to non-network providers than other plan types with a greater emphasis on steering enrollees to network providers. The remaining, more cost-conscious consumers/employers are nearly split between the less risk-averse who opt for HDHP/SO plans and those who accept more restrictive HMO or POS plan types with more generous in-network coverage.

Medicare Managed Care

In 2013, 14.4 million Medicare beneficiaries, 28% of the total 51.4 million, were enrolled in Medicare Advantage (MA) plans offered by a private company that contracts with Medicare to provide all Medicare Part A and B benefits (Gold 2013). Current enrollment is an increase from the enrollment low of 5.3 million MA plan enrollees and 13% of all Medicare beneficiaries in 2003 and 2004. MA plan enrollment does include private FFS plans, but they had declined to 3% of enrollees in 2013 from a high of 21% in 2009, so nearly all MA plan enrollees are in managed care plans. Enrollment grew by 1 million from 2012 to 2013, a 9.7% increase and by 30% since 2010. The majority, 65%, of MA plan enrollees in 2013 had an HMO plan, a share of enrollees that has been steady recently as HMO enrollment increased similarly to total MA plan enrollment. The next largest share of MA plan enrollees, 29%, had local or regional PPOs in 2013, an increase from a 6% share in 2007.

Managed Care Medicaid

In 2011, 42.4 million Medicaid recipients, 74.2% of the total 57.1 million covered by Medicaid, were enrolled in a managed care program, an increase from 57.6% in 2002 (Swisher 2011). Of the 61.5 million Medicaid managed care policies (19.1 million had more than one plan type), 28.2 million individuals had a comprehensive coverage plan from either a commercial or Medicaid-only Managed Care Organization (MCO); 8.9 million had a primary care case

management plan; and 22.0 million were covered by a prepaid inpatient or ambulatory care health plan for specific services (e.g. dental or long-term care) that is a narrower breadth of services than what is considered comprehensive coverage.

Current Composition and Trends in Health Plan Enrollment Summary

Collectively these figures suggest approximately two-thirds of Americans, around 200 million people, possess health plans that belong to the general umbrella of managed care (commercial, Medicare or Medicaid plans labeled HMO, POS, PPO, or HDHP/SO). Plans vary in the extent of how managed they are. The large share of the employer-sponsored insurance population with PPO plans, ~85 million people, receive and are reimbursed for health services in much the same way as traditional FFS plans except for having preferred provider networks. As discussed before, labels belie a health plan's underlying makeup, but the enormous number of Americans identified as belonging to some kind of MCO indicates that the constituent insurance features that make up health plans influence all Americans' health services use, directly as plan holders or indirectly through spillover effects on the greater health care system.

Summary Measures of Health Plan Performance

A few sources offer summary assessments of performance by types of health plans. HEDIS reports annual health plan performance covering 136 million Americans enrolled in HMOs and PPOs in the commercial nonelderly and MA markets (National Committee for Quality Assurance 2013). HEDIS is used to inform health plans' internal efforts to improve quality, to inform NCQA's accreditation of health plans, and to rank quality across health plans. Although summary metrics have been devised to summarize performance across HEDIS measures (Reid 2010), deriving such metrics is difficult because either all individual HEDIS measures have to be assumed equally important or justification

needs to be provided for weighting measures unequally and/or considering only subgroups of measures. In addition, the composition of HEDIS measures evolves because NCQA's review process adds to, drops and modifies measures annually, which makes assessing HEDIS trends difficult, as well; although NCQA reports that most measures improve over time (National Committee for Quality Assurance 2013).

Literature sources that review summary domains of performance (i.e. not individual process and outcomes measures as HEDIS assesses) for health plans by type are dated. Miller and Luft published three literature reviews of managed care performance covering 1980-2001 (Miller and Luft 1997; Miller and Luft 1994; Miller and Luft 2002). The last review of HMO plan performance from 1997-2001 (Miller and Luft 2002) found that quality of care was similar between HMOs and non-HMOs; some evidence suggested that HMOs had lower use of expensive services including hospitals; and that HMO enrollees generally experienced poorer access to care and had lower satisfaction levels. In their 1997 review of managed care plan performance (Miller and Luft 1997), Miller and Luft found that managed care plans generally had reduced use of more expensive services, increased outpatient services, and had inconsistent effects on hospital care, access and quality. Miller and Luft warned that the literature had largely varying technical rigor and generalizability and often was older with limited relevance to the current makeup of managed care. No similarly comprehensive assessment of managed care plan performance (or a more comprehensive review distinguishing health plan types and features) was found since Miller and Luft's 2002 review.

Managed Care and Preventive Services Use

Miller and Luft (Miller and Luft 2002) detailed general effects of HMO membership on preventive services use. HMOs in comparison to non-HMOs had predominantly favorable preventive service use with no unfavorable findings. For

preventive services that HMOs probably had less cost-sharing for than non-HMOs (cancer screenings and flu shots), 12 of 31 study findings were predominantly favorable to HMOs with no predominantly unfavorable findings. For preventive services where HMOs likely provided equivalent financial coverage as non-HMOs (blood pressure checks, clinical breast exams, digital rectal exams and smoking advice), two of nine results were predominantly favorable for HMOs with no predominantly unfavorable results.

Managed Care and Overuse of Health Care Services

Studies comparing FFS and managed care populations were included in a recent systematic review of overuse of health care services in different health care systems/coverage models with inconclusive findings (Keyhani 2010). Managed care and FFS covered populations were compared in four studies and found similar rates of inappropriate use of cardiology procedures, and mixed findings regarding inappropriate antibiotics use and inappropriate diagnostic testing for respiratory conditions. Only one of the studies included in the review was published since 2000, and the authors concluded that the evidence on overuse in different systems of care is limited and does not suggest any particular system that best reduces overuse.

Summary of Overall Health Plan Performance

Evidence is limited for summarizing health plan performance. HEDIS measures are reported annually for health plans that provide coverage to 44% of Americans, although NCQA does not report summary metrics of overall performance (National Committee for Quality Assurance 2013). In the most recent review of managed care plan performance (Miller and Luft 2002), quality of care was similar for HMOs and non-HMOs, although the authors cautioned that the methodological quality of the literature varied, and it is now very dated. Similar caveats were stated in a more recent systematic review of the overuse of

health care services in different systems that found similar overuse of services between managed care and FFS covered population (Keyhani 2010).

Health Plan Colorectal Cancer Screening Performance

In the 2012 HEDIS, the CRC screening measure estimated that 63.3 and 55.8% of eligible persons in commercial HMOs and PPOs, respectively, and 62.1 and 58.4% of eligible persons in Medicare HMOs and PPOs, respectively, were up-to-date with recommended CRC screening defined as colonoscopy in the previous ten years, FSIG in the previous five years, or FOBT within the last year (National Committee for Quality Assurance 2013). Over time, there has been a general trend of better performance on the CRC screening measure for all plan types since the early 2000s. Two studies have assessed the effects of Medicare plan types on CRC screening use.

Medicare Plan Types

Using data from 10,173 Medicare beneficiaries in the 2000 Medicare Current Beneficiary Survey (MCBS) (Schneider 2008b), differences in CRC screening use across Medicare plan types were compared (FFS with supplemental insurance; FFS with no supplemental; and Medicare managed care (MMC) for each having received 1) endoscopy in the past five years, 2) FOBT in the past two years, or 3) overall being up-to-date with screening by either technique. Schneider et al. had hypothesized that MMC plans favored a cost-effective screening strategy emphasizing FOBT and limiting more expensive endoscopy use while FFS Medicare with supplemental insurance would increase endoscopy use by reducing coinsurance. In propensity score adjusted analyses, MMC predicted greater FOBT use and overall screening than FFS without

supplemental coverage, although endoscopy use alone was similar, consistent with first hypothesis. FFS with supplemental insurance in comparison to MMC predicted increased odds of endoscopy and overall CRC screening, although FOBT use was similar between the two plan types, consistent with the second hypothesis. Schneider et al. reasoned that the findings accorded with policy changes around that time following CMS initiating coverage of FOBT, FSIG, and DCBE for average-risk beneficiaries in 1998, but before expanding coverage to include colonoscopy in 2001 (Gross 2006). In another study using the 2000 MCBS, but examining beneficiaries who had a usual physician (O'Malley 2005), HMO beneficiaries had higher odds of overall CRC screening (defined as endoscopy in the past five years or FOBT in the previous year) than FFS beneficiaries.

Managed Care Medicare Penetration Spillover Effects

In the 11 state analysis of FFS Medicare beneficiaries included in the SEER cancer registries from 2000-2005 (Mobley 2010), MMC penetration spillover was measured as the proportion of Medicare beneficiaries enrolled in MMC organizations in a Primary Care Service Area (PCSA) (a set of validated geographic units more numerous than counties developed by Dartmouth researchers designating natural PCP markets derived from Medicare patients flows to PCPs (Goodman 2003)). Significant coefficients for this variable were reported at the $\alpha = 0.10$ level because of its policy importance. For each percentage point increasing in MMC penetration, the probability of endoscopy use decreased in eight states by 0.05-0.6%, while Iowa was the only state to experience positive effects, 0.25% increase in probability of endoscopy use for each percentage point increase in MMC penetration. The authors commented that these effects are consistent with Schneider et al.'s findings that MMC favors FOBT over endoscopy in comparison to FFS Medicare, and the finding may be explained by spillover of managed care practices and/or if increased managed

care penetration limited the supply of endoscopic services by discouraging entry of providers.

Summary of Health Plan Colorectal Cancer Screening Performance

HEDIS performance for CRC screening is the percentage of the covered eligible population up-to-date with recommended CRC screening and had a range of 55.8 to 63.3% for commercial and Medicare HMOs and PPOs in 2012 (National Committee for Quality Assurance 2013). In HEDIS 2012, HMOs outperformed PPOs in both the commercial and Medicare markets, and commercial HMOs achieved higher screening rates than Medicare HMOs, while Medicare PPOs achieved higher rates than commercial PPOs. Studies have assessed CRC screening use by screening strategy, and findings suggest that MMC plans favored FOBT over endoscopy before Medicare expanded colonoscopy reimbursement to all average risk persons. Using 2000 Medicare data, hypothesized effects of Medicare plan types on the use of endoscopy vs. FOBT were substantiated (Schneider 2008b): MMC predicted greater low-cost FOBT use while Medicare FFS with a supplemental predicted greater endoscopy use. In another study of Medicare FFS beneficiaries from 2000-2005 (Mobley 2010), increasing MMC penetration, a greater proportion of MMC enrollment in a market area, was found to generally predict lower endoscopy use in Medicare FFS, plausibly due to hypothesized managed care spillover effects. No more recent studies were found addressing variations in use of different CRC screening strategies for nonelderly/non-Medicare commercial health plan types.

Health Insurance Attributes Literature Review

A formal literature search in PubMed covering the previous ten years was conducted on 06/08/2013 to obtain evidence regarding insurance features that might predict CRC screening use. General insurance terms and terms for types of health insurance were paired with specific phrases that would suggest health

insurance attributes or would suggest a study used the Behavioral Model of Health Services Use (Andersen 1995): ("Insurance, Health"[Mesh] OR "fee-for-service" OR "health maintenance organization" OR "preferred provider organization" OR "point of service" OR "independent practice association" OR "health insurance" OR "health plan" OR "managed care") AND (typolog* OR "system factors" OR "system characteristics" OR Andersen[tiab] OR "behavioral model" OR "predisposing characteristics" OR "enabling characteristics"). The search was designed to generate a breadth of evidence, although the challenge of searching this topic without any standardized terminology prohibited conducting a more sensitive search due to the reduced specificity that would have been necessary. The findings are supplemented with relevant literature found elsewhere. The literature search generated 107 results from 2003 to 2013; 14 studies were obtained and reviewed; and six were determined to have studied insurance features effects on health services use. Four additional articles were identified from reference lists and the literature search of CRC screening predictors. The findings pertain to provider factors, cost-sharing, and composite measures of managed care.

Summary of insurance feature Literature search

The insurance feature literature search findings identified many potential influences of insurance features relating to provider arrangements, cost-sharing, and composite measures of managed care (Table 2.1).

Table 2.1 Features Identified by Insurance Features Literature Review		
Perspective	**General Factors**	**Specific Factors**
Enrollee	Cost-sharing	Favored services/tiered cost-sharing
		Deductible Amount First-dollar coverage for preventive services
	Consumer Access*	Standing referrals for chronically ill
		Exemptions from prior authorization
		Ombudsperson program
	Consumer Protection*	Right to sue health plan
		Time limit for approval decisions/internal appeals
		External review procedures required
Provider	Contractual Relationships*	Prompt payment to providers
		Whether there are “Hold harmless” provisions
	Professional Autonomy*	Providers can learn review criteria
		Reviewer is professional peer
		Internal appeals are reviewed by professional peer
		Limit financial incentives for utilization review employees
		Prohibit discharge of physicians for nonmedical reasons
		Prohibit “gag clauses”

		Whistle-blower protections
		Require that medical director be licensed in state
	Nature of risk or rewards to providers	Withholds for ER use
		Bonuses for (relevant) preventive service use
Medical Group	Organization	% of (relevant) MD type in PCP or specialty network
		Use of nurse/mid-level provider coordinators
	Basic compensation to medical group	% of providers paid by FFS
		% of providers paid by salary
*All from Kronebusch et al. 2009		

Four studies reported findings pertaining to provider arrangements. First, physician gatekeeping was associated with delays in melanoma biopsy, but no change in health outcomes (Swetter 2007). Second, individuals cared for in their last year of life by physicians compensated on a FFS basis rather than capitation had more prescription drug fills, prescription drug claims and out-of-pocket expenditures (Fahlman 2006). Third, a Medicare beneficiary having specialists available when s/he thought they were needed significantly positively predicted recent CRC screening (O'Malley 2005). Last, percentage of practice revenue from managed care did not influence utilization of six common preventive services by the practice's Medicare patients including lower endoscopy (Pham 2005).

Three studies reported findings on cost-sharing effects. First, for every 1% point increase in the proportion of family income spent on all health care out-of-pocket

payments, child asthma exacerbations increased 14% (Ungar 2011). Second, first dollar (zero deductible) coverage of preventive services contributed to increased use of four common preventive services assessed, which included FOBT, in comparison to a control health plan without first dollar coverage, and preventive services use gains were greater for a low deductible group within the first dollar coverage cohort than a high deductible group (Meeker 2011). The authors proposed that individuals who select high-deductible plans are predisposed to use fewer health services for fundamental unobserved reasons. Third, having a higher copayment for brand name prescriptions (>$5 in 1998) reduced prescription drug switching from initial using lansoprazole, the proton pump inhibitor (PPI) that did not have direct-to-consumer advertising, to subsequently using of omeprazole, the PPI with direct-to-consumer advertising (Hansen 2005), while having a deductible for outpatient services predicted higher switching.

Three studies reported findings on composite measures of managed care. First, practicing in a state with high managed care state-level regulations vs. no regulations generally predicted higher physician-level satisfaction on measures of clinical practice for physicians with a high portion of practice with managed care enrollees, but markets with greater managed care activity (measured by the market HMO penetration rate) in states with high state-level managed care regulations did not experience satisfaction effects at the market-level (Kronebusch 2009). Second, in a study assessing the health services utilization of children with special health care needs (CSHCN), principle component and factor analyses were used to derive three MCO indices of composite MCO qualities, and their effects were assessed: 1) the Pediatrician-Focused Index predicted lower outpatient and inpatient use; 2) the Specialist-Focused Index predicted increased ER visits; and 3) the FFS MCO Index predicted greater outpatient use and charges. Third, examining the same sample of CSHCN as in the previous study, an increased likelihood of CSHCN receiving an outpatient

specialty care visit was predicted by a higher percentage of pediatricians in a MCO's PCP network, a lower percentage of network PCPs paid on a FFS basis versus capitation, and giving bonuses to PCPs for high quality care were associated with increased odds of receiving an outpatient specialty care visit, while visits were not predicted by prior authorization exemptions for CSHCN or percentage of MCO PCPs who were salaried (Shenkman 2005).

Summary of Health Insurance Effects

Overall, the review of health insurance effects on health services utilization did not provide substantial evidence that pertains to insurance feature effects on CRC screening. The present enrollment composition of health plans indicates that managed care network restrictions and cost controls are ubiquitous today, although the continued popularity of PPOs with less restrictive network rules and the rising share of persons covered by HDHP/SO plans indicates that access to providers and affordability are clearly key concerns for consumers (The Kaiser Family Foundation and Health Research & Educational Trust 2013). Long-term trends for annual HEDIS measures show that health plan performance on some process and outcome measures of quality has been improving across plan types (National Committee for Quality Assurance 2013). For CRC screening performance specifically, the HEDIS CRC screening measure indicates that HMOs achieve higher CRC screening rates than PPOs, and study findings suggest that consistent with expected organizational incentives, MMC plans have historically favored lower cost FOBT compared to endoscopy procedures (Schneider 2008b).

A systematic literature search discovered only three findings that pertained to CRC screening utilization specifically; first-dollar coverage of preventive services increased FOBT use in a commercial health plan compared to a control plan without first-dollar coverage (Meeker 2011); believing that specialists were available when desired predicted increased CRC screening use (O'Malley 2005);

and percentage of practice revenue from managed care did not affect use of six preventive services including lower endoscopy (Pham 2005). Many of the variables in these studies may be unlikely to affect CRC screening use because the questions they were originally used to assess are not relevant to whether an individual receives CRC screening (e.g. coinsurance effects on medication utilization and MCO characteristics' effects on CSHCN receiving needed services). Even if variables are specified in a way that is applicable to CRC screening, including them in analyses depends on their availability in MEPS, which may be limited. In addition, even though the insurance feature literature search was constrained to the previous ten years, the findings mostly pertain to data from the late 1990s and early 2000s and therefore do not indicate more recent evolving or emerging influences of insurance features.

Full Literature Review Summary

CRC causes substantial morbidity and mortality. CRC incidence and mortality increases with age, is greater for men than women, and is particularly high for African Americans compared to other racial and ethnic groups. Other racial and ethnic minorities (Asians, Hispanics, and AIANs) generally have CRC incidence and mortality rates lower than the population average, as well as rates among whites and non-Hispanics (Surveillance, Epidemiology, and End Results Program 2013). CRC risk increases due to medical history factors including family history of CRC and personal history of some gastrointestinal conditions and due to lifestyle risk factors including obesity and cigarette smoking. Overall five-year survival is 64.9%, although prognosis varies from >90% survival for earliest stage cancers to <10% survival for late stage cancers, which provides the rationale for routine CRC screening by detecting cancers earlier and removing pre-cancerous polyps.

Rates of CRC screening use have increased substantially since the 1980s, driven by increased colonoscopy use after Medicare's reimbursement expansions (Gross 2006) and by a shift in provider opinion (Klabunde 2009). A large number of diverse factors predict CRC screening use, which were reviewed and organized according to the Behavioral Model of Health Services Use framework as predisposing, enabling, and need-based factors (Andersen 1995). Predisposing factors include the categories of demographics, acculturation, health beliefs, preventive services utilization history, patient-provider communication, and health status; need-based factors include the categories of medical history related to CRC risk and risk-modifying lifestyle factors; and enabling factors include SES, health care access, health services utilization history, and social ties. The large number of factors influencing CRC screening implies many potential origins and mechanisms contributing to disparities and many potential avenues for promoting CRC screening to under screened groups.

To evaluate the influence of insurance features on CRC screening use, this study adopted Tye et al.'s framework based on the Behavioral Model of Health Services Use specifying insurance features as individual enabling factors. By assessing insurance features instead of types of health insurance, the study attempted to isolate effects of specific insurance features. Testable hypotheses of insurance feature effects are guided by organizational theory that insurance features affect CRC screening use among enrollees by influencing a health insurer's information-processing capacity that affects how effectively an insurer communicates appropriate CRC screening to providers and enrollees (Galbraith 1973), and by economic theory, which posits that insurance features can influence the inverse relationship between out-of-pocket costs and demand for CRC screening (Manning 1987).

An informal review of general effects of health plan types and a systematic review of insurance feature effects were conducted to inform the selection of

insurance features for analysis. The informal review of general effects of health plans by type provided a small amount of mostly dated evidence. Health plan performance for a couple big categorizations (HMOs vs. PPOs and Commercial vs. Medicare markets) is reported annually by NCQA in the HEDIS measures, which have generally improved over time including CRC screening, although NCQA does not aggregate HEDIS performance into assessments of general performance domains for different type of health plans or by insurance features (National Committee for Quality Assurance 2013). Reviews of studies of health plan performance by type concords with expected effects: MCOs tend to have lower use of expensive services and have lower performance on patient access and satisfaction than FFS plans (Miller and Luft 2002). General effects of health plans on CRC screening performance include improving HEDIS performance over time and the consistently higher rates of CRC screening for HMOs compared to PPOs (National Committee for Quality Assurance 2013). Additionally, literature evidence suggests that MMC plans in comparison to Medicare FFS plans prefer low-cost FOBT CRC screening to endoscopic CRC screening (Schneider 2008b). The systematic literature search of insurance feature effects yielded a small number of studies. Many insurance features were suggested in the studies pertaining to provider arrangements, cost-sharing and composite measures of managed care, although it is unlikely that the influences of insurance features assessed in the reviewed studies would be helpful for determining insurance feature effects on CRC screening.

Chapter 3

Methods

This section details the study design, data sources, eligibility criteria, study variables, data management and statistical analyses for each specific aim.

Study Design

The study is a cross-sectional analysis of secondary survey data assessing the association between insurance features and likelihood of being up-to-date with recommended CRC screening. The dependent variable, insurance features, and control variables were derived from literature review findings and available measures in the data. The study sample was all respondents in the survey data who were eligible for CRC screening. Effects of insurance features on CRC screening likelihood were estimated in multivariate logistic regression models with several alternate specifications of covariates decided after preliminary diagnostic analyses. Each insurance feature was evaluated separately because of collinearity between features. Analyses were guided by the Behavioral Model of Health Services Use, and hypotheses for the effects of insurance features were informed by economic and organizational theory.

Data Sources

The data source for this analysis was the MEPS Household Component (MEPS-HC), the primary component of the family of MEPS health and health services utilization surveys, produced by AHRQ, which has a unique breadth of information on insurance coverage details, CRC screening use, and demographic and socioeconomic predictors of CRC screening (Agency for Healthcare Research and Quality 2010). The MEPS-HC is a nationally representative sample of the civilian non-institutionalized population and collects

information pertaining to household and individual-level demographics and SES; health status, medical conditions and health behaviors; health care encounters, payments and sources of payment; and health insurance characteristics. MEPS-HC data was pooled from the years 2011, 2010 and 2009.

The MEPS-HC uses an overlapping panel design whereby a new respondent panel is formed each year and surveyed five times over two years by computer-assisted personal interviewing (CAPI) (Agency for Healthcare Research and Quality 2013c). Each new panel is sampled from the previous year's NHIS, which is produced by the National Center for Health Statistics (NCHS). The primary MEPS-HC data file is the full-year consolidated file. The 2011, 2010, and 2009 MEPS-HC sampled 33,622 persons (13,449 families) from panels 15 and 16; 31,228 persons (12,445 families) from panels 14 and 15; and 34,920 persons (13,875 families) individuals from panels 13 and 14, respectively. The combined response rates for each of the 2009, 2010 and 2011 full year files were 57.2%, 53.5% and 54.9%, respectively. Individuals who appeared twice in the pooled 2009-2011 dataset (panels 14 and 15) were included in the analyses twice, which was recommended by MEPS for this study's multiyear cross-sectional analyses by using appropriate survey analyses (rather than only including them in only one of their two appearances) (Zibman 2014). In addition to the full-year consolidated file, the Medical Conditions File, one of the other MEPS-HC data files, was used to derive a comorbidity index (Agency for Healthcare Research and Quality 2013a). The study exclusively used de-identified data, so institutional review board approval was not needed.

Eligibility Criteria

MEPS respondents were included in the study if they were aged 50-75, did not have a prior CRC diagnosis, were insured for any amount of time during the year, and had been "in scope" for the entire survey year (had responded during all scheduled interview rounds in the survey year) (2009, 2010 or 2011).

Study Variables

Dependent Variable

The outcome measure for CRC screening status was a binary variable for whether a person had received CRC screening by any technique within the USPSTF recommended time intervals (US Preventive Services Task Force 2008). According to the Grade A recommendation for average risk persons aged 50-75, acceptable screening techniques and intervals are 1) a colonoscopy every ten years, 2) FSIG every five years with FOBT every three years, or 3) FOBT annually. The MEPS questionnaire asks when a respondent last received each test (within the past one, two, three, five, or ten years, more than ten years, or never), which was used in this study to determine if a respondent was up-to-date with the recommendations. Persons with missing values for all CRC screening techniques were conservatively assumed not up-to-date with CRC screening.

The 2008 USPSTF recommendations were used, although other notable guidelines with minor differences were also released around that time including, in 2008, the "joint effort of the American Cancer Society, US Multisociety Task Force on Colorectal Cancer, and American College of Radiology", (McFarland 2008), and, in 2009, the American College of Gastroenterology (Rex 2009). All of the guidelines agree that routine screening for average risk persons should begin at age 50 (the American College of Gastroenterology uniquely recommends that African Americans should start screening at 45 (Rex 2009)), and have screening strategy recommendations and time intervals that are very similar to the USPSTF. The USPSTF uniquely asserts that FSIG within the past five years should be accompanied by FOBT every three years based on findings from a meta-analysis and modeling simulation of different screening strategies

(Whitlock 2008). The USPSTF concluded that the evidence was insufficient to recommend CT colonography and fecal DNA testing and was sufficient to recommend against DCBE, although the other guidelines have recommendations for each of those techniques. While the other guidelines do not declare a stop age for CRC screening (Rex 2009; McFarland 2008), the USPSTF guidelines recommend stopping routine CRC screening at age 75. The USPSTF recommendations have been used to define being up-to-date with CRC screening in recent benchmark estimates of the percentage of the national population that was screened using national survey data (Klabunde 2013; Shapiro 2012; Joseph 2012). By specifying the dependent variable in this study consistent with the main USPSTF screening recommendation for those aged 50-75, this study focused on the segment of the population that is most universally agreed upon by all guidelines and was consistent with recent benchmark estimates of national CRC screening use.

Control Variables

Different combinations of CRC screening predictor covariates were controlled for in several models. Table 3.1 lists the relevant control variables that were available in MEPS for all three data years. All control variables were derived from respondent self-report either in the full-year consolidated file or the Medical Conditions File for self-reported medical conditions, which were used to compute the updated Charlson comorbidity score (Quan 2011). The available control variables encompassed all three domains of factors that influence health services use according to the Behavioral model, which are predisposing factors: demographics, acculturation, preventive services utilization and health status; need-based factors: lifestyle factors and personal medical history; and enabling factors: education/income, health care access, and social ties. Fixed effect dummy variables for survey year were included in all models.

Table 3.1 Control Variables	
Variable	**Levels**
Predisposing Factors	
Demographics	
Age	Continuous
Sex	Male/Female
Race/Ethnicity	White, non-Hispanic White, Hispanic Black, non-Hispanic Asian, non-Hispanic Other
Census region	Northeast Midwest South West
Metropolitan Statistical Area	Yes/No
Acculturation	
Immigration status	US born Foreign born, lived in US <15 years Foreign born, lived in US >15 years
Whether comfortable speaking English	Yes/No
Survey Language	English Spanish/English and Spanish/Other
Preventive Services Utilization	
Dental check-up frequency	Twice a year or more Once a year Less than once a year Never go to the dentist
Most recent flu vaccine	Within the last year Within past two years More than two years Never

Table 3.1 (cont.)

Health Status	
Self-reported health status	Excellent Very good Good Fair/Poor
Comorbidity (Quan et al.'s updated Charlson's comorbidity index)	0 1 2 3 or more comorbidities
Need-Based Factors	
Lifestyle Factors	
Current smoker	Yes/No
Body mass index	Underweight Normal weight Overweight Obese
Personal Medical History	
Personal cancer diagnosis other than CRC	Yes/No
Enabling Factors	
Education/Income	
Educational attainment	Less than a HSD HSD/GED Bachelor's degree Graduate/Doctorate degree Other degree
Household income (% of the federal poverty level)	<100% 100-200% 200-400% >400%

Table 3.1 (cont.)	
Health Care Access	
Having a usual source of care	Yes/No
Months of insurance coverage in survey year	1-6 months 7-11 months Continuous coverage
Number of office-based physician/nurse practitioner/physician's assistant visits in last year	Zero One Two Three Four or more
Social Ties	
Marital status	Married Widowed Divorced/Separated Never Married
HSD: high school degree; GED: general educational development	

Insurance Features

Insurance features were the primary independent variables of interest, which act as individual enabling factors. Organizational health plan features and whether a respondent's household had a FSA were derived from self-reported health plan characteristics in the Managed Care (MC) questionnaire section. Self-reported responses are obtained using computer-assisted personal interview, which includes questions, instructions, help available with definitions for key terms (e.g. HMO, primary care doctor, and routine care), and skip patterns depending on the topic and a respondent's answers. Cost-sharing percentage was calculated using payment amount and sources of payments data. Insurance features and variable levels are listed in Table 3.2.

Table 3.2 Insurance Features (***Enabling Factors***)		
Variable	**Levels**	**MEPS Criteria for having feature**
Organizational		
Whether respondent's insurance defined a provider network (DPN)	Yes/No	PRVDRL31/42/11 = 1 or PRVHMO31/42/11 = 1 or MCDHMO31/42/11 = 1
Whether respondent's insurance restricted coverage to a DPN	Yes/No	PRDRNP31/42/11 = 2 or PHMONP31/42/11 = 2 or PMNCNP31/42/11 = 2 (No if INSURC11 = 4 or 6)
Whether insurance used gatekeeping	Yes/No	PRVMNC31/42/11 = 1 or MCDMC31/42/11 = 1 or PRVHMO31/42/11 = 1 or MCDHMO31/42/11 = 1
Financial		
Cost-sharing categories	• 0% • Top fifth percentile of cost-sharing distribution • Internal tertiles of cost-sharing distribution (other than 0% and top fifth percentile) • Those with no spending in the survey year	Cost-sharing computation: TOTSLF09/10/11 / TOTEXP09/10/11 Variable categories: • 0% cost-sharing • >0% to 35th percentile • 35th to 65th percentile • 65th to 95th percentile • 95th percentile to 100% • TOTEXP11 = 0
Whether respondent's family had a Flexible Spending Account (FSA)	Yes/No	FSAGT31 = 1

Organizational Features

Having a DPN

Respondents were identified as having insurance with a DPN if the respondent reported being in an HMO from a private source (PRVHMO31/42/11 = 1) or through Medicaid (MCDHMO31/42/11 = 1), or if they reported having "coverage by a private insurance source that has a book or list of doctors" (PRVDRL31/42/11 = 1).

Provider network restrictions

Respondents were defined as having insurance that restricted care to a coverage network if the respondent reported having insurance that does not pay for visits to non-plan doctors without a referral (PRDRNP31/42/11 = 2, or PHMONP31/42/11 = 2 or PMNCNP31/42/11 = 2). The MEPS variables used to construct this variable only apply to those with any private insurance, i.e., those who are privately insured under age 65 and MA beneficiaries. Medicare recipients without any private insurance (i.e. traditional FFS Medicare) were assumed to not have provider network restrictions (INSURC11 = 4 or 6; INSURC11 was introduced in MEPS 2011, so was manually derived to use with MEPS 2009 and 2010). Whether individuals under age 65 with only public insurance had coverage restricted to a DPN could not be ascertained, so those respondents were excluded from analyses of this variable.

Gatekeeper requirement

Respondents were defined as having insurance that used gatekeeping if the respondent reported being in an HMO (PRVHMO31/42/11 = 1

or MCDHMO31/42/11 = 1) or being in a gatekeeper plan from any private insurance (PRVMNC31/42/11 = 1) or Medicaid (MCDMC31/42/11 = 1) meaning

the respondent was required to sign up with a gatekeeper for all routine care (physician, group of doctors or clinic).

Financial Features

Cost-sharing percentage

A respondent's level of cost-sharing in the survey year was estimated by computing the proportion of total expenditures that were paid out-of-pocket by the respondent (TOTSLF09/10/11 / TOTEXP09/10/11), which corresponds to a percentage from 0% to 100%. Cost-sharing percentage could not be estimated for those who did not have any spending in the survey year (TOTEXP09/10/11 = 0). The cost-sharing distribution had decreasing density of respondents from to zero to 100% with a bolus of people at each 0% and 100%. The boluses and persons with no spending potentially contain unique population segments. At the low end of the cost-sharing distribution, those with zero cost sharing were probably more likely to be recipients of public insurance, Medicaid or other programs with zero cost-sharing, and made up ~6% of each sample. Having zero cost-sharing because of having public insurance suggests this segment of the distribution was more likely poorer and disadvantaged in other ways. The disadvantage in the population segment with 0% cost-sharing was expected would reduce the likelihood of being up-to-date with recommended CRC screening independent of the effect of having zero or extremely low cost-sharing. It is not clear what would be the net effect to screening use for this population segment when also accounting for the cost-sharing effect.

At the other end of the cost-sharing range, two possible, non-exhaustive explanations for having 100% or close to 100% cost-sharing were that a respondent had insurance with a high deductible, which was not exceeded in the year, or that a respondent was only insured for part of the year and only or primarily had health care expenses during the time that they were uninsured.

These two explanations did not suggest a single gestalt for those with 100% or near 100% cost-sharing, so it is unclear what would be the ultimate effect on screening use for this population segment.

The ultimate effect of cost-sharing at each end of the cost-sharing distribution is unclear and may not accord with the expected inverse relationship between cost-sharing and utilization (Manning 1987). In consideration of this ambiguity, cost-sharing was specified as a categorical variable cutting the cost-sharing distribution into five levels. The first level was those with no (0%) cost-sharing (approximately 6% of the distribution as previously noted) and the fifth level was the top 5% of the cost sharing distribution (95^{th} percentile to 100% cost-sharing) for the practical analytic purpose of ensuring that all samples had at least 100 respondents in the highest cost-sharing category. The remaining internal distribution was split into three groups, so each includes approximately 30% of the sample (>0% to the 35^{th} percentile, 35^{th} to 65^{th} percentile, and 65^{th} to 95^{th} percentile). Sample weights were accounted for when splitting the cost-sharing distribution. Those without any medical spending in the survey year were included in the cost-sharing variable as a sixth category. Not having any spending in the survey year suggests a person did not encounter the health care system in the survey year, which may indicate that the person was fairly healthy and/or not health aware, although the ultimate implication for CRC screening use among those without any spending is unclear. The procedure for constructing the categorical variable was repeated separately for each sample.

Flexible Spending Accounts

A binary variable for whether a respondent's household had a FSA in the survey year was included for the first time in the 2011 MEPS. A FSA is an employer-established savings account that the employee funds with pre-tax dollars and can use to pay for qualified out-of-pocket medical expense (Internal Revenue Service 2013). FSA funds are "use-it-or-lose-it": remaining funds in the FSA account are

forfeit at the end of the plan year, although plans are allowed to permit a grace period of up to 2.5 months into the following plan year during which the funds may be used. The literature review findings and causal pathways used from Tye et al. did not provide immediate guidance for how having a FSA account might affect CRC screening use. For these analyses, it was assumed that having an FSA (FSAGT31 = 1) suggests that a person is health aware, so those who have FSAs were expected to be more likely to be up-to-date with recommended preventive services including CRC screening. Analyses for the FSA variable are restricted to the MEPS 2011 sample.

Data Management

The 2009, 2010 and 2011 MEPS Household Components and Medical Conditions files were freely downloadable on the MEPS website (Agency for Healthcare Research and Quality 2013). Survey methods were used to account for MEPS' complex survey design and correlation between survey years, so that standard errors were correctly computed. Sampling weights were used corresponding to the US civilian, non-institutionalized population. Stata version 13.1 was used for all analyses (StataCorp, LP College Station, TX). All categorical covariates were included with a "missing" category, because STATA removes observations from analyses "listwise" (if a value for any covariate is missing, the observation is dropped from the analyses). In addition to preserving sample size, including the "missing" category accounts for variance in the outcome explained by missing values.

Statistical Analyses

Aim 1. ***Evaluate the association between insurance features and likelihood of being up-to-date with USPSTF-recommended CRC screening.***

Analytic Plan for Aim 1

The analytic approach for Aim 1 was to perform multivariate logistic regression to assess insurance feature effects on likelihood of being up-to-date with recommended CRC screening while accounting for covariates. The following sections detail descriptive statistics, fitting the multivariate logistic regression models, and sensitivity analyses.

Descriptive Univariate and Bivariate Statistics

Summary univariate statistics were computed. For age, counts were reported by five-year increments, although age was included in analyses as a continuous variable. Any sparse variable levels were combined with other levels of the variable. Bivariate associations between CRC screening status and independent variables were assessed by performing Chi-square tests using an F statistic, which is derived from the Pearson Chi-Square statistic corrected for the survey design with the second-order correction of Rao and Scott (Rao and Scott 1984). This statistic, the “Design-based F statistic” is Stata 13.1’s default test of independence for two-way tables of survey data and is recommended “in all situations”. The p value is interpreted in the same way as the uncorrected Pearson Chi-Square test. Covariates that did not have a significant bivariate association at $p<0.1$ were not included in subsequent analyses.

Multivariate Logistic Regressions

MVLR was performed to assess insurance feature effects while controlling for covariates. Logistic regression is the standard method to model binary outcomes. Logistic regression is a generalized linear model that uses maximum likelihood estimation with a binomial family and logit link function to predict probabilities between zero and one. The following procedure was used to select covariates for models and estimate insurance feature effects.

Multiple models were run for each insurance feature and for each sample to reveal variation in insurance effects depending on model specification. First, covariates were assessed in blocks of substantively related covariates (demographics; acculturation; education and income; lifestyle factors; health status; prevention history; and health care access) in multivariate logistic regressions without including any insurance features. In this step, marital status was included in the demographics block and personal cancer history was included in the health status block. Any covariates in each block that did not remain significant at $p<0.05$ were not included in subsequent analyses. For the remaining covariates in each block, whether any covariates were collinear or collinear with the outcome was assessed using the stata command —_–rmdcoll–, which can accommodate categorical variables.

Second, Insurance features were then assessed with each covariate block separately. In this step, demographics and acculturation factors were collapsed as one block, and lifestyle and health status/personal cancer history were collapsed as one block. The effect of the binary insurance features on likelihood of being up-to-date with recommended CRC screening was estimated in terms of multivariate adjusted percentage point change (e.g. “having a DPN predicted an X% point change in likelihood of being up-to-date with recommended CRC screening”) with 95% confidence interval using the Stata –margins– command and –dydx()– option and in terms of multivariate-adjusted percentages for the categories of the cost-sharing percentage variable using the main option in the –margins– command. The reported multivariate adjusted percentages are the percentages of respondents predicted to be up-to-date with recommended CRC screening at each level of an independent variable level when the independent variable is alternately artificially fixed at each of its levels while all other covariates remain varied at their observed levels. Multivariate-adjusted percentages are known by other names including “predictive margins” (Graubard and Korn 1999) and “recycled predictions” (Basu and Rathouz 2005).

Multivariate-adjusted percentages are easy to interpret and avoid the problem of adjusted odds ratios diverging from relative risk ratios when the outcome variable is common, especially >50%, as is the case for CRC screening status.

Third, Insurance feature effects were then assessed in two multi-block models including multiple covariate blocks. A full model was assessed including all blocks, and a reduced full model was run including all covariate blocks except for the preventive services utilization and health care access blocks, which may bias insurance feature effects toward a null effect if factors in those blocks (or unobserved factors associated with those factors) are intermediate factors on the causal pathway from insurance features to obtaining CRC screening.

Logistic Equation formula and notation

The general logistic equation for the analyses is

$Y_i = \log (p_i/(1-p_i)) = \beta_0 + \beta_1$ (insurance feature) + $\Sigma\beta$(covariates) + μ

Where

Y_i = logit of the probability, p_i, that a person was up-to-date with recommend CRC screening

β_0 = intercept

μ = error term

Hypotheses

Hypotheses for the insurance features that were actually analyzed were specified based on the criteria in the overarching Aim 1 hypothesis in Chapter 1. Study hypotheses were derived from the causal pathways noted by Tye et al., which

proposed that organizational factors would influence CRC screening use according to the information-processing theory, and financial characteristics influence out-of-pocket costs thereby altering demand for CRC screening procedures. This study's three organizational insurance features were the same as those used by Tye et al. and have equivalent hypotheses. This study's two financial insurance features were newly examined. As previously discussed, an effect for the FSA variables was not suggested by the extant literature and the causal pathways, so a basis for a hypothesis for that variable has been proposed. The hypotheses are tested by assessing whether multivariate logistic regression coefficient estimates for the insurance features are different from zero.

Organizational Hypotheses

DPN

Having insurance that defined a provider network was hypothesized would increase likelihood of being up-to-date with recommended CRC screening in comparison to individuals with insurance without a DPN.

Coverage Restricted to a DPN

Having insurance that restricted care to a DPN was hypothesized would increase likelihood of being up-to-date with recommended CRC screening in comparison to not having insurance that restricted care to a DPN

Physician Gatekeeper Requirement

Having insurance that used gatekeeping was predicted would increase likelihood of being up-to-date with CRC screening in comparison to not having gatekeeping

Rationale for Organizational insurance feature Hypotheses

Following Tye et al.'s rationale, structures that enable insurers to improve information flows from administration to clinicians and enrollees will be more likely to achieve organizational goals (Galbraith 1973) such as increasing CRC screening. Having a DPN, having care restricted to a DPN, and using gatekeeping were expected to increase the insurer's ability to communicate and motivate appropriate CRC screening to providers and enrollees.

Financial Hypotheses

Cost-Sharing

Overall, greater cost-sharing, i.e. a higher percentage of total payments paid out-of-pocket in the survey year, was hypothesized would predict decreased likelihood of being up-to-date with recommended CRC screening. An exception to that relationship occurred: having 0% cost-sharing predicted a negative effect on likelihood of being up-to-date with recommended CRC screening, although it is unclear what effect 0% cost-sharing would have relative to other cost-sharing percentages. Having no spending in a year was hypothesized would have a negative effect on likelihood of being up-to-date with recommended CRC screening, although it is unclear what effect having no spending would have relative to the cost-sharing percentages.

Flexible Spending Account

Having a FSA was hypothesized would increase likelihood of being up-to-date with CRC screening in comparison not having a FSA.

Rationale for Financial insurance feature Hypotheses

Having greater cost-sharing during the survey year was expected would be correlated with higher out-of-pocket costs or otherwise greater financial barriers

to obtaining needed services (and/or possibly is associated with other non-financial barriers). The disadvantage suggested by greater cost-sharing during the survey year was therefore expected would predict decreased likelihood of being up-to-date with recommended CRC screening. Those with 0% cost-sharing were probably more likely to be recipients of public insurance, Medicaid or other programs with 0% cost-sharing in the survey year. Disadvantage that is associated with being a recipient of those programs was expected to have a negative effect on CRC screening likelihood. Individuals who had no medical spending during the survey year probably had not encountered the health care system during the survey year, which may indicate that the person was fairly healthy; averse to encountering the health care system because of financial barriers, personal preferences, or other reasons; and/or was not health aware. Intentional or unintentional avoidance of the healthcare system would reduce the probability of receiving a recommendation to obtain CRC screening. In total, not having any spending was expected to predict reduced CRC screening likelihood.

Evidence of financial planning for medical expenses may be associated with generally being more health aware. Having a FSA may indicate that an individual or family was planning for medical expenses.

Aim 2. ***Evaluate the association between insurance features and likelihood of being up-to-date with USPSTF-recommended CRC screening among Western US Hispanic and non-Hispanic whites.***

Hypothesis: Aim 1's hypothesized benefits of increased CRC screening use due to insurance features will be greater for Western non-Hispanic whites than Hispanic whites.

Rationale for Hypothesis for Aim 2:

Greater socioeconomic disadvantage among Western Hispanic whites in comparison to non-Hispanic whites is expected to limit the ability of Hispanic whites to benefit from having insurance features that foster CRC screening use.

Analytic Plan for Aim 2

The sample for the Aim 2 sub-analysis of Western Hispanic and non-Hispanic whites was generated using the sample from Aim 1 analyses and further limiting eligibility to Hispanics and non-Hispanic whites in the Western US census region. Model selection for Aim 2 followed the same procedure as for Aim 1 with two modifications. In the multivariate logistic regressions, Hispanic vs. non-Hispanic white ethnicity was included in the models without insurance features and the models with insurance features and separate covariate blocks. In the models with covariate blocks and insurance features, an interaction term for insurance features and Hispanic ethnicity was included to assess if ethnicity mediated insurance feature effects.

In all Aim 2 analyses that estimated main effects, the Bonferroni correction was applied for calculating 95% confidence intervals to account for multiple comparisons within the interaction term (insurance feature*Hispanic ethnicity). The Bonferroni correction protects against inflating the experimentwise error rate (the probability of a Type I error) by dividing the experimentwise error rate by the number of comparisons performed to calculate the comparisonwise error rate.

Contrast tests were performed to test specific effects in the findings. For the binary insurance features, five contrast test were performed: the difference between predicted screening likelihood for Hispanics vs. non-Hispanics, 1) without the insurance feature, and 2) with the insurance feature; the difference between predicted screening likelihood with the feature vs. without the feature, 3) for non-Hispanic whites, and 4) for Hispanics whites; and 5) the net effect for Hispanics vs. non-Hispanics of contrast test 4) minus contrast test 3). For the

cost-sharing variable, five contrast tests were performed for Hispanics vs. non-Hispanics whites within each of the cost-sharing variable levels.

Sensitivity Analyses

Potential Incorrect Temporal Ordering of Insurance Features and Being Up-To-Date with Recommended CRC screening

A sensitivity analysis was performed to account for potential bias due to incorrect temporal ordering, that a person could have gained their current insurance features after their last screening. Respondents' insurance features pertained to the MEPS survey year although a respondent could have been up-to-date with recommended CRC screening due to having received screening prior to the survey year (as much as 10 years before for colonoscopy). Because people change insurance when they gain employment, change employment, enroll in Medicare or for other reasons, it is likely that some respondents had different insurance when they were last screened than reported in MEPS, and the likelihood of having different insurance is expected to increase for individuals who had their last CRC screening further in the past. In order to assess this temporal ordering concern, sensitivity analyses of Aims 1 and 2 were conducted with a second dependent variable: any colonoscopy, FSIG or FOBT within the last year. If insurance features more strongly influenced more recent CRC screening use, insurance features would be expected to have a greater impact on CRC screening use in the previous year than on being up-to-date with USPSTF-recommended CRC screening. For the sensitivity analyses, the samples were restricted to those who had been screened in the past year and those who were not up-to-date with recommended CRC screening. Those who were up-to-date with screening but not in the past year were excluded from the

sample because it would not have been appropriate to combine them with those who were not up-to-date with screening. The procedure used to fit models for Aims 1 and 2 was repeated to perform the sensitivity analysis.

Chapter 4

Results

This chapter presents analytic findings that address the main and sensitivity analyses for Aims 1 and 2. The reported analyses include univariate sample characteristics; unadjusted bivariate associations of the CRC screening outcomes and the levels of the covariates and of the insurance features; and multivariate adjusted estimates of the main effects for each insurance feature. Results are presented for the binary insurance features first for each Aim and then for the cost-sharing variable for each Aim.

Sample Characteristics

Aim 1 Sample Characteristics

Table 4.1a presents the characteristics of the full Aim 1 sample, which included all MEPS respondents who were eligible for CRC screening. The sample included persons aged 50-75, with insurance for any part of the survey year and without a prior colon or rectal cancer diagnosis, which includes 21,085 respondents from 2009-2011 MEPS representing an annualized population-weighted 74,526,972 Americans. The MEPS years 2009, 2010, and 2011 made contributions of 31.8%, 33.2%, and 35.0% of the weighted sample, respectively. The sample mostly represented insured Baby Boomers, so the sample was more white, non-Hispanic, and female than the full American population, which also includes those under age 50, greater than age 75, and the uninsured. The sample's mean and median ages were 60.5 and 60, and each subsequent five-year band had fewer respondents with 5,440 (26.3%) respondents aged 50-54 years and 3,008 (14.3%) respondents aged 70-75 years. The sample was

52.3% female and 76.8% non-Hispanic white with small minorities each of Hispanic whites, 7.3%; non-Hispanic blacks, 9.9%; non-Hispanic Asians, 3.9%; and other race/ethnicities, 2.1%. The contributions of the categories of

Table 4.1 Univariate Summary Statistics						
	4.1a, Aim 1 Full Sample			4.1b, Aim 2 Full Sample		
	Weighted-sample annualized population size	Unweighted sample size	Weighted % of sample	Weighted-sample annualized population size	Unweighted sample size	Weighted % of sample
Total	74,526,972	21,085	100.0	13,853,125	3,751	100.0
Covariates						
Age groups						
50-54	19,616,829	5,440	26.3	3,732,117	976	26.9
55-59	17,113,336	4,955	23.0	3,093,918	848	22.3
60-64	14,799,696	4,006	19.9	2,755,905	728	19.9
65-69	12,344,575	3,676	16.6	2,310,724	675	16.7
70-75	10,652,535	3,008	14.3	1,960,462	524	14.2
Sex						
Male	35,522,688	9,659	47.7	6,689,884	1,775	48.3
Female	39,004,283	11,426	52.3	7,163,240	1,976	51.7
Race/Ethnicity						
non-Hispanic white	57,230,823	12,086	76.8			
Hispanic white	5,435,947	2,933	7.3			
non-Hispanic black	7,402,528	4,062	9.9			
non-Hispanic Asian	2,893,011	1,429	3.9			
Other	1,564,664	575	2.1			

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
White/Ethnicity						
non-Hispanic white				11,647,438	2,584	84.1
Hispanic white				2,205,687	1,167	15.9
Marital status						
Married	49,932,668	13,180	67.0	9,287,045	2,463	67.0
Widowed	5,579,601	1,880	7.5	883,773	276	6.4
Divorced/Separated	13,698,075	4,289	18.4	2,699,080	741	19.5
Never married	5,316,628	1,736	7.1	983,226	271	7.1
Census region						
Northeast	14,602,864	3,639	19.6			
Midwest	16,826,354	4,432	22.6			
South	26,798,988	7,935	36.0			
West	16,298,767	5,079	21.9			
Metropolitan Statistical Area Status						
Urban	61,445,605	17,598	82.4	12,163,438	3,412	87.8
Rural	13,081,367	3,487	17.6	1,689,686	339	12.2
Immigration status						
US born	65,621,990	16,955	88.1	11,861,037	2,843	85.6
Foreign born, lived in US <15 years	1,175,053	574	1.6	169,394	66	1.2
Foreign born, lived in US > 15 years	7,546,034	3,388	10.1	1,770,013	812	12.8
missing	183,895	168	0.2	52,681	30	0.4

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
Whether comfortable speaking English						
Comfortable	71,561,893	19,307	96.0	13,129,265	3,277	94.8
Not comfortable	2,297,908	1,358	3.1	573,108	374	4.1
missing	667,170	420	0.9	150,751	100	1.1
Interview language						
English	71,683,863	19,379	96.2	13,021,417	3,220	94.0
Spanish, Spanish and English, or other	2,843,108	1,706	3.8	831,708	531	6.0
Dental checkup frequency						
Twice a year or more	35,880,939	8,550	48.1	7,300,778	1,703	52.7
Once a year	14,571,697	4,434	19.6	2,830,157	837	20.4
Less than once a year	12,437,074	4,003	16.7	2,245,895	702	16.2
Never go to dentist	10,949,689	3,754	14.7	1,345,834	453	9.7
missing	687,572	344	0.9	130,461	56	0.9
Most recent flu shot						
Within past year	39,279,276	10,632	52.7	7,071,013	1,892	51.0
Within past two years	6,072,806	1,752	8.1	1,342,285	348	9.7
More than two years	6,691,000	1,859	9.0	1,436,096	354	10.4
Never received flu shot	20,816,672	6,177	27.9	3,684,262	1,046	26.6
missing	1,667,217	665	2.2	319,469	111	2.3

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
Perceived health status						
Excellent	14,710,229	3,660	19.7	3,097,957	736	22.4
Very good	24,730,156	6,461	33.2	4,740,141	1,230	34.2
Good	22,582,379	6,692	30.3	3,729,675	1,064	26.9
Fair/Poor	12,431,749	4,219	16.7	2,268,360	713	16.4
missing	72,459	53	0.1	16,992	8	0.1
Have any personal non-CRC cancer history						
No	61,732,591	17,944	82.8	11,294,213	3,139	81.5
Yes	12,768,428	3,114	17.1	2,558,130	611	18.5
missing	25,953	27	0.0	782	1	0.0
Quan et al.'s updated Charlson comorbidity index						
0	47,693,178	13,186	64.0	9,118,062	2,419	65.8
1	13,852,869	4,287	18.6	2,316,786	709	16.7
2	7,772,125	2,111	10.4	1,546,859	391	11.2
3+	5,208,799	1,501	7.0	871,417	232	6.3
Smoking status						
Non-smoker	58,449,915	15,887	78.4	11,448,867	3,019	82.6
Current Smoker	10,969,071	3,189	14.7	1,419,922	394	10.2
missing	5,107,986	2,009	6.9	984,336	338	7.1

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
BMI categories						
Underweight	676,202	201	0.9	103,927	29	0.8
Normal weight	19,842,682	5,489	26.6	3,966,023	1,025	28.6
Overweight	27,122,296	7,577	36.4	5,159,187	1,419	37.2
Obese	25,133,732	7,243	33.7	4,300,219	1,184	31.0
missing	1,752,059	575	2.4	323,768	94	2.3
Household income as a percentage of the federal poverty level						
Poor/Negative (<100%)	5,931,779	2,580	8.0	950,485	353	6.9
Near poor/Low income (100-200%)	10,094,014	3,598	13.5	1,738,222	606	12.5
Middle Income (200-400%)	20,011,870	6,226	26.9	3,623,543	1,107	26.2
High Income (>400%)	38,489,309	8,681	51.6	7,540,875	1,685	54.4
Educational attainment						
Less than a HSD	7,820,961	3,597	10.5	1,392,248	714	10.1
HSD/GED	35,097,336	9,935	47.1	6,016,338	1,581	43.4
Bachelor's	14,292,606	3,410	19.2	2,900,712	638	20.9
Graduate/Doctorate Degree	9,722,163	2,168	13.0	1,973,788	432	14.2
Other Degree	7,176,365	1,730	9.6	1,457,629	338	10.5
missing	417,540	245	0.6	112,410	48	0.8
Number of months insured in survey year						
1-6	2,277,851	902	3.1	478,550	161	3.5
7-11	2,988,984	1,019	4.0	623,928	206	4.5
12	69,260,137	19,164	92.9	12,750,646	3,384	92.0

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
Number of outpatient provider visits in year including physicians PAs and NPs						
0	11,980,980	4,129	16.1	2,541,009	827	18.3
1	10,245,516	3,026	13.7	1,947,692	526	14.1
2	9,597,893	2,744	12.9	1,774,052	486	12.8
3	7,695,299	2,135	10.3	1,395,529	361	10.1
4	6,170,006	1,659	8.3	1,032,987	271	7.5
5+	28,837,278	7,392	38.7	5,161,856	1,280	37.3
Had a usual source of care						
No	7,283,012	2,345	9.8	1,341,419	415	9.7
Yes	66,335,649	18,239	89.0	12,397,949	3,270	89.5
missing	908,310	501	1.2	113,756	66	0.8
Year						
2009		7,153	31.8		1,283	31.7
2010		6,662	33.2		1,196	34.3
2011		7,270	35.0		1,272	34.1
Insurance Features						
Insurance had a DPN						
No	35,547,734	10,095	47.7	6,017,505	1,596	43.4
Yes	36,606,857	10,085	49.1	7,536,354	2,048	54.4
missing	2,372,381	905	3.2	299,265	107	2.2

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
Coverage was restricted to a DPN						
No	56,370,038	15,068	75.6	9,709,907	2,469	70.1
Yes	12,317,995	3,588	16.5	3,194,268	903	23.1
missing	5,838,938	2,429	7.8	948,950	379	6.9
Insurance used gatekeeping						
No	45,724,432	12,314	61.4	7,798,892	1,989	56.3
Yes	26,577,943	7,941	35.7	5,768,384	1,667	41.6
missing	2,224,596	830	3.0	285,849	95	2.1
Household had a FSA						
No	22,746,654	6,440	87.2	4,121,188	1,130	87.3
Yes	2,713,425	579	10.4	493,562	101	10.5
missing	631,509	251	2.4	107,077	41	2.3
Cost-sharing categories for Aim 1 Sample						
0%	3,675,780	1,392	4.9			
0.1 to 13.0%	21,048,250	6,211	28.2			
13.1 to 29.8%	21,017,985	5,415	28.2			
29.8 to 85.8%	21,110,164	5,373	28.3			
85.8 to 100%	3,498,345	980	4.7			
No spending in year	4,176,448	1,714	5.6			

Table 4.1 (cont.)	Aim 1 Full Sample			Aim 2 Full Sample		
Cost-sharing categories for Aim 2 Sample						
0%				659,872	216	4.8
0.1 to 13.9%				3,961,279	1,127	28.6
14.0 to 32.3%				3,945,991	972	28.5
32.3 to 88.4%				3,940,298	974	28.4
88.4 to 100%				655,187	172	4.7
No spending in year				690,499	290	5.0
Prevalence of Being Up-to-Date with USPSTF-Recommended CRC Screening Strategies						
Received colonoscopy in past ten years						
No	30,691,116	9,621	41.2	6,063,081	1,806	43.8
Yes	43,835,855	11,464	58.8	7,790,043	1,945	56.2
Received flexible sigmoidoscopy in past five years with FOBT in past three years						
No	72,487,484	20,461	97.3	13,142,436	3,542	94.9
Yes	2,039,488	624	2.7	710,689	209	5.1
Received FOBT in past year						
No	65,427,664	18,430	87.8	11,546,560	3,123	83.3
Yes	9,099,307	2,655	12.2	2,306,565	628	16.7
Up-to-Date with USPSTF recommended CRC screening by any strategy						
No	27,913,067	8,739	37.5	5,082,242	1,519	36.7
Yes	46,613,905	12,346	62.5	8,770,883	2,232	63.3

race/ethnicity corresponded to weighted, annualized populations of 57.2 million white non-Hispanics, 5.4 million Hispanic whites, 7.4 million non-Hispanic blacks, 2.9 million non-Hispanic Asians, and 1.6 million persons of other race/ethnicity. Over one-third of respondents, 36.0%, resided in the Southern census region, while approximately one-fifth resided in the Northeast (19.6%), Midwest (22.6%), and Western (21.9%) regions. Large majorities of the respondents resided within a MSA, 82.4%; were born in the US, 88.1%; were comfortable speaking English, 96.0%; and had completed the MEPS-HC in English only, 96.2%. As a portion of the full sample, most foreign-born persons had resided in the US 15 or more years, 10.1% of the full sample, while foreign-born persons who had resided in the US less than 15 years comprised only 1.6% of the sample.

Majorities or near majorities reported being up-to-date with recommended preventive care and being in good health without serious illness. Nearly half reported receiving dental checkups twice a year or more often (48.1%), while progressively smaller minorities reported less frequent checkups. Most reported receiving a flu shot within the past year, 52.7% although the largest minority reported never having received a flu shot, 27.9%. For lifestyle-related need-based factors, respondents reported low smoking rates, 14.7%, and the mean and median BMI (to the tenth of a BMI point) were 28.6 and 27.5, respectively, with high rates of obesity, 33.7%, and overweight BMI, 36.4%, while only 0.9% were underweight. Most people reported very good, 33.2%, or good, 30.3%, health status, while small proportions perceived their health status to be at the extremes: excellent, 19.7%, and fair/poor, 16.7%. The mean score on Quan et al.'s updated Charlson Comorbidity index was 0.67, and the distribution was positively skewed with nearly two-thirds of the sample, 64.0%, having a score of zero (i.e. no conditions that accrued points on the index) and the largest minority, 18.6%, had an index score of one. 17.1% of the sample reported a prior cancer diagnosis other than CRC.

For enabling factors, the largest proportions had a household income that was considered high (>400% of the FPL), 51.6%; had only completed high school, 47.1%; were insured for all of the survey year, 92.9%; had visited outpatient providers five or more times in the survey year, 38.7%; had a usual source of care, 89.0%; and were married, 67.0%. The mean and median household incomes as a percentage of the federal poverty level were 499.4% and 413.7%, and the distribution of household income was negatively skewed. The mean and median numbers of outpatient provider visits were 5.6 and three, and the distribution was positively skewed with the largest minority having no visits, 16.1%.

Prevalence of the insurance features indicates the nature of some of the variation in national health insurance coverage. Nearly half of the sample, 49.1%, had insurance with a DPN, while only 16.5% had coverage that was restricted to their provider network. Just over one-third of the sample, 35.7%, had insurance that used gatekeeping. The mean and median cost-sharing percentages, were 27.6% and 20.7%, respectively while 5.6% had no spending (the cost-sharing percentage estimate for the entire 2009-2011 MEPS sample was consistent with recent national estimates of the percentage of national health expenditures paid by households (Martin 2014)). In 2011, only 10.4% of the respondents' households had a FSA.

CRCS use was consistent with other recent estimates of screening rates. In the sample, 62.5% were up-to-date with USPSTF-recommended CRC screening, which mostly reflected the 58.8% of the sample who had received colonoscopy within the previous ten years. In the sample, 12.2% had received FOBT in the previous year and 2.7% had received FSIG within the previous five years with FOBT within the previous three years. Over the included survey years, 60.4%, 63.4% and 63.6% of respondents were up-to-date with recommended CRC screening in 2009, 2010, and 2011, respectively.

Aim 2 Sample Characteristics

The Aim 2 sample of Western US Hispanic and non-Hispanic whites (Table 4.1b) was generally similar to the Aim 1 full US sample although had some notable differences. Patterns of key sociodemographic factors were generally similar between the samples including age, sex and marital status, although less of the Aim 2 sample resided in a rural area than the Aim 1 sample, 12.2 vs. 17.6%. The Aim 2 sample was less acculturated than the Aim 1 sample. In comparison to the Aim 1 sample, the Aim 2 sample had a greater proportion of foreign-born respondents, 14.4 vs. 11.9%; a greater proportion of respondents who were not comfortable speaking English, 4.1 vs. 3.1%; and a greater proportion of respondents who completed MEPS in Spanish, Spanish and English or another language, 6.0 vs. 3.8%.

Health-related covariates were generally similar between the samples. Receipt of preventive services was similar between Aim 1 and Aim 2's samples, and the health measures suggested similar overall health. Lifestyle factors were slightly favorable for the Aim 2 sample, which had a lower proportion of smokers 10.2 vs. 14.7%, a higher proportion of normal weight, 28.6 vs. 26.6%, and a lower proportion of obese, 31.0 vs. 33.7%.

Enabling factors were generally similar between the samples. The Aim 2 sample had a slightly more favorable profile for education and income measures, proxies for SES, with slightly greater proportions in higher income and education categories and smaller proportions in lower income and education categories than the Aim 1 sample. Health care access patterns did not consistently differ in a substantive way between the two aims' samples.

For the insurance features, the Aim 2 sample was more likely to have an organizational insurance feature indicating the insurer had greater administrative control. The Aim 2 sample, in comparison to the Aim 1 sample, had a larger

proportion of respondents with insurance that defined a provider network, 54.4 vs. 47.7%; a larger proportion with coverage restricted to a DPN, 23.1 vs. 16.5%; and a larger proportion of respondents with insurance that used gatekeeping, 41.6 vs. 35.7%. For the financial insurance features, the Aim 2 sample had an equal proportion of respondents who had a FSA as the Aim 1 sample, and the Aim 2 sample had a slightly greater cost-sharing mean, 29.4 vs. 27.6%, and median, 22.0 vs. 20.7%, than the Aim 1 sample.

A slightly greater proportion of the Aim 2 sample was up-to-date with recommended CRC screening by any technique, 63.3 vs. 62.5%, although the Aim 2 sample more often was up-to-date with screening by having received screening other than colonoscopy. Aim 2 had slightly lower colonoscopy use in the previous ten years, 56.2 vs. 58.8%; greater guideline-consistent FSIG use, 5.1 vs. 2.7%; and greater FOBT use in the previous year, 16.7 vs. 12.2%.

Bivariate Analyses

Aim 1 Analyses

In the Aim 1 samples, likelihood of being up-to-date with recommended CRC screening significantly varied across levels of most variables, which included the full Aim 1 sample (Table 4.2a, unadjusted n=21,085), the reduced sample excluding those under age 65 with only public insurance (Table 4.2b, unadjusted n=18,686) and the reduced sample with only MEPS 2011 (Table 4.2c, unadjusted n=7,270). The associations generally agreed with patterns in the literature. In this section, “significant” findings refer to all three samples unless noted otherwise. Reported percentages of screening likelihood apply only to the full sample unless noted otherwise.

CRCS likelihood varied significantly for some innate sociodemographic characteristics. As age increased screening likelihood generally increased, although did not significantly differ between the 60-64, 65-69, and 70-75 groups

Table 4.2 Aim 1 Bivariate Associations with Likelihood of Being Up-to-Date with Recommended CRC Screening for Main Analysis Samples								
4.2 a, Full MEPS 2009-2011 sample			**Table 4.2b, Reduced MEPS 2009-2011 sample excluding those age 50-64 with only public insurance**			**Table 4.2c, Reduced sample of only MEPS 2011**		
	%	**95% CI**		**%**	**95% CI**		**%**	**95% CI**
Total (n=21,085)	**62.5**	**[61.3,63.8]**	**Total (n=18,686)**	**63.7**	**[62.4,65.0]**	**Total (n=7,270)**	**63.6**	**[61.8,65.4]**
Covariates								
Age groups			**Age groups**			**Age groups**		
50-54 (n=5,440)	47.1	[45.0,49.2]	50-54 (n=4,551)	47.8	[45.5,50.1]	50-54 (n=1,825)	47.8	[44.4,51.1]
55-59 (n=4,955)	61.3	[59.1,63.5]	55-59 (n=4,153)	62.9	[60.6,65.2]	55-59 (n=1,675)	62.4	[59.0,65.6]
60-64 (n=4,006)	69.5	[67.6,71.3]	60-64 (n=3,298)	71.1	[68.9,73.1]	60-64 (n=1,396)	70.5	[67.9,72.9]
65-69 (n=3,676)	72.4	[70.1,74.6]	65-69 (n=3,676)	72.4	[70.1,74.6]	65-69 (n=1,298)	74.1	[70.8,77.2]
70-75 (n=3,008)	71.9	[69.3,74.4]	70-75 (n=3,008)	71.9	[69.3,74.4]	70-75 (n=1,076)	72.3	[68.3,76.0]
Design-based F(3.91, 809.91) = 111.4834 Pr = 0.000			**Design-based F(3.94, 816.11) = 96.9452 Pr = 0.000**			**Design-based F(3.68, 761.51) = 52.1362 Pr = 0.000**		
Sex			**Sex**			**Sex**		
Male (n=9,659)	63.0	[61.3,64.6]	Male (n=8,722)	64.3	[62.7,66.0]	Male (n=3,339)	64.9	[62.6,67.1]
Female (n=11,426)	62.2	[60.6,63.7]	Female (n=9,964)	63.1	[61.5,64.7]	Female (n=3,931)	62.5	[60.3,64.7]
Design-based F(1.00, 207.00) = 0.6461 Pr = 0.422			**Design-based F(1.00, 207.00) = 1.3966 Pr = 0.239**			**Design-based F(1.00, 207.00) = 3.2829 Pr = 0.071**		

Table 4.2 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced MEPS 2011 sample		
Race/Ethnicity			**Race/Ethnicity**			**Race/Ethnicity**		
non-Hispanic white (n=12,086)	64.6	[63.2,66.1]	non-Hispanic white (n=11,213)	65.5	[63.9,67.0]	non-Hispanic white (n=4,164)	65.5	[63.3,67.6]
Hispanic white (n=2,933)	53.1	[50.2,56.1]	Hispanic white (n=2,380)	54.6	[51.4,57.7]	Hispanic white (n=991)	56.0	[51.9,60.0]
non-Hispanic black (n=4,062)	61.3	[58.9,63.5]	non-Hispanic black (n=3,315)	63.9	[61.3,66.4]	non-Hispanic black (n=1,415)	63.8	[60.6,66.9]
non-Hispanic Asian (n=1,429)	46.2	[42.6,49.8]	non-Hispanic Asian (n=1,312)	47.0	[43.2,50.8]	non-Hispanic Asian (n=499)	44.4	[38.7,50.2]
Other (n=575)	54.7	[49.1,60.1]	Other (n=466)	56.1	[50.0,62.0]	Other (n=201)	61.3	[53.0,69.1]
Design-based F(3.86, 799.27) = 34.6689 Pr = 0.000			**Design-based F(3.90, 807.79) = 30.2854 Pr = 0.000**			**Design-based F(3.89, 806.05) = 16.4120 Pr = 0.000**		
Marital status			**Marital status**			**Marital status**		
Married (n=13,180)	64.4	[62.8,66.0]	Married (n=12,406)	65.0	[63.4,66.6]	Married (n=4,490)	65.6	[63.4,67.8]
Widowed (n=1,880)	67.3	[64.1,70.4]	Widowed (n=1,669)	68.4	[65.1,71.5]	Widowed (n=635)	67.2	[62.0,71.9]
Divorced/Separated (n=4,289)	57.9	[55.8,60.0]	Divorced/Separated (n=3,349)	59.4	[57.1,61.7]	Divorced/Separated (n=1,501)	59.3	[55.9,62.6]
Never married (n=1,736)	52.2	[48.8,55.5]	Never married (n=1,262)	54.7	[50.9,58.5]	Never married (n=644)	53.7	[48.8,58.6]
Design-based F(2.92, 603.45) = 24.1075 Pr = 0.000			**Design-based F(2.93, 607.20) = 15.5427 Pr = 0.000**			**Design-based F(2.92, 603.47) = 10.1448 Pr = 0.000**		

Table 4.2 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced MEPS 2011 sample		
Census Regions			**Census Regions**			**Census Regions**		
Northeast (n=3,639)	64.4	[61.8,66.9]	Northeast (n=3,104)	65.7	[62.9,68.4]	Northeast (n=1,277)	64.4	[60.6,68.0]
Midwest (n=4,432)	61.4	[58.7,64.0]	Midwest (n=4,018)	62.2	[59.5,64.8]	Midwest (n=1,589)	62.9	[59.9,65.7]
South (n=7,935)	62.7	[60.4,64.9]	South (n=7,021)	63.7	[61.4,65.9]	South (n=2,687)	64.9	[61.3,68.3]
West (n=5,079)	61.8	[59.3,64.3]	West (n=4,543)	63.5	[60.9,66.1]	West (n=1,717)	61.6	[57.4,65.7]
Design-based F(2.96, 613.61) = 0.9510 Pr = 0.415			**Design-based F(2.98, 617.17) = 1.0715 Pr = 0.360**			**Design-based F(2.84, 588.61) = 0.6872 Pr = 0.553**		
Metropolitan Statistical Area Status			**Metropolitan Statistical Area Status**			**Metropolitan Statistical Area Status**		
Urban (n=17,598)	63.2	[61.8,64.7]	Urban (n=15,650)	64.4	[62.9,65.8]	Urban (n=6,097)	64.3	[62.2,66.3]
Rural (n=3,487)	59.3	[56.5,62.1]	Rural (n=3,036)	60.3	[57.4,63.3]	Rural (n=1,173)	60.8	[56.9,64.6]
Design-based F(1.00, 207.00) = 5.9579 Pr = 0.015			**Design-based F(1.00, 207.00) = 5.7149 Pr = 0.018**			**Design-based F(1.00, 207.00) = 2.3982 Pr = 0.123**		
Immigration status			**Immigration status**			**Immigration status**		
US born (n=16,955)	64.0	[62.6,65.3]	US born (n=15,193)	65.0	[63.6,66.4]	US born (n=5,851)	65.4	[63.4,67.4]
Foreign born, lived in US <15 years (n=574)	33.7	[26.6,41.6]	Foreign born, lived in US <15 years (n=468)	34.2	[26.4,42.9]	Foreign born, lived in US <15 years (n=203)	36.0	[28.0,44.8]
Foreign born, lived in US > 15 years (n=3,388)	55.3	[52.6,58.0]	Foreign born, lived in US > 15 years (n=2,882)	56.6	[53.6,59.6]	Foreign born, lived in US > 15 years (n=1,139)	53.7	[49.4,58.0]
missing (n=168)	41.3	[28.6,55.3]	missing (n=143)	41.0	[26.9,56.7]	missing (n=77)	54.0	[34.9,72.0]
Design-based F(2.63, 545.41) = 38.1498 Pr = 0.000			**Design-based F(2.67, 551.97) = 31.8609 Pr = 0.000**			**Design-based F(2.59, 535.45) = 23.5010 Pr = 0.000**		

Table 4.2 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced MEPS 2011 sample		
Whether comfortable speaking English			**Whether comfortable speaking English**			**Whether comfortable speaking English**		
Comfortable (n=19,307)	63.3	[62.0,64.5]	Comfortable (n=17,337)	64.3	[63.0,65.6]	Comfortable (n=6,646)	64.3	[62.4,66.1]
Not comfortable (n=1,358)	44.2	[39.9,48.6]	Not comfortable (n=992)	43.8	[38.6,49.2]	Not comfortable (n=475)	47.2	[40.7,53.7]
missing (n=420)	48.6	[41.4,55.8]	missing (n=357)	50.3	[42.2,58.3]	missing (n=149)	59.1	[47.0,70.3]
Design-based F(1.65, 341.03) = 48.8486 Pr = 0.000			**Design-based F(1.61, 333.85) = 38.6057 Pr = 0.000**			**Design-based F(1.85, 383.18) = 15.1457 Pr = 0.000**		
Interview Language			**Interview Language**			**Interview Language**		
English (n=19,379)	63.1	[61.9,64.4]	English (n=17,396)	64.2	[62.9,65.5]	English (n=6,666)	64.1	[62.3,66.0]
Spanish, Spanish and English, or other (n=1,706)	47.6	[43.3,52.1]	Spanish, Spanish and English, or other (n=1,290)	47.8	[42.9,52.7]	Spanish, Spanish and English, or other (n=604)	52.7	[46.1,59.1]
Design-based F(1.00, 207.00) = 49.7657 Pr = 0.000			**Design-based F(1.00, 207.00) = 45.2884 Pr = 0.000**			**Design-based F(1.00, 207.00) = 12.1468 Pr = 0.001**		

Table 4.2 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced MEPS 2011 sample**		
Dental checkup frequency			**Dental checkup frequency**			**Dental checkup frequency**		
Twice a year or more (n=8,550)	72.4	[70.8,74.0]	Twice a year or more (n=8,207)	72.8	[71.1,74.4]	Twice a year or more (n=2,981)	74.3	[72.1,76.4]
Once a year (n=4,434)	59.8	[57.4,62.1]	Once a year (n=3,947)	60.2	[57.6,62.7]	Once a year (n=1,516)	60.5	[56.6,64.3]
Less than once a year (n=4,003)	53.0	[50.7,55.4]	Less than once a year (n=3,298)	53.5	[50.9,56.1]	Less than once a year (n=1,404)	53.5	[50.4,56.5]
Never go to dentist (n=3,754)	48.1	[45.8,50.4]	Never go to dentist (n=2,918)	49.8	[47.1,52.5]	Never go to dentist (n=1,234)	47.8	[43.3,52.2]
missing (n=344)	7.2	[4.2,12.1]	missing (n=316)	6.7	[3.8,11.7]	missing (n=135)	5.0	[1.5,14.9]
Design-based F(3.38, 699.65) = 151.3427 Pr = 0.000			**Design-based F(3.42, 707.65) = 124.7639 Pr = 0.000**			**Design-based F(3.86, 799.26) = 68.0761 Pr = 0.000**		
Most recent flu shot			**Most recent flu shot**			**Most recent flu shot**		
Within past year (n=10,632)	72.7	[71.3,74.0]	Within past year (n=9,515)	73.7	[72.4,75.0]	Within past year (n=3,693)	74.6	[72.7,76.5]
Within past two years (n=1,752)	60.8	[57.6,64.0]	Within past two years (n=1,521)	62.3	[59.0,65.5]	Within past two years (n=633)	62.0	[56.8,66.9]
More than two years (n=1,859)	55.4	[52.2,58.5]	More than two years (n=1,624)	56.1	[52.8,59.5]	More than two years (n=626)	55.9	[50.7,61.1]
Never received flu shot (n=6,177)	49.2	[47.2,51.1]	Never received flu shot (n=5,441)	50.5	[48.4,52.5]	Never received flu shot (n=2,066)	48.5	[45.1,51.8]
missing (n=665)	25.4	[20.4,31.1]	missing (n=585)	25.5	[20.1,31.7]	missing (n=252)	24.0	[16.6,33.5]
Design-based F(3.88, 803.84) = 179.1230 Pr = 0.000			**Design-based F(3.86, 799.26) = 162.9618 Pr = 0.000**			**Design-based F(3.91, 809.16) = 78.7728 Pr = 0.000**		

Table 4.2 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced MEPS 2011 sample**		
Perceived health status			**Perceived health status**			**Perceived health status**		
Excellent (n=3,660)	62.1	[60.1,64.2]	Excellent (n=3,539)	62.5	[60.4,64.6]	Excellent (n=1,305)	62.4	[59.3,65.4]
Very good (n=6,461)	64.4	[62.5,66.3]	Very good (n=6,177)	65.1	[63.1,67.0]	Very good (n=2,224)	65.5	[62.4,68.4]
Good (n=6,692)	62.2	[60.4,63.8]	Good (n=5,932)	63.5	[61.8,65.3]	Good (n=2,296)	62.7	[60.0,65.4]
Fair/Poor (n=4,219)	60.3	[58.2,62.4]	Fair/Poor (n=2,990)	62.8	[60.3,65.2]	Fair/Poor (n=1,428)	63.5	[60.4,66.5]
missing (n=53)	4.8	[1.0,19.8]	missing (n=48)	5.1	[1.1,20.8]	missing (n=17)	13.8	[2.0,55.1]
Design-based F(3.45, 714.99) = 8.6670 Pr = 0.000			**Design-based F(3.46, 715.46) = 6.6498 Pr = 0.000***			**Design-based F(3.70, 766.37) = 2.4395 Pr = 0.050***		
Have any personal non-CRC cancer history			**Have any personal non-CRC cancer history**			**Have any personal non-CRC cancer history**		
No (n=17,944)	60.1	[58.8,61.4]	No (n=15,851)	61.2	[59.9,62.5]	No (n=6,172)	60.9	[58.9,62.8]
Yes (n=3,114)	74.4	[71.8,76.8]	Yes (n=2,809)	75.5	[72.8,78.0]	Yes (n=1,086)	76.9	[73.2,80.1]
missing (n=27)	36.1	[9.6,75.0]	missing (n=26)	36.1	[9.6,75.0]	missing (n=12)	27.2	[3.2,81.0]
Design-based F(1.78, 367.80) = 69.7013 Pr = 0.000			**Design-based F(1.75, 362.37) = 64.5696 Pr = 0.000**			**Design-based F(1.82, 376.10) = 37.9292 Pr = 0.000**		
Quan et al.'s updated Charlson comorbidity index			**Quan et al.'s updated Charlson comorbidity index**			**Quan et al.'s updated Charlson comorbidity index**		
0 (n=13,186)	58.9	[57.6,60.3]	0 (n=12,180)	60.0	[58.6,61.3]	0 (n=4,503)	59.7	[57.8,61.6]
1 (n=4,287)	65.6	[63.2,68.0]	1 (n=3,582)	67.4	[64.7,69.9]	1 (n=1,549)	67.7	[64.0,71.1]
2 (n=2,111)	72.8	[70.1,75.4]	2 (n=1,786)	75.4	[72.4,78.1]	2 (n=702)	72.6	[67.8,76.9]
3+ (n=1,501)	72.0	[68.8,75.0]	3+ (n=1,138)	73.9	[70.5,77.0]	3+ (n=516)	75.1	[70.7,78.9]
Design-based F(2.93, 607.16) = 46.0909 Pr = 0.000			**Design-based F(2.92, 604.14) = 47.8177 Pr = 0.000**			**Design-based F(2.94, 608.39) = 21.8104 Pr = 0.000**		

Table 4.2 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced MEPS 2011 sample		
Smoking status			**Smoking status**			**Smoking status**		
Non-smoker (n=15,887)	65.6	[64.2,66.9]	Non-smoker (n=14,396)	66.5	[65.1,67.9]	Non-smoker (n=5,505)	66.2	[64.2,68.2]
Current Smoker (n=3,189)	51.1	[48.6,53.5]	Current Smoker (n=2,510)	52.6	[50.0,55.2]	Current Smoker (n=1,083)	53.6	[49.7,57.4]
missing (n=2,009)	52.4	[48.8,56.0]	missing (n=1,780)	52.8	[49.0,56.6]	missing (n=682)	53.6	[47.9,59.1]
Design-based F(1.97, 407.39) = 86.1723 Pr = 0.000			**Design-based F(1.97, 407.35) = 73.6614 Pr = 0.000**			**Design-based F(1.97, 407.65) = 26.3518 Pr = 0.000**		
BMI categories			**BMI categories**			**BMI categories**		
Underweight (n=201)	57.0	[47.2,66.2]	Underweight (n=154)	59.1	[48.1,69.2]	Underweight (n=76)	49.8	[32.9,66.6]
Normal weight (n=5,489)	59.8	[57.9,61.7]	Normal weight (n=4,991)	60.9	[58.9,62.8]	Normal weight (n=1,909)	60.9	[58.0,63.8]
Overweight (n=7,577)	63.5	[61.8,65.2]	Overweight (n=6,849)	64.6	[62.9,66.3]	Overweight (n=2,538)	64.4	[61.6,67.2]
Obese (n=7,243)	65.1	[63.4,66.8]	Obese (n=6,176)	66.6	[64.8,68.3]	Obese (n=2,534)	67.0	[64.6,69.4]
missing (n=575)	43.3	[37.7,49.0]	missing (n=516)	43.8	[37.9,49.8]	missing (n=213)	42.3	[34.1,50.9]
Design-based F(3.93, 814.16) = 17.6989 Pr = 0.000			**Design-based F(3.91, 809.78) = 17.6372 Pr = 0.000**			**Design-based F(3.75, 775.36) = 8.9901 Pr = 0.000**		

Table 4.2 (cont.)									
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced MEPS 2011 sample**		
Household income as a percentage of the federal poverty level			**Household income as a percentage of the federal poverty level**			**Household income as a percentage of the federal poverty level**		
Poor/Negative (<100%) (n=2,580)	55.1	[52.2,58.0]	Poor/Negative (<100%) (n=1,464)	60.6	[56.9,64.1]	Poor/Negative (<100%) (n=940)	59.3	[55.1,63.5]
Near poor/Low income (100-200%) (n=3,598)	54.0	[51.6,56.4]	Near poor/Low income (100-200%) (n=2,838)	55.8	[53.3,58.4]	Near poor/Low income (100-200%) (n=1,338)	55.7	[52.3,59.1]
Middle Income (200-400%) (n=6,226)	58.6	[56.6,60.5]	Middle Income (200-400%) (n=5,806)	59.0	[57.0,61.0]	Middle Income (200-400%) (n=2,092)	59.5	[56.6,62.4]
High Income (>400%) (n=8,681)	68.0	[66.4,69.6]	High Income (>400%) (n=8,578)	68.0	[66.4,69.7]	High Income (>400%) (n=2,900)	68.6	[66.2,70.9]
Design-based F(2.68, 555.57) = 56.4553 Pr = 0.000			**Design-based F(2.67, 551.82) = 39.8194 Pr = 0.000**			**Design-based F(2.91, 602.19) = 21.2537 Pr = 0.000**		
Educational attainment			**Educational attainment**			**Educational attainment**		
Less than a HSD (n=3,597)	50.2	[47.2,53.1]	Less than a HSD (n=2,654)	51.7	[48.5,54.8]	Less than a HSD (n=1,188)	52.6	[48.7,56.6]
HSD/GED (n=9,935)	60.3	[58.7,61.8]	HSD/GED (n=8,844)	61.3	[59.6,62.9]	HSD/GED (n=3,446)	62.6	[60.3,64.8]
Bachelor's (n=3,410)	67.5	[65.2,69.7]	Bachelor's (n=3,258)	68.0	[65.6,70.3]	Bachelor's (n=1,163)	65.7	[62.0,69.3]
Graduate/Doctorate Degree (n=2,168)	72.3	[69.4,75.1]	Graduate/Doctorate Degree (n=2,121)	72.5	[69.6,75.3]	Graduate/Doctorate Degree (n=776)	72.7	[68.4,76.6]
Other Degree (n=1,730)	65.2	[62.1,68.2]	Other Degree (n=1,603)	65.6	[62.4,68.8]	Other Degree (n=589)	64.2	[59.2,68.9]
missing (n=245)	42.6	[30.9,55.1]	missing (n=206)	45.1	[31.8,59.1]	missing (n=108)	49.5	[35.3,63.8]
Design-based F(4.76, 985.11) = 32.5034 Pr = 0.000			**Design-based F(4.72, 977.23) = 24.9177 Pr = 0.000**			**Design-based F(4.32, 894.51) = 10.5883 Pr = 0.000**		

Table 4.2 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced MEPS 2011 sample**		
Number of months insured in survey year			**Number of months insured in survey year**			**Number of months insured in survey year**		
1-6 (n=902)	43.5	[38.7,48.4]	1-6 (n=666)	45.0	[39.8,50.4]	1-6 (n=325)	41.1	[33.2,49.5]
7-11 (n=1,019)	47.1	[42.8,51.4]	7-11 (n=787)	48.6	[43.7,53.5]	7-11 (n=380)	54.8	[48.1,61.3]
12 (n=19,164)	63.8	[62.5,65.1]	12 (n=17,233)	64.8	[63.5,66.1]	12 (n=6,565)	64.8	[63.0,66.6]
Design-based F(2.00, 413.72) = 61.0515 Pr = 0.000			**Design-based F(1.99, 412.91) = 47.4388 Pr = 0.000**			**Design-based F(1.99, 411.30) = 21.1575 Pr = 0.000**		
Number of outpatient provider visits in year including physicians PAs and NPs			**Number of outpatient provider visits in year including physicians PAs and NPs**			**Number of outpatient provider visits in year including physicians PAs and NPs**		
0 (n=4,129)	35.4	[33.2,37.6]	0 (n=3,745)	36.4	[34.2,38.8]	0 (n=1,500)	37.3	[33.8,41.0]
1 (n=3,026)	53.3	[51.0,55.6]	1 (n=2,801)	54.3	[51.9,56.6]	1 (n=1,037)	56.1	[52.1,59.9]
2 (n=2,744)	61.5	[59.1,63.8]	2 (n=2,477)	62.5	[60.0,65.0]	2 (n=934)	59.9	[55.3,64.2]
3 (n=2,135)	64.1	[61.3,66.8]	3 (n=1,918)	65.9	[62.9,68.7]	3 (n=724)	65.3	[61.0,69.3]
4 (n=1,659)	68.3	[65.3,71.3]	4 (n=1,503)	69.7	[66.6,72.6]	4 (n=575)	68.6	[63.2,73.5]
5+ (n=7,392)	75.8	[74.2,77.4]	5+ (n=6,242)	77.7	[76.0,79.3]	5+ (n=2,500)	76.9	[74.6,79.0]
Design-based F(4.77, 987.34) = 222.3643 Pr = 0.000			**Design-based F(4.79, 991.82) = 212.1011 Pr = 0.000**			**Design-based F(4.68, 969.59) = 79.9336 Pr = 0.000**		
Had a usual source of care			**Had a usual source of care**			**Had a usual source of care**		
No (n=2,345)	34.6	[31.7,37.6]	No (n=2,048)	35.6	[32.7,38.7]	No (n=795)	32.7	[27.9,37.9]
Yes (n=18,239)	66.0	[64.7,67.2]	Yes (n=16,184)	67.2	[65.9,68.5]	Yes (n=6,264)	67.2	[65.4,69.0]
missing (n=501)	34.2	[27.5,41.6]	missing (n=454)	33.6	[26.7,41.2]	missing (n=211)	36.2	[24.1,50.3]
Design-based F(1.94, 400.74) = 257.2895 Pr = 0.000			**Design-based F(1.94, 402.21) = 243.7756 Pr = 0.000**			**Design-based F(1.98, 410.31) = 88.6458 Pr = 0.000**		

Table 4.2 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced MEPS 2011 sample		
Year			**Year**			**Year**		
2009 (n=7,153)	60.4	[58.8,62.0]	2009 (n=6,366)	61.5	[59.9,63.1]	2009 (n=0)	0.0	
2010 (n=6,662)	63.4	[61.8,65.0]	2010 (n=5,910)	64.6	[62.9,66.2]	2010 (n=0)	0.0	
2011 (n=7,270)	63.6	[61.8,65.4]	2011 (n=6,410)	64.8	[63.0,66.7]	2011 (n=7,270)	63.6	[61.8,65.4]
Design-based F(1.77, 365.88) = 6.8504 Pr = 0.002			**Design-based F(1.78, 369.39) = 6.7254 Pr = 0.002**					
Insurance Features								
Insurance had a DPN			**Coverage was restricted to a DPN**			**Household had a FSA**		
No (n=10,095)	63.5	[61.8,65.2]	No (n=15,068)	64.0	[62.6,65.4]	No (n=6,440)	63.2	[61.2,65.1]
Yes (n=10,085)	62.1	[60.6,63.6]	Yes (n=3,588)	62.2	[59.6,64.7]	Yes (n=579)	69.9	[64.8,74.6]
missing (n=905)	54.3	[49.7,58.8]	missing (n=30)	67.0	[43.5,84.3]	missing (n=251)	53.7	[42.7,64.4]
Design-based F(1.89, 391.33) = 6.6330 Pr = 0.002*			**Design-based F(1.94, 401.00) = 1.0863 Pr = 0.337**			**Design-based F(1.95, 403.74) = 4.8483 Pr = 0.009**		
Insurance used gatekeeping								
No (n=12,314)	63.8	[62.2,65.4]						
Yes (n=7,941)	61.0	[59.2,62.7]						
missing (n=830)	54.7	[50.0,59.4]						
Design-based F(1.85, 381.98) = 8.3021 Pr = 0.000								

Table 4.2 (cont.)

Full MEPS 2009-2011 sample		
Cost-sharing categories for Aim 1 full Sample		
0.0% (n=1,392)	51.7	[48.3,55.1]
0.1 to 13.0% (n=6,211)	67.4	[65.6,69.1]
13.1 to 29.8% (n=5,415)	69.4	[67.5,71.2]
29.8 to 85.8% (n=5,373)	63.9	[61.9,65.9]
85.8 to 100% (n=980)	44.1	[39.9,48.4]
No spending in year (n=1,714)	21.5	[18.9,24.4]
Design-based F(4.77, 988.09) = 151.8004 Pr = 0.000		

* there was not an overall significant difference (p<0.1) for the variable after excluding the missing category

and non-significantly declined in the 70-75 group compared to the 65-69 group. For race/ethnicity categories, screening likelihood was higher among non-Hispanic whites and non-Hispanic blacks than Hispanic whites and non-Hispanic Asians. For marital status, married and widowed persons had greater screening likelihood than divorced/separated or never married persons did. For the respondent's MSA designation, urban vs. rural had 4% points greater screening likelihood, 63.2 vs. 59.3%, which was significant in the full sample and the reduced 2009-2011 sample although the difference did not reach significance in the reduced MEPS 2011 sample, 64.3 vs. 60.8% (p=0.123). The sociodemographics with non-significant variation in screening likelihood were sex and census region, although the difference in the reduced 2011 MEPS sample almost reached significance for men having greater screening likelihood than women, 64.9 vs. 62.5% (p =0.071).

For other predisposing and enabling factors related to social status or SES, greater social status or SES generally predicted significantly higher screening likelihood including greater acculturation and higher income and educational attainment. Each greater income category did not though consistently increase screening likelihood. The lowest income category (household income <100% FPL) had non-significantly greater screening likelihood than the second lowest category (100-200% FPL) in the full sample and both reduced samples. The lowest sample income category also had similar screening likelihood as the middle-income category (200-400% FPL) in both reduced samples. Over the survey years, screening likelihood was equivalent in 2010, 63.4%, and 2011, 63.6%, which was an increase from 2009, 60.4%.

Considering the lifestyle and health-related predisposing and need factors, level of health and screening likelihood had inconsistent associations. For some variables, better health predicted greater screening likelihood including consistent and large increases for more frequent or recent use of other

preventive services (dental checkups and flu shots) and a large difference for being a non-smoker vs. smoker, 65.6 vs. 51.1%. For other variables, worse health predicted greater screening likelihood including having any non-CRC cancer diagnosis, 74.4 vs. 60.1%; being obese or overweight compared to normal weight; or having a Charlson Comorbidity Index score of two or greater in comparison to a score of one or having a score of one compared to zero. Perceived health status was a weaker predictor of screening likelihood and did not remain significant in either of the two reduced sample models for Aim 1. Greater health care access consistently predicted substantial significant increases in screening likelihood including being insured for all vs. part of the survey year, having a greater number of outpatient provider visits in the survey year, and having a usual source of care vs. not, 66.0 vs. 34.6%.

Insurance features were sometimes associated with significant variation in screening likelihood. Screening likelihood was significantly higher for respondents who had insurance that did not use gatekeeping, 63.8 vs. 61.0%; for respondents whose household had an FSA, 69.9 vs. 63.2% (Table 4.2b); and for respondents whose cost-sharing was in any of the internal tertiles of the cost-sharing distribution (greater than 0% and below the 95th percentile of cost-sharing) in comparison to respondents with 0% cost-sharing, cost-sharing in the top 5th percentile (85.8-100% of spending in the survey year paid out-of-pocket for the Aim 1 main analysis), or had no spending in the survey year. Screening likelihood did not significantly vary depending on having insurance with a DPN or having insurance that restricted coverage to a DPN (Table 4.2c).

Bivariate associations for the Aim 1 sensitivity analysis (Table 4.3) for the binary outcome of having received any CRC screening in the previous year vs. being not up-to-date with recommended screening were generally consistent with the main analysis findings.

Table 4.3 Aim 1 Bivariate Associations with Likelihood of Having Received CRC Screening in the Past Year for Sensitivity Analysis Samples								
Full MEPS 2009-2011 sample of those screened in previous year and those not up-to-date with recommended CRC screening			**Reduced MEPS 2009-2011 sample excluding those age 50-64 with only public insurance**			**Reduced sample of only MEPS 2011**		
	%	**95% CI**		**%**	**95% CI**		**%**	**95% CI**
Total (n=13,929)	**40.3**	**[39.0,41.7]**	**Total (n=12,103)**	**41.2**	**[39.7,42.8]**	**Total (n=4,574)**	**38.1**	**[36.2,40.1]**
Covariates								
Age groups			**Age groups**			**Age groups**		
50-54 (n=4,150)	27.9	[25.9,30.0]	50-54 (n=3,420)	28.0	[25.8,30.3]	50-54 (n=1,366)	27.1	[24.2,30.2]
55-59 (n=3,219)	36.6	[34.3,39.1]	55-59 (n=2,630)	37.5	[34.8,40.3]	55-59 (n=1,050)	34.8	[30.9,38.8]
60-64 (n=2,486)	48.4	[45.8,51.0]	60-64 (n=1,979)	50.2	[47.2,53.2]	60-64 (n=807)	43.8	[39.8,48.0]
65-69 (n=2,237)	51.0	[47.9,54.0]	65-69 (n=2,237)	51.0	[47.9,54.0]	65-69 (n=728)	49.5	[45.0,54.1]
70-75 (n=1,837)	52.2	[48.4,56.0]	70-75 (n=1,837)	52.2	[48.4,56.0]	70-75 (n=623)	49.5	[43.9,55.0]
Design-based F(3.84, 794.38) = 68.0447 Pr = 0.000			**Design-based F(3.86, 799.60) = 61.6643 Pr = 0.000**			**Design-based F(3.86, 798.02) = 25.2433 Pr = 0.000**		
Sex			**Sex**			**Sex**		
Male (n=6,371)	40.9	[39.2,42.7]	Male (n=5,631)	42.0	[40.1,43.9]	Male (n=2,105)	39.8	[37.1,42.6]
Female (n=7,558)	39.8	[38.1,41.5]	Female (n=6,472)	40.6	[38.7,42.5]	Female (n=2,469)	36.7	[34.1,39.3]
Design-based F(1.00, 207.00) = 1.0386 Pr = 0.309			**Design-based F(1.00, 207.00) = 1.3598 Pr = 0.245**			**Design-based F(1.00, 207.00) = 2.9176 Pr = 0.089**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Race/Ethnicity			**Race/Ethnicity**			**Race/Ethnicity**		
non-Hispanic white (n=7,357)	41.3	[39.7,43.0]	non-Hispanic white (n=6,736)	42.1	[40.3,43.9]	non-Hispanic white (n=2,413)	38.6	[36.0,41.1]
Hispanic white (n=2,267)	37.1	[34.0,40.3]	Hispanic white (n=1,810)	37.6	[34.2,41.0]	Hispanic white (n=716)	35.8	[31.3,40.6]
non-Hispanic black (n=2,807)	43.0	[40.2,45.9]	non-Hispanic black (n=2,237)	45.5	[42.2,48.8]	non-Hispanic black (n=926)	43.3	[39.2,47.5]
non-Hispanic Asian (n=1,096)	28.3	[24.7,32.1]	non-Hispanic Asian (n=1,002)	29.1	[25.2,33.2]	non-Hispanic Asian (n=381)	24.4	[19.4,30.2]
Other (n=402)	31.8	[27.0,37.0]	Other (n=318)	31.7	[26.8,37.2]	Other (n=138)	39.8	[31.2,49.1]
Design-based F(3.85, 797.52) = 12.9225 Pr = 0.000			**Design-based F(3.80, 786.88) = 13.1340 Pr = 0.000**			**Design-based F(3.68, 762.12) = 6.0854 Pr = 0.000**		
Marital status			**Marital status**			**Marital status**		
Married (n=8,474)	41.7	[40.0,43.5]	Married (n=7,873)	42.3	[40.5,44.2]	Married (n=2,734)	39.4	[36.8,42.0]
Widowed (n=1,221)	46.8	[42.7,50.9]	Widowed (n=1,072)	47.9	[43.6,52.2]	Widowed (n=387)	41.8	[35.8,48.0]
Divorced/Separated (n=2,949)	36.2	[33.9,38.6]	Divorced/Separated (n=2,252)	36.7	[34.0,39.5]	Divorced/Separated (n=993)	35.3	[31.5,39.3]
Never married (n=1,285)	33.0	[29.5,36.8]	Never married (n=906)	34.8	[30.7,39.2]	Never married (n=460)	32.6	[27.5,38.2]
Design-based F(2.93, 607.09) = 12.8878 Pr = 0.000			**Design-based F(2.96, 612.15) = 9.9234 Pr = 0.000**			**Design-based F(2.92, 604.56) = 2.7914 Pr = 0.041**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Census region			**Census region**			**Census region**		
Northeast (n=2,279)	39.3	[36.4,42.3]	Northeast (n=1,872)	39.8	[36.5,43.1]	Northeast (n=780)	36.8	[32.4,41.4]
Midwest (n=2,834)	38.0	[35.5,40.6]	Midwest (n=2,552)	39.0	[36.3,41.8]	Midwest (n=968)	36.1	[33.0,39.2]
South (n=5,202)	39.7	[37.1,42.4]	South (n=4,516)	40.3	[37.6,43.2]	South (n=1,645)	37.8	[33.9,41.8]
West (n=3,614)	44.3	[41.8,46.8]	West (n=3,163)	45.9	[43.0,48.8]	West (n=1,181)	41.6	[37.4,46.0]
Design-based F(2.90, 600.73) = 3.9458 Pr = 0.009			**Design-based F(2.93, 606.01) = 4.2629 Pr = 0.006**			**Design-based F(2.84, 587.08) = 1.3982 Pr = 0.244**		
Metropolitan Statistical Area Status			**Metropolitan Statistical Area Status**			**Metropolitan Statistical Area Status**		
Urban (n=11,642)	41.4	[39.8,42.9]	Urban (n=10,142)	42.2	[40.5,43.9]	Urban (n=3,852)	39.2	[37.1,41.4]
Rural (n=2,287)	35.6	[32.5,38.8]	Rural (n=1,961)	36.6	[33.2,40.2]	Rural (n=722)	33.1	[28.2,38.4]
Design-based F(1.00, 207.00) = 9.9994 Pr = 0.002			**Design-based F(1.00, 207.00) = 7.6966 Pr = 0.006**			**Design-based F(1.00, 207.00) = 4.3751 Pr = 0.038**		
Immigration status			**Immigration status**			**Immigration status**		
US born (n=10,763)	41.2	[39.7,42.8]	US born (n=9,468)	42.2	[40.5,43.8]	US born (n=3,527)	39.5	[37.3,41.8]
Foreign born, lived in US <15 years (n=475)	17.1	[12.3,23.3]	Foreign born, lived in US <15 years (n=384)	17.0	[11.9,23.8]	Foreign born, lived in US <15 years (n=166)	18.0	[12.1,25.9]
Foreign born, lived in US > 15 years (n=2,558)	38.1	[35.3,41.0]	Foreign born, lived in US > 15 years (n=2,134)	38.6	[35.3,41.9]	Foreign born, lived in US > 15 years (n=823)	32.4	[28.2,37.0]
missing (n=133)	27.6	[16.9,41.8]	missing (n=117)	28.4	[16.9,43.6]	missing (n=58)	27.3	[14.1,46.3]
Design-based F(2.80, 580.08) = 18.6144 Pr = 0.000			**Design-based F(2.75, 568.93) = 16.7170 Pr = 0.000**			**Design-based F(2.46, 509.16) = 10.4290 Pr = 0.000**		

Table 4.3 (cont.)

Full MEPS 2009-2011 sample			Full MEPS 2009-2011 sample			Full MEPS 2009-2011 sample		
Whether comfortable speaking English			**Whether comfortable speaking English**			**Whether comfortable speaking English**		
Comfortable (n=12,497)	40.9	[39.5,42.3]	Comfortable (n=11,022)	41.8	[40.2,43.4]	Comfortable (n=4,096)	38.5	[36.5,40.5]
Not comfortable (n=1,102)	29.5	[26.0,33.1]	Not comfortable (n=802)	28.1	[24.0,32.5]	Not comfortable (n=369)	29.8	[24.2,36.2]
missing (n=330)	30.1	[23.0,38.3]	missing (n=279)	31.2	[23.2,40.5]	missing (n=109)	39.7	[25.1,56.4]
Design-based F(1.88, 389.41) = 17.2263 Pr = 0.000			**Design-based F(1.84, 379.93) = 16.7633 Pr = 0.000**			**Design-based F(1.88, 389.84) = 2.7503 Pr = 0.068****		
Interview Language			**Interview Language**			**Interview Language**		
English (n=12,554)	40.7	[39.3,42.1]	English (n=11,067)	41.6	[40.1,43.1]	English (n=4,122)	38.3	[36.3,40.3]
Spanish, Spanish and English, or other (n=1,375)	34.0	[30.2,38.0]	Spanish, Spanish and English, or other (n=1,036)	33.4	[29.1,38.0]	Spanish, Spanish and English, or other (n=452)	35.2	[28.8,42.2]
Design-based F(1.00, 207.00) = 10.0181 Pr = 0.002			**Design-based F(1.00, 207.00) = 11.7045 Pr = 0.001**			**Design-based F(1.00, 207.00) = 0.7549 Pr = 0.386**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Dental checkup frequency			**Dental checkup frequency**			**Dental checkup frequency**		
Twice a year or more (n=5,020)	51.6	[49.4,53.9]	Twice a year or more (n=4,775)	52.0	[49.7,54.4]	Twice a year or more (n=1,638)	50.6	[47.4,53.9]
Once a year (n=3,040)	37.9	[35.1,40.7]	Once a year (n=2,659)	37.7	[34.7,40.9]	Once a year (n=985)	34.8	[30.5,39.4]
Less than once a year (n=2,769)	29.8	[27.4,32.2]	Less than once a year (n=2,242)	29.1	[26.4,31.9]	Less than once a year (n=916)	26.6	[23.2,30.4]
Never go to dentist (n=2,766)	28.5	[26.3,30.6]	Never go to dentist (n=2,120)	29.8	[27.2,32.6]	Never go to dentist (n=902)	26.2	[22.5,30.2]
missing (n=334)	3.2	[1.5,6.5]	missing (n=307)	2.9	[1.3,6.3]	missing (n=133)	1.9	[0.4,9.0]
Design-based F(3.28, 679.69) = 101.5055 Pr = 0.000			**Design-based F(3.32, 687.54) = 85.3917 Pr = 0.000**			**Design-based F(3.69, 764.61) = 42.8782 Pr = 0.000**		
Most recent flu shot			**Most recent flu shot**			**Most recent flu shot**		
Within past year (n=6,484)	53.0	[51.0,54.9]	Within past year (n=5,689)	53.9	[51.9,55.9]	Within past year (n=2,108)	52.2	[49.5,54.9]
Within past two years (n=1,138)	38.8	[35.3,42.5]	Within past two years (n=960)	39.9	[36.1,43.9]	Within past two years (n=385)	36.0	[29.9,42.5]
More than two years (n=1,260)	32.4	[28.8,36.3]	More than two years (n=1,079)	33.0	[29.0,37.3]	More than two years (n=408)	31.3	[25.3,37.9]
Never received flu shot (n=4,465)	26.2	[24.4,28.1]	Never received flu shot (n=3,863)	27.0	[25.0,29.1]	Never received flu shot (n=1,451)	22.0	[19.1,25.2]
missing (n=582)	9.5	[6.4,14.0]	missing (n=512)	9.6	[6.2,14.5]	missing (n=222)	6.7	[3.1,14.1]
Design-based F(3.87, 801.17) = 134.8566 Pr = 0.000			**Design-based F(3.84, 795.10) = 120.8314 Pr = 0.000**			**Design-based F(3.93, 813.45) = 57.0418 Pr = 0.000**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Perceived health status			**Perceived health status**			**Perceived health status**		
Excellent (n=2,340)	38.0	[35.4,40.6]	Excellent (n=2,248)	38.4	[35.8,41.1]	Excellent (n=820)	35.8	[32.0,39.9]
Very good (n=4,147)	41.7	[39.5,43.9]	Very good (n=3,921)	42.3	[40.1,44.6]	Very good (n=1,340)	38.4	[35.0,42.0]
Good (n=4,488)	40.7	[38.6,42.8]	Good (n=3,890)	41.8	[39.6,44.1]	Good (n=1,464)	37.9	[34.7,41.1]
Fair/Poor (n=2,901)	40.1	[37.8,42.5]	Fair/Poor (n=1,996)	42.0	[38.8,45.2]	Fair/Poor (n=933)	41.1	[36.8,45.5]
missing (n=53)	4.8	[1.0,19.8]	missing (n=48)	5.1	[1.1,20.8]	missing (n=17)	13.8	[2.0,55.1]
Design-based F(3.46, 715.65) = 3.8410 Pr = 0.007*			**Design-based F(3.45, 714.86) = 3.7640 Pr = 0.007**			**Design-based F(3.78, 781.76) = 1.2035 Pr = 0.308**		
Have any personal non-CRC cancer history			**Have any personal non-CRC cancer history**			**Have any personal non-CRC cancer history**		
No (n=12,051)	37.5	[36.2,38.9]	No (n=10,456)	38.3	[36.9,39.8]	No (n=3,978)	35.3	[33.4,37.2]
Yes (n=1,852)	55.5	[51.9,59.0]	Yes (n=1,622)	56.8	[52.9,60.6]	Yes (n=585)	54.5	[48.9,59.9]
missing (n=26)	26.4	[4.6,72.8]	missing (n=25)	26.4	[4.6,72.8]	missing (n=11)	0.0	
Design-based F(1.87, 386.74) = 66.3615 Pr = 0.000			**Design-based F(1.85, 382.35) = 62.5882 Pr = 0.000**			**Design-based F(1.96, 405.85) = 27.9462 Pr = 0.000**		
Quan et al.'s updated Charlson comorbidity index			**Quan et al.'s updated Charlson comorbidity index**			**Quan et al.'s updated Charlson comorbidity index**		
0 (n=8,838)	35.3	[33.8,36.7]	0 (n=8,051)	36.2	[34.6,37.8]	0 (n=2,919)	32.9	[31.0,35.0]
1 (n=2,807)	45.2	[42.6,47.9]	1 (n=2,268)	46.5	[43.5,49.5]	1 (n=943)	43.9	[39.5,48.4]
2 (n=1,320)	55.0	[51.2,58.8]	2 (n=1,076)	57.9	[53.5,62.2]	2 (n=417)	51.4	[44.7,58.0]
3+ (n=964)	53.9	[50.0,57.9]	3+ (n=708)	56.0	[51.5,60.4]	3+ (n=295)	53.2	[46.8,59.6]
Design-based F(2.91, 601.85) = 65.3284 Pr = 0.000			**Design-based F(2.84, 588.61) = 60.1533 Pr = 0.000**			**Design-based F(2.88, 596.08) = 23.7676 Pr = 0.000**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Smoking status			**Smoking status**			**Smoking status**		
Non-smoker (n=10,158)	43.5	[41.9,45.1]	Non-smoker (n=9,039)	44.2	[42.5,46.0]	Non-smoker (n=3,328)	40.6	[38.1,43.1]
Current Smoker (n=2,311)	30.2	[27.9,32.6]	Current Smoker (n=1,781)	31.1	[28.6,33.8]	Current Smoker (n=754)	29.9	[26.2,33.9]
missing (n=1,460)	30.7	[26.8,34.8]	missing (n=1,283)	31.0	[26.9,35.5]	missing (n=492)	30.0	[24.1,36.7]
Design-based F(1.91, 396.20) = 49.6083 Pr = 0.000			**Design-based F(1.92, 397.39) = 42.5504 Pr = 0.000**			**Design-based F(1.95, 404.46) = 11.6417 Pr = 0.000**		
BMI categories			**BMI categories**			**BMI categories**		
Underweight (n=141)	33.2	[23.8,44.0]	Underweight (n=106)	34.4	[23.2,47.7]	Underweight (n=54)	22.4	[11.0,40.1]
Normal weight (n=3,662)	37.0	[34.9,39.2]	Normal weight (n=3,274)	37.8	[35.5,40.2]	Normal weight (n=1,192)	34.5	[31.4,37.8]
Overweight (n=4,914)	41.0	[39.1,42.9]	Overweight (n=4,355)	41.9	[39.9,43.9]	Overweight (n=1,583)	38.2	[35.0,41.5]
Obese (n=4,748)	43.8	[41.7,46.0]	Obese (n=3,952)	45.0	[42.7,47.4]	Obese (n=1,579)	43.2	[39.9,46.6]
missing (n=464)	25.0	[19.7,31.1]	missing (n=416)	25.5	[19.8,32.0]	missing (n=166)	20.5	[14.2,28.6]
Design-based F(3.83, 793.35) = 12.7750 Pr = 0.000			**Design-based F(3.79, 783.69) = 11.9071 Pr = 0.000**			**Design-based F(3.83, 791.96) = 8.0895 Pr = 0.000**		

Table 4.3 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced sample of only MEPS 2011		
Household income as a percentage of the federal poverty level			**Household income as a percentage of the federal poverty level**			**Household income as a percentage of the federal poverty level**		
Poor/Negative (<100%) (n=1,851)	35.4	[32.7,38.2]	Poor/Negative (<100%) (n=997)	38.5	[34.6,42.7]	Poor/Negative (<100%) (n=632)	37.7	[32.8,42.8]
Near poor/Low income (100-200%) (n=2,591)	34.3	[31.7,37.1]	Near poor/Low income (100-200%) (n=2,001)	35.6	[32.7,38.7]	Near poor/Low income (100-200%) (n=912)	33.1	[29.4,37.0]
Middle Income (200-400%) (n=4,217)	36.1	[33.8,38.5]	Middle Income (200-400%) (n=3,905)	36.5	[34.0,39.0]	Middle Income (200-400%) (n=1,363)	34.4	[31.3,37.7]
High Income (>400%) (n=5,270)	45.6	[43.5,47.6]	High Income (>400%) (n=5,200)	45.6	[43.5,47.7]	High Income (>400%) (n=1,667)	42.1	[39.1,45.1]
Design-based F(2.73, 564.10) = 27.4707 Pr = 0.000			**Design-based F(2.61, 539.82) = 20.3973 Pr = 0.000**			**Design-based F(2.93, 606.05) = 7.3138 Pr = 0.000**		
Educational attainment			**Educational attainment**			**Educational attainment**		
Less than a HSD (n=2,705)	31.8	[29.2,34.5]	Less than a HSD (n=1,957)	32.6	[29.5,35.8]	Less than a HSD (n=863)	32.3	[28.0,36.8]
HSD/GED (n=6,593)	38.0	[36.3,39.8]	HSD/GED (n=5,782)	38.8	[36.8,40.7]	HSD/GED (n=2,145)	37.1	[34.5,39.6]
Bachelor's (n=2,085)	44.5	[41.7,47.4]	Bachelor's (n=1,975)	45.0	[42.0,48.0]	Bachelor's (n=702)	39.8	[35.6,44.1]
Graduate/Doctorate Degree (n=1,232)	50.7	[46.9,54.6]	Graduate/Doctorate Degree (n=1,196)	50.9	[46.9,54.8]	Graduate/Doctorate Degree (n=413)	46.0	[39.7,52.3]
Other Degree (n=1,108)	43.4	[39.5,47.5]	Other Degree (n=1,019)	43.7	[39.6,48.0]	Other Degree (n=366)	38.6	[32.5,45.1]
missing (n=206)	27.2	[17.8,39.3]	missing (n=174)	28.8	[18.4,42.1]	missing (n=85)	28.8	[15.3,47.5]
Design-based F(4.72, 976.47) = 18.3436 Pr = 0.000			**Design-based F(4.75, 982.79) = 14.5029 Pr = 0.000**			**Design-based F(4.63, 957.46) = 3.2355 Pr = 0.008**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Number of months insured in survey year			**Number of months insured in survey year**			**Number of months insured in survey year**		
1-6 (n=689)	22.6	[18.2,27.8]	1-6 (n=490)	22.3	[17.2,28.4]	1-6 (n=248)	18.5	[11.5,28.5]
7-11 (n=781)	28.4	[24.2,32.9]	7-11 (n=591)	28.8	[23.9,34.3]	7-11 (n=282)	36.5	[28.8,45.0]
12 (n=12,459)	41.6	[40.1,43.2]	12 (n=11,022)	42.4	[40.8,44.1]	12 (n=4,044)	39.0	[37.0,41.2]
Design-based F(1.99, 410.98) = 32.3347 Pr = 0.000			**Design-based F(2.00, 413.74) = 25.7721 Pr = 0.000**			**Design-based F(1.98, 408.86) = 7.5503 Pr = 0.001**		
Number of outpatient provider visits in year including physicians PAs and NPs			**Number of outpatient provider visits in year including physicians PAs and NPs**			**Number of outpatient provider visits in year including physicians PAs and NPs**		
0 (n=3,297)	15.8	[14.0,17.6]	0 (n=2,960)	16.3	[14.5,18.3]	0 (n=1,173)	14.6	[12.1,17.6]
1 (n=2,112)	29.4	[26.8,32.0]	1 (n=1,938)	30.3	[27.6,33.1]	1 (n=687)	29.3	[25.1,34.0]
2 (n=1,756)	37.6	[34.8,40.6]	2 (n=1,554)	38.5	[35.4,41.7]	2 (n=571)	31.7	[27.2,36.6]
3 (n=1,334)	40.7	[37.4,44.1]	3 (n=1,161)	42.4	[39.0,46.0]	3 (n=436)	40.7	[35.4,46.2]
4 (n=1,025)	46.4	[42.3,50.6]	4 (n=904)	47.8	[43.5,52.1]	4 (n=331)	39.8	[33.6,46.3]
5+ (n=4,405)	58.0	[55.7,60.3]	5+ (n=3,586)	60.2	[57.6,62.7]	5+ (n=1,376)	56.4	[52.9,59.8]
Design-based F(4.86, 1005.15) = 166.0569 Pr = 0.000			**Design-based F(4.84, 1002.10) = 157.7673 Pr = 0.000**			**Design-based F(4.90, 1014.22) = 65.6746 Pr = 0.000**		
Had a usual source of care			**Had a usual source of care**			**Had a usual source of care**		
No (n=1,893)	16.8	[14.7,19.1]	No (n=1,639)	17.3	[15.1,19.9]	No (n=619)	13.1	[10.1,16.8]
Yes (n=11,620)	44.1	[42.6,45.6]	Yes (n=10,085)	45.1	[43.4,46.7]	Yes (n=3,785)	42.1	[40.0,44.3]
missing (n=416)	18.2	[12.8,25.2]	missing (n=379)	17.7	[12.1,25.0]	missing (n=170)	14.4	[7.2,26.7]
Design-based F(1.86, 385.50) = 166.4117 Pr = 0.000			**Design-based F(1.89, 391.32) = 150.7793 Pr = 0.000**			**Design-based F(2.00, 412.99) = 64.7690 Pr = 0.000**		

Table 4.3 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Year			**Year**			**Year**		
2009 (n=4,917)	40.3	[38.2,42.4]	2009 (n=4,296)	41.1	[38.9,43.4]	2009 (n=0)	0.0	
2010 (n=4,438)	42.6	[40.6,44.5]	2010 (n=3,864)	43.6	[41.5,45.8]	2010 (n=0)	0.0	
2011 (n=4,574)	38.1	[36.2,40.1]	2011 (n=3,943)	38.9	[36.8,41.0]	2011 (n=4,574)	38.1	[36.2,40.1]
Design-based F(1.81, 375.35) = 5.9518 Pr = 0.004			**Design-based F(1.86, 385.22) = 6.1986 Pr = 0.003**					
Insurance Features								
Insurance had a DPN			**Coverage was restricted to a DPN**			**Household had a FSA**		
No (n=6,554)	40.5	[38.6,42.4]	No (n=9,637)	40.9	[39.2,42.5]	No (n=4,076)	37.9	[35.9,40.0]
Yes (n=6,733)	40.6	[38.9,42.4]	Yes (n=2,446)	42.7	[39.8,45.7]	Yes (n=317)	43.6	[36.6,50.9]
missing (n=642)	34.1	[29.5,39.1]	missing (n=20)	49.7	[24.2,75.4]	missing (n=181)	24.1	[14.7,37.0]
Design-based F(1.92, 397.44) = 2.5191 Pr = 0.084*			**Design-based F(1.95, 404.50) = 0.8896 Pr = 0.410**			**Design-based F(1.98, 410.67) = 3.5037 Pr = 0.031***		
Insurance used gatekeeping								
No (n=7,854)	40.2	[38.3,42.2]						
Yes (n=5,491)	41.0	[39.0,43.0]						
missing (n=584)	34.2	[29.2,39.7]						
Design-based F(1.82, 376.83) = 1.9186 Pr = 0.152								

Table 4.3 (cont.)

Full MEPS 2009-2011 sample		
Cost-sharing categories for Aim 1 sensitivity analysis full sample		
0.0% (n=887)	32.1	[28.2,36.2]
0.1 to 12.1% (n=4,006)	48.2	[46.1,50.3]
12.2 to 29.4% (n=3,455)	48.2	[45.7,50.7]
29.4 to 89.4% (n=3,451)	38.6	[36.3,41.0]
89.4 to 100% (n=634)	18.9	[15.0,23.6]
No spending in year (n=1,496)	8.0	[6.3,10.1]
Design-based F(4.67, 965.89) = 98.0839 Pr = 0.000		

* this variable was not significant (p<0.1) after excluding the missing category
** this variable was significant (p<0.05) after excluding the missing category

Notably, in the sensitivity analyses the Western census region had the highest likelihood of having received screening of the four census regions in all three samples, and there was overall significant variation in screening likelihood for the Aim 1 sensitivity analysis full sample and the reduced sample excluding those aged <65 with only public insurance. In the main analyses census regions did not predict significantly varying screening likelihood and the Western census region had the second least screening likelihood in two samples and the least in the reduced sample of only MEPS 2011. Another notable association in the Aim 1 sensitivity analysis was that survey year 2011 significantly predicted the lowest likelihood of previous year screening of the three survey years. In the main analysis, 2010 and 2011 had similarly screening likelihood, which was significantly greater than survey year 2009.

Bivariate Findings for Aim 2

In the Aim 2 sample, the patterns of bivariate associations were mostly consistent with findings for the Aim 1 samples (Table 4.4). In the Aim 2 sample, the screening likelihood pattern by age was consistent with Aim 1 except that the 70-75 age group had greater screening likelihood than the 65-69 group, although differences remained non-significant.

Patterns were also similar to the Aim 1 sample for factors with greater relevance to Aim 2 including Hispanic ethnicity and the acculturation variables. Screening likelihood was slightly greater for non-Hispanic whites in the Aim 2 sample vs. Aim 1 sample, 65.8 vs. 64.6%, and slightly lower for Hispanic whites, 50.2 vs. 53.1%. The covariates for survey language and for whether the respondent was comfortable speaking English had similar screening likelihood patterns. For the covariate incorporating US vs. foreign birth and length of time in the US for foreign born persons, the category for foreign born, lived in the US <15 year had a very small sample size and the estimate for screening likelihood was much lower than in the Aim 1 sample, 13.4 vs. 33.7%, although the Aim 2 estimate had

Table 4.4 Aim 2 Bivariate Associations with Likelihood of Being Up-to-Date with Recommended CRC Screening for Main Analysis Samples								
Full MEPS 2009-2011 sample of Hispanic and non-Hispanic whites in Western census region			**Reduced MEPS 2009-2011 sample excluding those age 50-64 with only public insurance**			**Reduced sample of only MEPS 2011**		
	%	**95% CI**		**%**	**95% CI**		**%**	**95% CI**
Total (n=3,751)	**63.3**	**[60.8,65.8]**	**Total (n=3,375)**	**64.8**	**[62.1,67.4]**	**Total (n=1,272)**	**62.5**	**[58.3,66.6]**
Covariates								
Age groups			**Age groups**			**Age groups**		
50-54 (n=976)	43.9	[39.9,47.9]	50-54 (n=840)	44.4	[40.3,48.5]	50-54 (n=354)	41.2	[35.5,47.0]
55-59 (n=848)	64.6	[58.5,70.1]	55-59 (n=724)	67.5	[61.6,73.0]	55-59 (n=259)	64.5	[55.8,72.3]
60-64 (n=728)	70.0	[65.5,74.2]	60-64 (n=612)	72.3	[67.2,76.8]	60-64 (n=244)	70.6	[62.3,77.7]
65-69 (n=675)	74.3	[67.8,79.9]	65-69 (n=675)	74.3	[67.8,79.9]	65-69 (n=228)	72.5	[64.3,79.4]
70-75 (n=524)	76.0	[71.6,79.9]	70-75 (n=524)	76.0	[71.6,79.9]	70-75 (n=187)	80.8	[74.3,86.0]
Design-based F(3.03, 481.44) = 28.3963 Pr = 0.000			**Design-based F(3.14, 486.28) = 28.1307 Pr = 0.000**			**Design-based F(3.29, 502.89) = 20.3561 Pr = 0.000**		
Sex			**Sex**			**Sex**		
Male (n=1,775)	64.9	[61.9,67.9]	Male (n=1,616)	66.4	[63.1,69.6]	Male (n=602)	64.6	[59.6,69.3]
Female (n=1,976)	61.8	[58.5,65.0]	Female (n=1,759)	63.2	[59.7,66.7]	Female (n=670)	60.6	[55.8,65.2]
Design-based F(1.00, 159.00) = 2.7558 Pr = 0.099			**Design-based F(1.00, 155.00) = 2.3752 Pr = 0.125**			**Design-based F(1.00, 153.00) = 2.8811 Pr = 0.092**		

Table 4.4 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced sample of only MEPS 2011		
White/Ethnicity			**White/Ethnicity**			**White/Ethnicity**		
non-Hispanic white (n=2,584)	65.8	[62.9,68.6]	non-Hispanic white (n=2,422)	66.9	[63.8,69.8]	non-Hispanic white (n=899)	64.3	[59.6,68.8]
Hispanic white (n=1,167)	50.2	[45.8,54.7]	Hispanic white (n=953)	52.3	[47.3,57.3]	Hispanic white (n=373)	53.8	[48.4,59.2]
Design-based F(1.00, 159.00) = 32.3124 Pr = 0.000			**Design-based F(1.00, 155.00) = 24.7308 Pr = 0.000**			**Design-based F(1.00, 153.00) = 10.2973 Pr = 0.002**		
Marital status			**Marital status**			**Marital status**		
Married (n=2,463)	64.8	[61.2,68.3]	Married (n=2,294)	65.9	[62.1,69.5]	Married (n=859)	63.6	[58.0,68.7]
Widowed (n=276)	71.9	[62.0,80.1]	Widowed (n=252)	73.6	[63.3,81.8]	Widowed (n=81)	73.5	[59.5,83.9]
Divorced/Separated (n=741)	60.0	[55.4,64.5]	Divorced/Separated (n=620)	62.1	[57.0,67.0]	Divorced/Separated (n=241)	62.6	[53.1,71.1]
Never married (n=271)	50.1	[41.4,58.9]	Never married (n=209)	51.3	[41.0,61.4]	Never married (n=91)	45.4	[33.1,58.3]
Design-based F(2.86, 454.83) = 4.5696 Pr = 0.004			**Design-based F(2.81, 436.05) = 3.7528 Pr = 0.013**			**Design-based F(2.74, 419.21) = 2.7791 Pr = 0.046**		
Metropolitan Statistical Area Status			**Metropolitan Statistical Area Status**			**Metropolitan Statistical Area Status**		
Urban (n=3,412)	63.5	[60.8,66.2]	Urban (n=3,081)	64.9	[62.0,67.6]	Urban (n=1,137)	62.3	[57.9,66.4]
Rural (n=339)	61.8	[55.8,67.4]	Rural (n=294)	64.1	[55.8,71.6]	Rural (n=135)	64.2	[51.2,75.5]
Design-based F(1.00, 159.00) = 0.2963 Pr = 0.587			**Design-based F(1.00, 155.00) = 0.0343 Pr = 0.853**			**Design-based F(1.00, 153.00) = 0.0918 Pr = 0.762**		

Table 4.4 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Immigration status			**Immigration status**			**Immigration status**		
US born (n=2,843)	65.3	[62.5,67.9]	US born (n=2,640)	66.5	[63.5,69.4]	US born (n=971)	64.6	[59.9,69.1]
Foreign born, lived in US <15 years (n=66)	13.4	[3.5,40.0]	Foreign born, lived in US <15 years (n=53)	13.5	[3.1,43.0]	Foreign born, lived in US <15 years (n=28)	14.5	[5.9,31.7]
Foreign born, lived in US > 15 years (n=812)	56.2	[51.0,61.2]	Foreign born, lived in US > 15 years (n=654)	58.6	[52.8,64.2]	Foreign born, lived in US > 15 years (n=262)	55.1	[47.8,62.1]
missing (n=30)	24.1	[9.0,50.6]	missing (n=28)	25.5	[9.3,53.4]	missing (n=11)	63.1	[23.3,90.6]
Design-based F(2.35, 373.35) = 14.2586 Pr = 0.000			**Design-based F(2.32, 360.30) = 12.0744 Pr = 0.000**			**Design-based F(2.70, 413.35) = 12.4822 Pr = 0.000**		
Whether comfortable speaking English			**Whether comfortable speaking English**			**Whether comfortable speaking English**		
Comfortable (n=3,277)	64.6	[62.0,67.0]	Comfortable (n=3,019)	65.8	[63.0,68.4]	Comfortable (n=1,114)	63.4	[59.2,67.4]
Not comfortable (n=374)	39.5	[30.8,48.9]	Not comfortable (n=271)	41.3	[30.3,53.2]	Not comfortable (n=128)	44.2	[33.7,55.2]
missing (n=100)	44.3	[30.7,58.9]	missing (n=85)	45.4	[30.2,61.6]	missing (n=30)	68.5	[45.1,85.2]
Design-based F(1.64, 260.64) = 21.5597 Pr = 0.000			**Design-based F(1.65, 256.50) = 13.7777 Pr = 0.000**			**Design-based F(2.00, 305.54) = 6.8836 Pr = 0.001**		
Interview Language			**Interview Language**			**Interview Language**		
English (n=3,220)	64.8	[62.2,67.2]	English (n=2,974)	66.0	[63.3,68.7]	English (n=1,098)	63.7	[59.5,67.8]
Spanish, Spanish and English, or other (n=531)	40.4	[32.8,48.6]	Spanish, Spanish and English, or other (n=401)	41.1	[32.7,50.0]	Spanish, Spanish and English, or other (n=174)	44.3	[33.1,56.2]
Design-based F(1.00, 159.00) = 38.3291 Pr = 0.000			**Design-based F(1.00, 155.00) = 32.9106 Pr = 0.000**			**Design-based F(1.00, 153.00) = 12.0262 Pr = 0.001**		

Table 4.4 (cont.)

Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Dental checkup frequency			**Dental checkup frequency**			**Dental checkup frequency**		
Twice a year or more (n=1,703)	72.7	[69.1,76.0]	Twice a year or more (n=1,663)	72.8	[69.1,76.1]	Twice a year or more (n=576)	74.9	[69.7,79.4]
Once a year (n=837)	61.7	[56.4,66.8]	Once a year (n=766)	62.4	[56.7,67.9]	Once a year (n=282)	53.8	[46.1,61.4]
Less than once a year (n=702)	50.5	[45.0,55.9]	Less than once a year (n=562)	53.1	[47.1,59.0]	Less than once a year (n=248)	48.9	[41.1,56.7]
Never go to dentist (n=453)	42.6	[36.7,48.7]	Never go to dentist (n=332)	43.5	[36.9,50.4]	Never go to dentist (n=146)	42.6	[33.3,52.4]
missing (n=56)	9.0	[2.6,26.8]	missing (n=52)	7.3	[1.7,26.7]	missing (n=20)	0.0	
Design-based F(3.50, 556.16) = 30.7634 Pr = 0.000			**Design-based F(3.46, 536.66) = 25.0290 Pr = 0.000**			**Design-based F(3.75, 574.27) = 21.2913 Pr = 0.000**		
Most recent flu shot			**Most recent flu shot**			**Most recent flu shot**		
Within past year (n=1,892)	74.6	[72.0,77.1]	Within past year (n=1,711)	76.2	[73.4,78.7]	Within past year (n=644)	76.6	[72.9,80.0]
Within past two years (n=348)	61.1	[53.6,68.2]	Within past two years (n=307)	63.5	[56.2,70.3]	Within past two years (n=131)	66.3	[53.7,76.9]
More than two years (n=354)	56.6	[50.4,62.6]	More than two years (n=326)	55.3	[48.9,61.5]	More than two years (n=109)	52.2	[41.5,62.6]
Never received flu shot (n=1,046)	48.3	[43.5,53.2]	Never received flu shot (n=935)	50.5	[45.2,55.8]	Never received flu shot (n=349)	42.4	[34.9,50.3]
missing (n=111)	24.9	[15.3,37.8]	missing (n=96)	24.3	[14.2,38.4]	missing (n=39)	13.0	[4.2,33.5]
Design-based F(3.62, 576.28) = 38.8891 Pr = 0.000			**Design-based F(3.49, 541.61) = 36.5583 Pr = 0.000**			**Design-based F(3.34, 511.74) = 25.7139 Pr = 0.000**		

Table 4.4 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Perceived health status			**Perceived health status**			**Perceived health status**		
Excellent (n=736)	62.0	[56.5,67.1]	Excellent (n=713)	62.3	[56.8,67.6]	Excellent (n=253)	57.9	[50.3,65.2]
Very good (n=1,230)	65.7	[61.5,69.7]	Very good (n=1,182)	66.2	[61.9,70.2]	Very good (n=447)	66.1	[59.7,72.1]
Good (n=1,064)	62.9	[58.3,67.3]	Good (n=963)	64.5	[59.9,68.8]	Good (n=345)	61.5	[53.1,69.3]
Fair/Poor (n=713)	61.1	[56.8,65.3]	Fair/Poor (n=509)	66.4	[61.0,71.4]	Fair/Poor (n=224)	62.7	[55.1,69.7]
missing (n=8)	15.4	[2.7,54.6]	missing (n=8)	15.4	[2.7,54.6]	missing (n=3)	54.4	[6.8,95.1]
Design-based F(3.14, 499.29) = 1.5012 Pr = 0.212			**Design-based F(3.01, 466.09) = 1.3615 Pr = 0.254**			**Design-based F(3.48, 532.52) = 0.9510 Pr = 0.425**		
Have any personal non-CRC cancer history			**Have any personal non-CRC cancer history**			**Have any personal non-CRC cancer history**		
No (n=3,139)	60.2	[57.6,62.7]	No (n=2,801)	61.6	[58.7,64.3]	No (n=1,082)	58.9	[54.7,62.9]
Yes (n=611)	77.3	[72.1,81.8]	Yes (n=573)	78.4	[73.0,83.0]	Yes (n=190)	81.3	[73.8,87.0]
missing (n=1)	0.0		missing (n=1)	0.0		missing (n=0)	0.0	
Design-based F(1.21, 192.20) = 32.0869 Pr = 0.000			**Design-based F(1.18, 183.16) = 26.8255 Pr = 0.000**			**Design-based F(., .) = . Pr = . ****		
Quan et al.'s updated Charlson comorbidity index			**Quan et al.'s updated Charlson comorbidity index**			**Quan et al.'s updated Charlson comorbidity index**		
0 (n=2,419)	60.0	[57.2,62.7]	0 (n=2,268)	61.3	[58.5,64.1]	0 (n=841)	57.7	[52.9,62.4]
1 (n=709)	64.4	[59.8,68.7]	1 (n=590)	66.2	[61.3,70.9]	1 (n=239)	66.8	[59.3,73.5]
2 (n=391)	76.3	[70.9,80.9]	2 (n=334)	79.1	[72.9,84.2]	2 (n=115)	83.5	[75.3,89.3]
3+ (n=232)	72.6	[63.6,80.1]	3+ (n=183)	75.1	[64.9,83.1]	3+ (n=77)	73.0	[61.5,82.1]
Design-based F(2.76, 438.78) = 11.7138 Pr = 0.000			**Design-based F(2.72, 421.43) = 11.4085 Pr = 0.000**			**Design-based F(2.85, 435.50) = 11.2565 Pr = 0.000**		

Table 4.4 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Smoking status			**Smoking status**			**Smoking status**		
Non-smoker (n=3,019)	66.1	[63.5,68.7]	Non-smoker (n=2,735)	67.5	[64.8,70.1]	Non-smoker (n=1,040)	65.1	[61.0,69.0]
Current Smoker (n=394)	50.7	[45.0,56.3]	Current Smoker (n=334)	52.6	[46.2,59.0]	Current Smoker (n=120)	49.8	[41.2,58.3]
missing (n=338)	48.8	[40.9,56.7]	missing (n=306)	50.2	[41.9,58.5]	missing (n=112)	47.5	[33.7,61.8]
Design-based F(1.98, 315.15) = 21.9931 Pr = 0.000			**Design-based F(1.97, 304.65) = 19.1647 Pr = 0.000**			**Design-based F(1.70, 259.74) = 8.3114 Pr = 0.001**		
BMI categories			**BMI categories**			**BMI categories**		
Underweight (n=29)	44.7	[25.3,65.9]	Underweight (n=22)	40.5	[19.7,65.3]	Underweight (n=13)	32.4	[11.4,64.2]
Normal weight (n=1,025)	59.1	[55.1,63.1]	Normal weight (n=948)	60.5	[56.3,64.5]	Normal weight (n=341)	57.6	[50.9,64.0]
Overweight (n=1,419)	63.4	[59.9,66.8]	Overweight (n=1,289)	64.6	[61.1,67.9]	Overweight (n=478)	62.7	[56.4,68.6]
Obese (n=1,184)	68.9	[65.3,72.3]	Obese (n=1,034)	71.0	[67.1,74.6]	Obese (n=411)	69.3	[62.3,75.5]
missing (n=94)	44.4	[30.9,58.8]	missing (n=82)	47.1	[32.7,62.0]	missing (n=29)	32.3	[14.2,57.9]
Design-based F(3.67, 583.03) = 6.7332 Pr = 0.000			**Design-based F(3.70, 574.27) = 7.0084 Pr = 0.000**			**Design-based F(3.55, 542.76) = 4.2589 Pr = 0.003**		

Table 4.4 (cont.)

Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Household income as a percentage of the federal poverty level			**Household income as a percentage of the federal poverty level**			**Household income as a percentage of the federal poverty level**		
Poor/Negative (<100%) (n=353)	51.1	[43.0,59.2]	Poor/Negative (<100%) (n=192)	58.5	[47.5,68.8]	Poor/Negative (<100%) (n=125)	57.0	[43.6,69.4]
Near poor/Low income (100-200%) (n=606)	52.8	[46.8,58.8]	Near poor/Low income (100-200%) (n=478)	56.1	[49.5,62.4]	Near poor/Low income (100-200%) (n=219)	55.2	[45.1,64.8]
Middle Income (200-400%) (n=1,107)	61.1	[57.0,65.0]	Middle Income (200-400%) (n=1,035)	61.7	[57.4,65.8]	Middle Income (200-400%) (n=373)	56.7	[48.7,64.4]
High Income (>400%) (n=1,685)	68.3	[65.0,71.5]	High Income (>400%) (n=1,670)	68.3	[64.9,71.5]	High Income (>400%) (n=555)	68.1	[62.5,73.2]
Design-based F(2.79, 444.14) = 12.1090 Pr = 0.000			**Design-based F(2.90, 449.90) = 6.2798 Pr = 0.000**			**Design-based F(2.87, 439.12) = 3.3720 Pr = 0.020**		
Educational attainment			**Educational attainment**			**Educational attainment**		
Less than a HSD (n=714)	48.0	[40.8,55.2]	Less than a HSD (n=524)	51.6	[43.2,59.8]	Less than a HSD (n=224)	52.1	[41.4,62.6]
HSD/GED (n=1,581)	60.4	[56.8,63.9]	HSD/GED (n=1,462)	62.0	[58.0,65.9]	HSD/GED (n=509)	58.4	[52.2,64.3]
Bachelor's (n=638)	66.7	[61.8,71.4]	Bachelor's (n=608)	67.1	[62.1,71.8]	Bachelor's (n=240)	61.5	[53.7,68.7]
Graduate/Doctorate Degree (n=432)	74.2	[66.8,80.5]	Graduate/Doctorate Degree (n=420)	74.0	[66.6,80.2]	Graduate/Doctorate Degree (n=172)	73.7	[65.2,80.7]
Other Degree (n=338)	71.7	[65.8,77.0]	Other Degree (n=318)	71.9	[65.7,77.4]	Other Degree (n=110)	76.2	[65.5,84.3]
missing (n=48)	20.0	[10.2,35.5]	missing (n=43)	21.0	[10.7,37.0]	missing (n=17)	24.8	[10.5,47.9]
Design-based F(3.85, 612.62) = 11.6172 Pr = 0.000			**Design-based F(3.87, 600.45) = 8.2979 Pr = 0.000**			**Design-based F(3.45, 527.53) = 5.5011 Pr = 0.001**		

Table 4.4 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Number of months insured in survey year			**Number of months insured in survey year**			**Number of months insured in survey year**		
1-6 (n=161)	41.1	[29.5,53.7]	1-6 (n=120)	43.1	[30.3,56.8]	1-6 (n=51)	41.2	[23.9,60.9]
7-11 (n=206)	37.2	[26.6,49.2]	7-11 (n=150)	42.8	[30.0,56.6]	7-11 (n=72)	44.9	[31.0,59.7]
12 (n=3,384)	65.4	[62.9,67.8]	12 (n=3,105)	66.4	[63.7,69.0]	12 (n=1,149)	64.2	[59.9,68.2]
Design-based F(2.00, 317.50) = 19.3913 Pr = 0.000			**Design-based F(1.99, 308.98) = 12.0756 Pr = 0.000**			**Design-based F(1.91, 291.62) = 6.1270 Pr = 0.003**		
Number of outpatient provider visits in year including physicians PAs and NPs			**Number of outpatient provider visits in year including physicians PAs and NPs**			**Number of outpatient provider visits in year including physicians PAs and NPs**		
0 (n=827)	36.9	[32.4,41.6]	0 (n=759)	37.7	[33.1,42.5]	0 (n=290)	37.5	[30.7,44.7]
1 (n=526)	56.3	[51.5,60.9]	1 (n=497)	56.8	[51.9,61.5]	1 (n=183)	53.8	[43.9,63.4]
2 (n=486)	65.2	[59.7,70.4]	2 (n=453)	66.3	[60.8,71.5]	2 (n=158)	61.8	[52.0,70.8]
3 (n=361)	67.8	[62.5,72.7]	3 (n=337)	69.6	[64.5,74.2]	3 (n=118)	61.5	[51.7,70.5]
4 (n=271)	69.8	[61.8,76.7]	4 (n=245)	72.1	[64.1,78.9]	4 (n=90)	69.8	[57.2,80.0]
5+ (n=1,280)	75.8	[72.0,79.2]	5+ (n=1,084)	78.8	[74.7,82.3]	5+ (n=433)	77.5	[72.1,82.1]
Design-based F(4.29, 682.48) = 42.3014 Pr = 0.000			**Design-based F(4.23, 655.47) = 45.3505 Pr = 0.000**			**Design-based F(4.29, 655.64) = 16.9422 Pr = 0.000**		
Had a usual source of care			**Had a usual source of care**			**Had a usual source of care**		
No (n=415)	37.3	[31.1,43.9]	No (n=360)	39.1	[32.9,45.7]	No (n=136)	35.2	[24.7,47.3]
Yes (n=3,270)	66.4	[63.8,69.0]	Yes (n=2,954)	67.9	[65.0,70.7]	Yes (n=1,112)	65.7	[61.6,69.6]
missing (n=66)	28.4	[14.0,49.0]	missing (n=61)	28.0	[13.4,49.5]	missing (n=24)	23.2	[7.2,54.2]
Design-based F(1.99, 317.08) = 49.8483 Pr = 0.000			**Design-based F(2.00, 309.76) = 47.8755 Pr = 0.000**			**Design-based F(1.96, 300.19) = 19.0388 Pr = 0.000**		

Table 4.4 (cont.)

Full MEPS 2009-2011 sample			Full MEPS 2009-2011 sample			Full MEPS 2009-2011 sample		
Year			**Year**			**Year**		
2009 (n=1,283)	62.7	[59.6,65.8]	2009 (n=1,153)	64.3	[61.1,67.3]	2009 (n=0)	0.0	
2010 (n=1,196)	64.6	[61.4,67.7]	2010 (n=1,084)	66.0	[62.5,69.3]	2010 (n=0)	0.0	
2011 (n=1,272)	62.5	[58.3,66.6]	2011 (n=1,138)	64.0	[59.5,68.3]	2011 (n=1,272)	62.5	[58.3,66.6]
Design-based F(1.72, 273.78) = 0.5828 Pr = 0.534			**Design-based F(1.70, 264.08) = 0.4995 Pr = 0.578**					
Insurance Features								
Insurance had a DPN			**Coverage was restricted to a DPN**			**Household had a FSA**		
No (n=1,596)	66.0	[61.9,69.8]	No (n=2,469)	64.7	[61.1,68.2]	No (n=1,130)	62.0	[57.4,66.5]
Yes (n=2,048)	61.6	[59.0,64.3]	Yes (n=903)	65.1	[60.9,69.0]	Yes (n=101)	71.9	[58.9,82.0]
missing (n=107)	51.3	[38.1,64.3]	missing (n=3)	0.0		missing (n=41)	39.7	[21.5,61.3]
Design-based F(1.86, 294.98) = 3.6761 Pr = 0.030			**Design-based F(1.34, 207.11) = 0.4138 Pr = 0.579**			**Design-based F(1.85, 282.90) = 2.9640 Pr = 0.057***		
Insurance used gatekeeping								
No (n=1,989)	64.1	[60.1,67.8]						
Yes (n=1,667)	62.9	[59.1,66.5]						
missing (n=95)	50.6	[36.9,64.3]						
Design-based F(1.79, 284.65) = 1.2425 Pr = 0.288								

Table 4.4 (cont.)

Full MEPS 2009-2011 sample		
Cost-sharing categories for Aim 2 main analysis full sample		
0.0% (n=216)	43.2	[34.2,52.7]
0.1 to 13.9% (n=1,127)	68.6	[64.9,72.2]
14.0 to 32.3% (n=972)	72.1	[68.3,75.7]
32.3 to 88.4% (n=974)	63.5	[59.3,67.5]
88.4 to 100% (n=172)	35.2	[28.1,42.9]
No spending in year (n=290)	27.3	[20.4,35.6]
Design-based F(4.48, 712.21) = 33.1234 Pr = 0.000		

* there was not an overall significant difference (p<0.1) for the variable after excluding the missing category
** there was an overall significant difference (p<0.05) for the variable after excluding the missing category

Table 4.5 Aim 2 Bivariate Associations with Likelihood of Having Received CRC Screening in the Past Year for Sensitivity Analysis Samples								
Full MEPS 2009-2011 sample of those screened in previous year and those not up-to-date with recommended CRC screening			**Reduced MEPS 2009-2011 sample excluding those age 50-64 with only public insurance**			**Reduced sample of only MEPS 2011**		
	%	**95% CI**		**%**	**95% CI**		**%**	**95% CI**
Total (n=2,591)	**45.7**	**[42.8,48.5]**	**Total (n=2,275)**	**47.0**	**[43.7,50.3]**	**Total (n=848)**	**41.9**	**[37.1,46.8]**
Covariates								
Age groups			**Age groups**			**Age groups**		
50-54 (n=801)	30.6	[25.7,36.0]	50-54 (n=680)	30.7	[25.7,36.3]	50-54 (n=291)	27.7	[23.1,32.9]
55-59 (n=564)	45.0	[38.2,52.1]	55-59 (n=463)	48.1	[40.6,55.7]	55-59 (n=164)	41.9	[30.1,54.6]
60-64 (n=475)	53.8	[47.8,59.6]	60-64 (n=381)	55.8	[49.2,62.1]	60-64 (n=141)	46.1	[34.4,58.3]
65-69 (n=433)	57.8	[50.5,64.8]	65-69 (n=433)	57.8	[50.5,64.8]	65-69 (n=145)	55.6	[45.5,65.2]
70-75 (n=318)	59.3	[52.5,65.8]	70-75 (n=318)	59.3	[52.5,65.8]	70-75 (n=107)	62.4	[53.9,70.2]
Design-based F(2.80, 433.53) = 15.1307 Pr = 0.000			**Design-based F(2.81, 422.01) = 15.0016 Pr = 0.000**			**Design-based F(3.00, 438.58) = 9.0388 Pr = 0.000**		
Sex			**Sex**			**Sex**		
Male (n=1,214)	47.6	[44.1,51.2]	Male (n=1,084)	49.1	[45.0,53.1]	Male (n=396)	43.9	[38.4,49.5]
Female (n=1,377)	43.9	[40.0,47.8]	Female (n=1,191)	45.0	[40.6,49.5]	Female (n=452)	40.1	[34.1,46.4]
Design-based F(1.00, 155.00) = 2.3592 Pr = 0.127			**Design-based F(1.00, 150.00) = 2.2471 Pr = 0.136**			**Design-based F(1.00, 146.00) = 1.2273 Pr = 0.270**		

Table 4.5 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced sample of only MEPS 2011		
White/Ethnicity			**White/Ethnicity**			**White/Ethnicity**		
non-Hispanic white (n=1,635)	47.6	[44.4,50.9]	non-Hispanic white (n=1,515)	48.9	[45.2,52.6]	non-Hispanic white (n=563)	43.3	[37.5,49.2]
Hispanic white (n=956)	37.1	[32.2,42.2]	Hispanic white (n=760)	37.5	[32.1,43.3]	Hispanic white (n=285)	35.9	[30.3,41.8]
Design-based F(1.00, 155.00) = 12.7378 Pr = 0.000			**Design-based F(1.00, 150.00) = 11.7107 Pr = 0.001**			**Design-based F(1.00, 146.00) = 2.8524 Pr = 0.093**		
Marital status			**Marital status**			**Marital status**		
Married (n=1,681)	46.8	[42.5,51.1]	Married (n=1,533)	47.9	[43.4,52.4]	Married (n=558)	41.7	[35.2,48.6]
Widowed (n=175)	54.7	[43.0,66.0]	Widowed (n=155)	56.7	[44.1,68.5]	Widowed (n=51)	55.6	[37.4,72.4]
Divorced/Separated (n=512)	41.8	[36.7,47.1]	Divorced/Separated (n=419)	42.8	[36.6,49.3]	Divorced/Separated (n=167)	43.7	[32.6,55.5]
Never married (n=223)	40.0	[30.2,50.7]	Never married (n=168)	41.0	[30.0,53.1]	Never married (n=72)	31.7	[19.2,47.6]
Design-based F(2.83, 438.34) = 1.6627 Pr = 0.177			**Design-based F(2.83, 424.63) = 1.5494 Pr = 0.203**			**Design-based F(2.75, 401.17) = 1.0634 Pr = 0.361**		
Metropolitan Statistical Area Status			**Metropolitan Statistical Area Status**			**Metropolitan Statistical Area Status**		
Urban (n=2,352)	46.0	[43.0,49.1]	Urban (n=2,072)	47.1	[43.7,50.6]	Urban (n=757)	41.7	[36.8,46.7]
Rural (n=239)	43.0	[35.4,50.9]	Rural (n=203)	45.9	[36.1,56.1]	Rural (n=91)	43.4	[30.1,57.6]
Design-based F(1.00, 155.00) = 0.5333 Pr = 0.466			**Design-based F(1.00, 150.00) = 0.0462 Pr = 0.830**			**Design-based F(1.00, 146.00) = 0.0554 Pr = 0.814**		

Table 4.5 (cont.)								
Full MEPS 2009-2011 sample			**Reduced MEPS 2009-2011 sample**			**Reduced sample of only MEPS 2011**		
Immigration status			**Immigration status**			**Immigration status**		
US born (n=1,849)	47.0	[43.6,50.4]	US born (n=1,690)	48.2	[44.4,52.1]	US born (n=618)	43.7	[38.1,49.6]
Foreign born, lived in US <15 years (n=60)	6.0	[1.2,25.2]	Foreign born, lived in US <15 years (n=48)	6.5	[1.3,27.4]	Foreign born, lived in US <15 years (n=24)	2.8	[0.4,18.5]
Foreign born, lived in US > 15 years (n=654)	43.4	[37.2,49.8]	Foreign born, lived in US > 15 years (n=511)	45.0	[37.3,52.9]	Foreign born, lived in US > 15 years (n=196)	37.0	[29.5,45.2]
missing (n=28)	22.7	[7.8,50.5]	missing (n=26)	24.1	[8.2,53.0]	missing (n=10)	59.2	[18.3,90.4]
Design-based F(2.66, 412.25) = 7.1710 Pr = 0.000			**Design-based F(2.62, 392.39) = 6.1250 Pr = 0.001**			**Design-based F(2.65, 386.92) = 6.4274 Pr = 0.001**		
Whether comfortable speaking English			**Whether comfortable speaking English**			**Whether comfortable speaking English**		
Comfortable (n=2,186)	46.8	[43.6,50.0]	Comfortable (n=1,979)	47.9	[44.4,51.5]	Comfortable (n=724)	42.6	[37.5,47.7]
Not comfortable (n=316)	26.7	[20.6,33.9]	Not comfortable (n=221)	25.9	[18.5,35.1]	Not comfortable (n=99)	25.8	[17.6,36.2]
missing (n=89)	38.3	[26.3,52.0]	missing (n=75)	39.5	[26.7,53.8]	missing (n=25)	61.1	[37.1,80.7]
Design-based F(1.84, 284.59) = 12.4500 Pr = 0.000			**Design-based F(1.78, 267.67) = 10.4856 Pr = 0.000**			**Design-based F(1.98, 289.58) = 5.2244 Pr = 0.006**		
Interview Language			**Interview Language**			**Interview Language**		
English (n=2,136)	47.0	[43.9,50.2]	English (n=1,939)	48.2	[44.7,51.8]	English (n=713)	43.3	[38.2,48.5]
Spanish, Spanish and English, or other (n=455)	28.6	[22.8,35.2]	Spanish, Spanish and English, or other (n=336)	27.3	[21.0,34.6]	Spanish, Spanish and English, or other (n=135)	22.8	[16.1,31.1]
Design-based F(1.00, 155.00) = 22.0192 Pr = 0.000			**Design-based F(1.00, 150.00) = 23.5169 Pr = 0.000**			**Design-based F(1.00, 146.00) = 15.9766 Pr = 0.000**		

Table 4.5 (cont.)

Full MEPS 2009-2011 sample			Reduced MEPS 2009-2011 sample			Reduced sample of only MEPS 2011		
Dental checkup frequency			**Dental checkup frequency**			**Dental checkup frequency**		
Twice a year or more (n=1,074)	57.6	[52.4,62.7]	Twice a year or more (n=1,043)	57.6	[52.3,62.8]	Twice a year or more (n=345)	57.9	[49.6,65.7]
Once a year (n=580)	42.2	[37.0,47.6]	Once a year (n=517)	42.6	[36.9,48.6]	Once a year (n=195)	31.6	[23.8,40.5]
Less than once a year (n=518)	30.3	[25.5,35.7]	Less than once a year (n=400)	30.9	[25.5,36.9]	Less than once a year (n=178)	26.3	[19.1,35.1]
Never go to dentist (n=366)	27.9	[23.4,33.0]	Never go to dentist (n=265)	28.9	[23.6,34.8]	Never go to dentist (n=110)	20.0	[14.2,27.3]
missing (n=53)	1.1	[0.1,8.0]	missing (n=50)	1.2	[0.2,8.2]	missing (n=20)	0.0	
Design-based F(2.81, 435.37) = 32.4849 Pr = 0.000			**Design-based F(2.95, 443.22) = 28.1272 Pr = 0.000**			**Design-based F(3.24, 472.92) = 16.4994 Pr = 0.000**		
Most recent flu shot			**Most recent flu shot**			**Most recent flu shot**		
Within past year (n=1,215)	59.9	[56.5,63.1]	Within past year (n=1,070)	61.5	[57.8,65.0]	Within past year (n=392)	59.7	[55.0,64.3]
Within past two years (n=226)	42.7	[34.5,51.3]	Within past two years (n=190)	45.3	[36.3,54.6]	Within past two years (n=75)	40.2	[24.0,58.7]
More than two years (n=249)	36.7	[28.8,45.5]	More than two years (n=232)	36.5	[28.1,45.8]	More than two years (n=79)	35.3	[23.5,49.2]
Never received flu shot (n=803)	30.4	[25.4,35.8]	Never received flu shot (n=699)	31.9	[26.5,37.8]	Never received flu shot (n=266)	22.2	[16.5,29.2]
missing (n=98)	11.1	[4.3,25.6]	missing (n=84)	8.4	[2.1,28.5]	missing (n=36)	5.8	[1.3,22.0]
Design-based F(3.65, 565.00) = 27.7441 Pr = 0.000			**Design-based F(3.47, 521.01) = 23.5668 Pr = 0.000**			**Design-based F(3.44, 502.74) = 17.7983 Pr = 0.000**		

Table 4.5 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Perceived health status			**Perceived health status**			**Perceived health status**		
Excellent (n=467)	41.6	[34.8,48.6]	Excellent (n=447)	41.9	[35.1,49.0]	Excellent (n=172)	39.2	[31.0,48.1]
Very good (n=838)	48.5	[43.9,53.1]	Very good (n=800)	49.1	[44.4,53.8]	Very good (n=286)	43.4	[36.2,51.0]
Good (n=751)	46.3	[41.7,51.1]	Good (n=665)	47.7	[42.7,52.7]	Good (n=231)	40.3	[31.0,50.4]
Fair/Poor (n=527)	44.4	[39.4,49.5]	Fair/Poor (n=355)	48.6	[41.6,55.6]	Fair/Poor (n=156)	45.2	[34.9,55.9]
missing (n=8)	15.4	[2.7,54.6]	missing (n=8)	15.4	[2.7,54.6]	missing (n=3)	54.4	[6.8,95.1]
Design-based F(3.14, 487.29) = 1.4754 Pr = 0.219			**Design-based F(3.11, 466.78) = 1.6063 Pr = 0.185**			**Design-based F(3.48, 507.44) = 0.3121 Pr = 0.845**		
Have any personal non-CRC cancer history			**Have any personal non-CRC cancer history**			**Have any personal non-CRC cancer history**		
No (n=2,221)	41.9	[39.1,44.8]	No (n=1,938)	43.1	[39.9,46.4]	No (n=748)	38.4	[34.1,42.8]
Yes (n=369)	64.0	[57.8,69.8]	Yes (n=336)	65.1	[58.3,71.4]	Yes (n=100)	64.5	[51.1,75.9]
missing (n=1)	0.0		missing (n=1)	0.0		missing (n=0)	0.0	
Design-based F(1.32, 204.22) = 45.0785 Pr = 0.000			**Design-based F(1.28, 192.69) = 38.0901 Pr = 0.000**			**Design-based F(., .) = . Pr = . ****		
Quan et al.'s updated Charlson comorbidity index			**Quan et al.'s updated Charlson comorbidity index**			**Quan et al.'s updated Charlson comorbidity index**		
0 (n=1,679)	40.8	[37.5,44.2]	0 (n=1,546)	42.2	[38.7,45.8]	0 (n=574)	36.5	[31.7,41.5]
1 (n=500)	47.9	[43.3,52.5]	1 (n=399)	49.4	[44.0,54.9]	1 (n=166)	49.0	[40.7,57.3]
2 (n=267)	65.8	[57.9,73.0]	2 (n=221)	68.8	[59.1,77.1]	2 (n=64)	68.5	[53.8,80.2]
3+ (n=145)	56.4	[46.7,65.6]	3+ (n=109)	58.8	[47.3,69.5]	3+ (n=44)	53.0	[35.8,69.6]
Design-based F(2.51, 389.08) = 16.8927 Pr = 0.000			**Design-based F(2.50, 374.92) = 14.2369 Pr = 0.000**			**Design-based F(2.64, 385.35) = 8.8260 Pr = 0.000**		

Table 4.5 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Smoking status			**Smoking status**			**Smoking status**		
Non-smoker (n=2,045)	48.8	[45.5,52.2]	Non-smoker (n=1,802)	50.0	[46.3,53.7]	Non-smoker (n=676)	44.4	[39.6,49.2]
Current Smoker (n=281)	31.3	[25.3,38.1]	Current Smoker (n=237)	32.7	[26.2,40.0]	Current Smoker (n=84)	28.8	[19.7,39.9]
missing (n=265)	33.3	[25.5,42.0]	missing (n=236)	34.4	[26.2,43.6]	missing (n=88)	32.7	[18.6,50.9]
Design-based F(1.98, 307.20) = 13.9238 Pr = 0.000			**Design-based F(1.97, 295.34) = 12.6360 Pr = 0.000**			**Design-based F(1.80, 262.13) = 3.3220 Pr = 0.043**		
BMI categories			**BMI categories**			**BMI categories**		
Underweight (n=20)	20.4	[9.8,37.7]	Underweight (n=16)	16.1	[4.3,45.0]	Underweight (n=10)	19.7	[4.1,58.3]
Normal weight (n=701)	40.5	[35.5,45.7]	Normal weight (n=634)	41.5	[36.2,47.0]	Normal weight (n=220)	35.1	[28.8,42.1]
Overweight (n=974)	46.3	[42.4,50.3]	Overweight (n=862)	47.1	[42.8,51.5]	Overweight (n=321)	41.9	[34.4,49.7]
Obese (n=823)	52.3	[47.9,56.6]	Obese (n=701)	54.7	[49.7,59.6]	Obese (n=274)	51.1	[41.6,60.4]
missing (n=73)	24.4	[13.0,41.1]	missing (n=62)	26.6	[14.2,44.3]	missing (n=23)	10.2	[2.3,35.3]
Design-based F(2.97, 459.73) = 7.1376 Pr = 0.000			**Design-based F(3.11, 466.48) = 6.7012 Pr = 0.000**			**Design-based F(3.04, 443.26) = 3.9143 Pr = 0.009**		

Table 4.5 (cont.)

Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Household income as a percentage of the federal poverty level			**Household income as a percentage of the federal poverty level**			**Household income as a percentage of the federal poverty level**		
Poor/Negative (<100%) (n=277)	37.0	[29.9,44.8]	Poor/Negative (<100%) (n=143)	41.4	[29.7,54.2]	Poor/Negative (<100%) (n=93)	39.6	[27.8,52.6]
Near poor/Low income (100-200%) (n=472)	37.6	[31.5,44.1]	Near poor/Low income (100-200%) (n=362)	40.3	[32.9,48.2]	Near poor/Low income (100-200%) (n=157)	35.3	[24.5,47.7]
Middle Income (200-400%) (n=780)	43.0	[37.9,48.2]	Middle Income (200-400%) (n=719)	43.3	[38.0,48.7]	Middle Income (200-400%) (n=260)	36.2	[27.6,45.6]
High Income (>400%) (n=1,062)	50.6	[45.8,55.4]	High Income (>400%) (n=1,051)	50.7	[45.9,55.5]	High Income (>400%) (n=338)	47.4	[39.7,55.2]
Design-based F(2.92, 453.25) = 5.5083 Pr = 0.001			**Design-based F(2.95, 442.35) = 2.9773 Pr = 0.032**			**Design-based F(2.82, 412.20) = 1.8679 Pr = 0.138**		
Educational attainment			**Educational attainment**			**Educational attainment**		
Less than a HSD (n=583)	31.6	[26.1,37.7]	Less than a HSD (n=413)	33.6	[27.0,40.9]	Less than a HSD (n=168)	26.3	[18.3,36.1]
HSD/GED (n=1,095)	43.0	[38.5,47.6]	HSD/GED (n=996)	44.3	[39.2,49.6]	HSD/GED (n=346)	38.5	[32.5,45.0]
Bachelor's (n=403)	48.3	[41.5,55.2]	Bachelor's (n=382)	48.7	[41.7,55.8]	Bachelor's (n=157)	41.2	[32.7,50.2]
Graduate/Doctorate Degree (n=247)	56.8	[47.5,65.6]	Graduate/Doctorate Degree (n=240)	56.4	[47.0,65.3]	Graduate/Doctorate Degree (n=94)	52.1	[39.4,64.6]
Other Degree (n=217)	57.5	[49.8,64.8]	Other Degree (n=203)	57.5	[49.0,65.6]	Other Degree (n=68)	61.7	[47.7,74.0]
missing (n=46)	17.8	[8.0,35.2]	missing (n=41)	18.7	[8.3,36.7]	missing (n=15)	16.1	[3.0,54.3]
Design-based F(3.96, 613.72) = 7.1938 Pr = 0.000			**Design-based F(3.99, 597.76) = 5.1157 Pr = 0.000**			**Design-based F(4.24, 619.35) = 4.8126 Pr = 0.001**		

Table 4.5 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Number of months insured in survey year			**Number of months insured in survey year**			**Number of months insured in survey year**		
1-6 (n=125)	22.9	[13.9,35.5]	1-6 (n=88)	24.4	[13.9,39.1]	1-6 (n=38)	18.7	[6.2,44.5]
7-11 (n=169)	20.9	[12.1,33.7]	7-11 (n=119)	24.5	[13.3,40.7]	7-11 (n=54)	18.5	[7.2,39.8]
12 (n=2,297)	48.1	[44.9,51.3]	12 (n=2,068)	48.9	[45.3,52.6]	12 (n=756)	44.0	[39.0,49.1]
Design-based F(1.98, 306.56) = 13.7066 Pr = 0.000			**Design-based F(1.97, 295.69) = 8.4935 Pr = 0.000**			**Design-based F(2.00, 291.59) = 4.7499 Pr = 0.009**		
Number of outpatient provider visits in year including physicians PAs and NPs			**Number of outpatient provider visits in year including physicians PAs and NPs**			**Number of outpatient provider visits in year including physicians PAs and NPs**		
0 (n=674)	19.3	[14.8,24.8]	0 (n=614)	20.1	[15.3,25.8]	0 (n=233)	20.1	[14.3,27.5]
1 (n=376)	37.8	[32.2,43.8]	1 (n=353)	38.7	[32.9,44.9]	1 (n=132)	36.9	[26.4,48.7]
2 (n=322)	46.4	[38.9,54.0]	2 (n=294)	47.7	[39.8,55.8]	2 (n=108)	39.5	[29.7,50.2]
3 (n=232)	51.4	[43.7,58.9]	3 (n=211)	53.3	[45.8,60.7]	3 (n=74)	41.1	[28.9,54.5]
4 (n=181)	54.6	[43.4,65.4]	4 (n=157)	56.4	[44.7,67.5]	4 (n=59)	49.0	[33.6,64.6]
5+ (n=806)	61.4	[56.8,65.7]	5+ (n=646)	64.7	[59.3,69.8]	5+ (n=242)	59.3	[50.8,67.3]
Design-based F(4.17, 645.97) = 28.2297 Pr = 0.000			**Design-based F(4.17, 626.12) = 29.1859 Pr = 0.000**			**Design-based F(4.34, 633.99) = 9.9258 Pr = 0.000**		
Had a usual source of care			**Had a usual source of care**			**Had a usual source of care**		
No (n=336)	19.3	[14.4,25.3]	No (n=286)	20.2	[15.0,26.7]	No (n=106)	16.2	[8.6,28.3]
Yes (n=2,195)	49.4	[46.4,52.3]	Yes (n=1,933)	50.8	[47.3,54.2]	Yes (n=721)	45.5	[40.6,50.4]
missing (n=60)	16.4	[4.4,45.2]	missing (n=56)	16.9	[4.6,46.2]	missing (n=21)	8.8	[1.1,45.6]
Design-based F(1.77, 273.70) = 30.6188 Pr = 0.000			**Design-based F(1.80, 269.50) = 28.5074 Pr = 0.000**			**Design-based F(1.95, 285.39) = 12.3316 Pr = 0.000**		

Table 4.5 (cont.)								
Full MEPS 2009-2011 sample			**Full MEPS 2009-2011 sample**			**Full MEPS 2009-2011 sample**		
Year			**Year**			**Year**		
2009 (n=925)	47.4	[42.6,52.2]	2009 (n=811)	48.9	[43.8,54.0]	2009 (n=0)	0.0	
2010 (n=818)	47.6	[43.5,51.8]	2010 (n=725)	48.8	[44.3,53.3]	2010 (n=0)	0.0	
2011 (n=848)	41.9	[37.1,46.8]	2011 (n=739)	43.1	[37.7,48.8]	2011 (n=848)	41.9	[37.1,46.8]
Design-based F(1.61, 248.92) = 2.1301 Pr = 0.131			**Design-based F(1.66, 248.66) = 1.8588 Pr = 0.165**					
Insurance Features								
Insurance had a DPN			**Coverage was restricted to a DPN**			**Household had a FSA**		
No (n=1,040)	45.4	[40.8,50.1]	No (n=1,621)	44.7	[40.4,49.0]	No (n=759)	41.7	[36.7,47.0]
Yes (n=1,468)	46.3	[42.9,49.7]	Yes (n=651)	53.1	[47.5,58.6]	Yes (n=58)	49.7	[33.0,66.5]
missing (n=83)	34.2	[22.6,48.0]	missing (n=3)	0.0		missing (n=31)	20.4	[8.1,42.7]
Design-based F(1.75, 270.70) = 1.1566 Pr = 0.311			**Design-based F(1.32, 197.29) = 4.2290 Pr = 0.030**			**Design-based F(1.70, 247.75) = 1.7669 Pr = 0.178**		
Insurance used gatekeeping								
No (n=1,290)	42.5	[37.8,47.4]						
Yes (n=1,228)	49.9	[45.4,54.4]						
missing (n=73)	32.9	[21.0,47.5]						
Design-based F(1.61, 249.64) = 3.6949 Pr = 0.035								

Table 4.5 (cont.)

Full MEPS 2009-2011 sample		
Cost-sharing categories for Aim 2 sensitivity analysis full sample		
0.0% (n=156)	24.9	[16.7,35.5]
0.1 to 13.0% (n=759)	54.3	[50.0,58.4]
13.1 to 32.3% (n=647)	56.0	[51.0,60.8]
32.3 to 93.1% (n=659)	43.0	[37.9,48.2]
93.1 to 100% (n=116)	14.5	[8.7,23.1]
No spending in year (n=254)	11.7	[7.6,17.7]
Design-based F(4.55, 705.07) = 28.8871 Pr = 0.000		

** there was an overall significant difference (p<0.05) for the variable after excluding the missing category

a very wide confidence interval (3.5 to 40.0%).

Some variables that had significant variation, but of a small difference, in the Aim 1 sample were not significant in the Aim 2 sample, which had about one-sixth the sample size as the full Aim 1 sample 3,751 vs. 21,085. In the Aim 2 full sample and both reduced samples, screening likelihood did not significantly vary depending on urban vs. rural MSA designation, perceived health status, or survey year.

Bivariate associations for the Aim 2 sensitivity analysis for the binary outcome of had received any CRC screening in the previous year vs. was not up-to-date with recommended screening were generally consistent with the main analysis findings (Table 4.5). Notably, in the sensitivity analyses marital status no longer predicted significant variation in screening likelihood as it had in the main analyses. In the sensitivity analyses, foreign born persons who had lived in the US for less than 15 years were predicted to have a 6.0% likelihood of having received screening in the previous year in the full sample for the Aim 2 sensitivity analysis, and only a 2.8% likelihood in the reduced sample of only MEPS 2011. Those estimates were 13.4 and 14.5% for the same samples of the main analyses, respectively. In the Aim 2 sensitivity analysis, the overall significance tests for the bivariate associations for the insurance features switched from the findings for the main analyses' samples. In the sensitivity analyses' samples, having a DPN was no longer significant, while each having insurance that used gatekeeping and having insurance with coverage that was restricted to a DPN was significant.

Multivariate Logistic Regression Model Specifications

Covariate Effects

In the first part of the multivariate logistic regression procedure, the covariates from the bivariate analyses were fit into blocks of substantively related variables, with a separate model fitting for each unique sample used in the main and sensitivity analyses for Aims 1 and 2. Although generally similar overall (Table 4.6), the covariates included in each block varied some across the 10 analytic samples. The prevention history and health care access blocks were consistent across the samples, while the education and income block was consistent except for the two Aim 2 sensitivity analysis samples, which dropped the income variable. In all samples, the health/lifestyle block included all covariates minus perceived health status, except for two samples that did not drop perceived health status. The sociodemographics block had the most variation in included covariates: MEPS interview language was dropped from the block in all samples; census regions were dropped in four of the six applicable Aim 1 samples; and urban vs. rural residence and whether comfortable speaking English were dropped in five and six of the ten samples, respectively. For the covariates that remained following the first step of the multivariate logistic regression procedure, collinearity diagnostics indicated no collinearity, so no covariates were excluded due to collinearity. The collinearity diagnostics revealed that there were no Western Hispanics who had an FSA in MEPS 2011, so the FSA variable was not assessed for the Aim 2 main or sensitivity analyses.

Table 4.7 reports multivariate-adjusted screening likelihoods across the levels of covariates for the full set of covariates controlled for in the analyses of each of the full samples (the full sample is the first row for each Aim's main and sensitivity analyses in Table 4.6). For centered age (age minus 50) and squared centered age the predicted continuous change in screening likelihood for each one year of age or squared age change is reported. Covariates that are blank in the table were dropped from the covariate block as either noted in Table 4.6 or were not applicable to a particular analysis (census region and race/Hispanic ethnicity for Aim 2 and Hispanic ethnicity for Aim 1).

Table 4.6 Covariates Included/Dropped in Blocks for each Multivariate Logistic Regression Analysis

Analyses	Sample and Insurance Features Analyzed	Covariate Blocks†					
		Sociodemographics		Education and income		Health/lifestyle	
		Included	Dropped	Included	Dropped	Included	Dropped
Aim 1 main analyses	**Full MEPS 2009-2011 Sample:** Whether insurance had DPN; Whether insurance used gatekeeping; and Cost-sharing categories	Age and Age^2; Sex; Race/Hispanic ethnicity; Urban vs. rural residence; Marital status; Immigration categories; and Whether comfortable speaking English	Census regions*; and MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Perceived health status; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	-
Aim 1 Sensitivity Analyses with previous year CRC screening outcome	**Full MEPS 2009-2011 Sample:** Whether insurance had DPN; Whether insurance used gatekeeping; and Cost-sharing categories	Age and Age^2; Sex; Race/Hispanic ethnicity; Marital status; Census regions; Urban vs. rural residence; Marital status; Immigration categories; and Whether comfortable speaking English	MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*

Table 4.6 (cont.)		Sociodemographics		Education and income		Health/lifestyle	
Analyses	**Sample**	**Included**	**Dropped**	**Included**	**Dropped**	**Included**	**Dropped**
Aim 1 main analyses	**Reduced MEPS 2009-2011 Sample excluding those age 50-64 with only public insurance:** Whether insurance restricted coverage to DPN	Age and Age^2; Sex; Race/Hispanic ethnicity; Urban vs. rural residence; Marital status; Immigration categories; and Whether comfortable speaking English	Census regions*; and MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*
Aim 1 Sensitivity Analyses with previous year CRC screening outcome	**Reduced MEPS 2009-2011 Sample excluding those age 50-64 with only public insurance:** Whether insurance restricted coverage to DPN	Age and Age^2; Sex; Race/Hispanic ethnicity; Marital status; Census regions; Urban vs. rural residence; Immigration categories; and Whether comfortable speaking English	MEPS interview language*	Educational attainment and FPL categories	-	Charlson comorbidity index; Perceived health status; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	-

Table 4.6 (cont.)		Sociodemographics		Education and income		Health/lifestyle	
Analyses	**Sample**	**Included**	**Dropped**	**Included**	**Dropped**	**Included**	**Dropped**
Aim 1 main analyses	**Reduced MEPS 2011 Sample:** Whether respondent had FSA in 2011	Age and Age^2; Sex; Race/Hispanic ethnicity; Marital status; and Immigration categories	Census regions*; Urban vs. rural residence*; Whether comfortable speaking English; and MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*
Aim 1 Sensitivity Analyses with previous year CRC screening outcome	**Reduced MEPS 2011 Sample:** Whether respondent had FSA in 2011	Age and Age^2; Sex; Race/Hispanic ethnicity; Marital status; Urban vs. rural residence; and Immigration categories	Census regions*; Whether comfortable speaking English; and MEPS interview language*	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*
Aim 2 main analyses**	**Full MEPS 2009-2011 Sample:** Whether insurance had DPN; Whether insurance used gatekeeping; and Cost-sharing categories	Age and Age^2; Sex; and Immigration categories	Urban vs. rural residence;* Marital status; Whether comfortable speaking English; and MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*

Table 4.6 (cont.)		Sociodemographics		Education and income		Health/lifestyle	
Analyses	**Sample**	**Included**	**Dropped**	**Included**	**Dropped**	**Included**	**Dropped**
Aim 2 Sensitivity Analyses with previous year CRC screening outcome	**Full MEPS 2009-2011 Sample:** Whether insurance had DPN; Whether insurance used gatekeeping; and Cost-sharing categories	Age and Age^2; Sex; and Immigration categories	Marital status; Urban vs. rural residence; Whether comfortable speaking English; and MEPS interview language	Educational attainment	FPL categories	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*
Aim 2 main analyses**	**Reduced MEPS 2009-2011 Sample excluding those age 50-64 with only public insurance:** Whether insurance restricted coverage to DPN	Age and Age^2; Sex; and Immigration categories	Urban vs. rural residence;* Marital status; Whether comfortable speaking English; and MEPS interview language	Educational attainment and FPL categories	-	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*

Table 4.6 (cont.)		Sociodemographics		Education and income		Health/lifestyle	
Analyses	**Sample**	**Included**	**Dropped**	**Included**	**Dropped**	**Included**	**Dropped**
Aim 2 Sensitivity Analyses with previous year CRC screening outcome	**Reduced MEPS 2009-2011 Sample excluding those age 50-64 with only public insurance:** Whether insurance restricted coverage to DPN	Age and Age^2; Sex; and Immigration categories	Marital status; Urban vs. rural residence; Whether comfortable speaking English; and MEPS interview language	Educational attainment	FPL categories	Charlson comorbidity index; Whether ever had non-CRC cancer diagnosis; Smoking status; and BMI categories	Perceived health status*
†The prevention history block consistently included the same two variables: dental checkup frequency and time since most recent flu shot. The health care access block consistently included the same three variables: survey year insurance duration; Number of outpatient provider visits; and Whether had a usual source of care.							
* Covariate was dropped after having non-significant ($p<0.1$) bivariate association with CRC screening outcome and was not included in multivariate analyses							

Table 4.7 Multivariate Adjusted Predicted Effects and Likelihoods of CRC Screening for Fully Adjusted Models Including All Covariates Without Insurance Features

Covariates	Table 4.7a: Aim 1 Main Analysis		Table 4.7b: Aim 1 Sensitivity Analysis		Table 4.7c: Aim 2 Main Analysis		Table 4.7d: Aim 2 Sensitivity Analysis	
	Predicted continuous change in likelihood of being up-to-date with CRC screening	95% Confidence Interval	Predicted continuous change in likelihood of Having Received CRC screening in the Previous Year	95% Confidence Interval	Predicted continuous change in likelihood of being up-to-date with CRC screening	95% Confidence Interval	Predicted continuous change in likelihood of Having Received CRC screening in the Previous Year	95% Confidence Interval
Centered age	2.68%*	2.26% to 3.10%	2.10%*	1.58% to 2.63%	3.16%*	1.98% to 4.34%	2.87%*	1.30% to 4.45%
Squared centered age	-0.08%*	-0.09% to -0.06%	-0.05%*	-0.08% to -0.03%	-0.09%*	-0.14% to -0.04%	-0.08%*	-0.15% to -0.02%
	Predicted likelihood of being up-to-date with CRC screening	95% Confidence Interval	Predicted likelihood of having received CRC screening in previous year	95% Confidence Interval	Predicted likelihood of being up-to-date with CRC screening	95% Confidence Interval	Predicted likelihood of having received CRC screening in previous year	95% Confidence Interval
Full Sample	62.50%	61.3% to 63.8%	40.30%	39.0% to 41.7%	63.30%	60.8% to 65.8%	45.70%	42.8% to 48.5%

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Sex								
Male	65.4%*	63.8% to 66.9%	44.0%*	42.2% to 45.9%	66.7%*	63.6% to 69.7%	49.7%*	46.1% to 53.3%
Female	60.00%	58.4% to 61.5%	37.20%	35.6% to 38.9%	60.20%	57.1% to 63.2%	42.20%	38.3% to 46.2%
Race/Hispanic Ethnicity								
REF: Non-Hispanic white	62.30%	60.8% to 63.7%	39.20%	37.6% to 40.8%				
Hispanic white	61.60%	58.4% to 64.7%	42.40%	38.7% to 46.2%				
Non-Hispanic black	68.7%*	66.7% to 70.8%	51.1%*	48.5% to 53.7%				
Non-Hispanic Asian	54.6%*	50.3% to 58.8%	32.3%*	27.6% to 37.0%				
Other	59.60%	54.1% to 65.1%	35.20%	29.9% to 40.6%				
Hispanic ethnicity								
REF: Non-Hispanic white					64.10%	61.3% to 66.8%	46.00%	43.2% to 48.8%
Hispanic white					59.70%	54.3% to 65.1%	44.10%	37.8% to 50.4%
Census region								
REF: Northeast			38.80%	36.2% to 41.5%				
Midwest			38.10%	35.6% to 40.6%				
South			39.70%	37.5% to 41.9%				
West			44.6%*	42.4% to 46.8%				
MSA Designation								
Urban	63.1%*	61.7% to 64.5%	40.9%*	39.4% to 42.4%				
Rural	60.10%	57.5% to 62.7%	37.60%	34.7% to 40.4%				

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Marital Status								
REF: Married	63.20%	61.6% to 64.7%	40.90%	39.3% to 42.6%				
Widowed	64.90%	62.0% to 67.9%	42.90%	39.4% to 46.4%				
Divorced/Separated	61.60%	59.6% to 63.6%	38.90%	36.8% to 41.1%				
Never married	57.0%*	54.0% to 60.0%	36.1%*	32.6% to 39.5%				
Immigration Status								
REF: US born	62.80%	61.4% to 64.1%	40.20%	38.7% to 41.7%	63.80%	61.1% to 66.5%	45.50%	42.1% to 48.8%
Foreign born, lived in the US <15 years	50.1%*	43.1% to 57.2%	29.1%*	21.6% to 36.5%	32.9%*	6.1% to 59.7%	15.3%*	-2.2% to 32.8%
Foreign born, lived in the US >15 years	62.40%	59.2% to 65.6%	42.90%	39.0% to 46.7%	62.80%	57.7% to 67.9%	49.00%	42.5% to 55.5%
missing	63.10%	48.8% to 77.4%	44.70%	24.2% to 65.2%	55.60%	5.4% to 105.8%	42.50%	-19.1% to 104.2%
Whether comfortable speaking English								
REF: Comfortable	62.60%	61.3% to 63.8%	40.40%	39.0% to 41.8%				
Not comfortable	61.60%	56.7% to 66.5%	38.60%	33.4% to 43.8%				
missing	62.40%	55.9% to 69.0%	38.60%	29.8% to 47.4%				
Educational attainment								
Less than a HSD	57.9%*	54.9% to 60.9%	36.4%*	33.3% to 39.4%	59.80%	53.6% to 66.0%	38.2%*	31.3% to 45.1%
REF: HSD/GED	61.90%	60.3% to 63.4%	39.80%	38.1% to 41.5%	62.50%	59.3% to 65.7%	46.00%	42.0% to 50.1%
Bachelor's	64.8%*	62.7% to 67.0%	41.80%	39.3% to 44.4%	63.00%	58.6% to 67.4%	44.20%	38.3% to 50.1%
Graduate/Doctoral degree	65.3%*	62.3% to 68.3%	42.80%	39.3% to 46.4%	65.50%	58.8% to 72.2%	47.50%	40.1% to 54.9%
Other Degree	63.30%	60.5% to 66.2%	41.50%	37.9% to 45.1%	69.30%	63.3% to 75.2%	52.70%	44.8% to 60.7%
missing	64.30%	55.7% to 72.9%	43.90%	34.3% to 53.5%	43.4%*	29.9% to 56.8%	36.40%	19.1% to 53.7%

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Household Income as a % of the FPL								
Poor/Negative (<100%)	61.60%	58.7% to 64.4%	39.00%	36.0% to 41.9%	61.00%	54.5% to 67.5%		
Near poor/Low income (100-200%)	58.5%*	56.1% to 60.9%	37.1%*	34.2% to 40.0%	56.8%*	51.2% to 62.4%		
Middle Income (200-400%)	61.70%	59.9% to 63.4%	39.00%	36.6% to 41.3%	64.40%	60.9% to 67.9%		
REF: High Income (>400%)	64.30%	62.7% to 65.9%	42.30%	40.5% to 44.1%	64.70%	61.7% to 67.7%		
Charlson Comorbidity Index								
REF: 0	62.50%	61.1% to 63.9%	40.00%	38.3% to 41.7%	63.50%	60.6% to 66.4%	45.30%	41.9% to 48.7%
1	62.50%	60.2% to 64.7%	40.40%	38.1% to 42.8%	62.00%	58.2% to 65.8%	44.40%	40.1% to 48.6%
2	62.60%	59.7% to 65.5%	41.70%	38.4% to 45.0%	64.20%	58.4% to 70.1%	49.80%	41.9% to 57.7%
3+	63.30%	59.9% to 66.6%	41.00%	37.5% to 44.5%	63.20%	54.8% to 71.7%	45.50%	37.6% to 53.5%
Perceived Health Status								
REF: Excellent	64.10%	62.1% to 66.0%						
Very good	63.50%	61.8% to 65.3%						
Good	61.7%*	60.1% to 63.3%						
Fair/Poor	60.3%*	57.9% to 62.7%						
missing	31.2%*	14.8% to 47.7%						
Whether ever had any non-CRC cancer diagnosis								
REF: No	62.00%	60.7% to 63.3%	39.70%	38.3% to 41.1%	62.80%	60.2% to 65.4%	45.20%	42.3% to 48.0%
Yes	65.7%*	62.9% to 68.6%	43.8%*	40.6% to 47.0%	66.00%	59.8% to 72.2%	48.20%	41.7% to 54.7%
missing	46.50%	-4.2% to 97.2%	37.8%	-15.2% to 90.9%	.		.	

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Smoking status								
REF: Non-smoker	63.40%	62.1% to 64.7%	41.10%	39.6% to 42.6%	64.20%	61.7% to 66.8%	46.90%	43.8% to 49.9%
Current Smoker	59.3%*	56.9% to 61.6%	37.2%*	34.6% to 39.7%	59.80%	54.0% to 65.6%	37.6%*	30.6% to 44.6%
missing	60.70%	57.6% to 63.9%	38.70%	35.0% to 42.5%	58.3%*	51.9% to 64.7%	43.90%	36.1% to 51.8%
BMI categories								
Underweight	61.00%	53.0% to 69.1%	37.60%	27.8% to 47.5%	52.10%	30.5% to 73.7%	25.60%	5.9% to 45.3%
REF: Normal weight	61.40%	59.7% to 63.2%	39.30%	37.4% to 41.2%	59.80%	56.3% to 63.3%	42.00%	38.1% to 46.0%
Overweight	62.90%	61.3% to 64.5%	40.50%	38.7% to 42.2%	63.10%	59.7% to 66.4%	45.80%	42.4% to 49.3%
Obese	63.5%*	61.9% to 65.1%	41.40%	39.5% to 43.4%	67.4%*	64.3% to 70.6%	49.7%*	45.2% to 54.2%
missing	55.3%*	49.9% to 60.7%	34.70%	28.6% to 40.8%	57.60%	47.1% to 68.0%	36.50%	25.8% to 47.1%
Dental checkup frequency								
REF: Twice a year or more	68.70%	67.1% to 70.3%	47.70%	45.7% to 49.7%	69.40%	66.1% to 72.7%	53.50%	48.7% to 58.2%
Once a year	62.1%*	59.9% to 64.4%	39.8%*	37.0% to 42.5%	63.6%*	59.2% to 68.1%	44.5%*	39.3% to 49.7%
Less than once a year	56.5%*	54.3% to 58.7%	31.8%*	29.5% to 34.2%	54.6%*	49.9% to 59.3%	34.5%*	29.8% to 39.1%
Never go to dentist	52.4%*	50.0% to 54.7%	31.4%*	29.0% to 33.7%	47.5%*	42.3% to 52.7%	30.9%*	25.7% to 36.1%
missing	20.3%*	10.9% to 29.8%	8.3%*	2.6% to 14.1%	28.1%*	-0.2% to 56.3%	4.6%*	-5.4% to 14.6%

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Time since last flu shot								
REF: Within past year	67.50%	66.2% to 68.8%	46.10%	44.4% to 47.9%	68.00%	65.1% to 70.9%	51.10%	47.8% to 54.4%
Within past two years	62.2%*	59.4% to 65.0%	40.1%*	36.8% to 43.5%	64.00%	58.0% to 70.1%	45.10%	37.6% to 52.6%
More than two years	59.3%*	56.5% to 62.1%	36.8%*	32.9% to 40.7%	61.6%*	55.9% to 67.3%	42.90%	34.6% to 51.2%
Never received flu shot	56.2%*	54.2% to 58.2%	32.3%*	30.2% to 34.3%	56.6%*	52.3% to 61.0%	38.1%*	32.9% to 43.3%
missing	45.5%*	38.3% to 52.8%	21.4%*	13.9% to 28.9%	48.0%*	33.1% to 62.8%	29.60%	8.1% to 51.2%
Duration insured during survey year								
1-6 months	60.40%	56.2% to 64.6%	35.40%	30.1% to 40.6%	58.40%	49.1% to 67.7%	38.60%	27.4% to 49.9%
7-11 months	60.40%	56.5% to 64.3%	40.40%	35.6% to 45.1%	54.0%*	43.3% to 64.7%	34.7%*	22.9% to 46.5%
REF: Full year	62.70%	61.4% to 64.0%	40.50%	39.1% to 41.9%	64.00%	61.5% to 66.4%	46.40%	43.5% to 49.3%
Number of Outpatient Provider visits in Survey year								
REF: 0	46.60%	44.2% to 49.0%	23.20%	20.8% to 25.6%	48.70%	43.7% to 53.8%	29.50%	23.1% to 35.8%
1	56.1%*	54.0% to 58.2%	32.2%*	29.8% to 34.6%	58.5%*	53.8% to 63.2%	40.1%*	35.2% to 44.9%
2	61.3%*	59.0% to 63.5%	38.0%*	35.3% to 40.7%	64.5%*	59.4% to 69.5%	46.7%*	39.7% to 53.6%
3	63.0%*	60.3% to 65.7%	39.4%*	36.3% to 42.5%	66.6%*	62.4% to 70.9%	49.6%*	43.6% to 55.6%
4	65.2%*	62.3% to 68.0%	43.0%*	39.2% to 46.7%	66.3%*	58.7% to 74.0%	49.9%*	38.4% to 61.4%
5+	71.6%*	69.9% to 73.3%	51.5%*	49.3% to 53.7%	70.7%*	67.2% to 74.3%	53.8%*	49.4% to 58.2%
Whether had a Usual Source of Care								
REF: No	49.80%	46.7% to 52.9%	29.30%	26.2% to 32.4%	55.80%	49.7% to 61.8%	35.50%	27.8% to 43.3%
Yes	64.0%*	62.7% to 65.2%	41.5%*	40.1% to 42.9%	64.2%*	61.6% to 66.8%	46.7%*	43.8% to 49.7%
missing	57.90%	50.4% to 65.5%	38.8%*	30.2% to 47.4%	52.60%	34.2% to 71.0%	33.70%	10.9% to 56.5%

Table 4.7 cont.)	Aim 1 Main Analysis		Aim 1 Sensitivity Analysis		Aim 2 Main Analysis		Aim 2 Sensitivity Analysis	
Survey Year								
REF: 2009	61.10%	59.6% to 62.7%	40.40%	38.4% to 42.4%	63.20%	60.3% to 66.2%	46.90%	42.3% to 51.5%
2010	63.1%*	61.6% to 64.7%	42.00%	40.1% to 43.8%	63.70%	60.7% to 66.8%	46.50%	42.6% to 50.5%
2011	63.3%*	61.5% to 65.1%	38.60%	36.7% to 40.5%	63.00%	59.2% to 66.7%	43.50%	39.4% to 47.6%
* covariate level was significantly different ($p<0.05$) than the referent level (REF:) in the multivariate logistic regression								

Some covariates were included in all analyses and had consistent multivariate-adjusted effects including age, sex and immigration status for the sociodemographics block, Quan et al.'s Charlson comorbidity index for the health/lifestyle block, dental checkup frequency for the prevention history block, and count of outpatient provider visits in the survey year and having a usual source of care for the health care access block. Increasing age significantly increased screening likelihood with a decreasing rate of increase, which was indicated by a positive 2.10-3.16% point increase in screening likelihood for each year increase of the centered age variable and a negative 0.05-0.09% point change in screening likelihood for each squared year increase. The net effect of the two age variables, for example, for a person aged 75 years in the Aim 2 main analysis is 3.16*25 – 0.09*(25^2)= 79 - 56.25 = a 22.75% points predicted greater likelihood of being up-to-date with recommended CRC screening than a person aged 50 years. In comparison to females, males' predicted likelihood of CRC screening was 5.4-7.5% points higher across all analyses. For immigration status, US-born persons consistently had significantly higher screening likelihood than foreign-born persons who had lived in the US less than 15 years, although screening likelihood was not significantly lower for foreign-born person who had lived in the US more than 15 years. The disparity between recent immigrants and US-born persons increased from ~10% points in the Aim 1 analyses to ~30% points in the Aim 2 analyses. The Charlson comorbidity index was included in all analyses and there were no significant differences in any analyses for having a positive value (1, 2, or 3+) vs. having an index score of zero. More frequent dental checkups and a greater number of outpatient provider visits in the survey year each significantly predicted higher screening likelihood in a dose-response fashion in all analyses. Reporting having a usual source of care significantly predicted higher screening likelihood in all analyses.

Some covariates were included in all analyses and had inconsistent effects including educational attainment for the education and income block; having any

non-CRC cancer diagnosis, smoking status, and BMI categories for the health/lifestyle block; most recent flu shot for the prevention history block; duration of time insured in the survey year for the health care access block; and survey year. For educational attainment, having a HSD/GED predicted significantly higher screening likelihood than having less than a HSD/GED and significantly lower screening likelihood than those with a Bachelor's degree or Graduate/Doctoral degree in the Aim 1 main analyses. Educational attainment did not significantly predict screening likelihood in the Aim 2 main analysis and in both sensitivity analyses was only significant for having a HSD/GED predicting higher screening likelihood than having less than a HSD/GED. Ever having a non-CRC cancer diagnosis vs. not predicted higher screening likelihood and was statistically significant in the Aim 1 analyses, while in the Aim 2 analyses, differences with the same direction and similar magnitude were not significant. Being a current smoker vs. non-smoker predicted lower screening likelihood, although the effect did not reach significance for the Aim 2 main analysis. For BMI categories, being normal weight predicted significantly lower screening likelihood than being obese, although did not predict significantly different screening likelihood in comparison to being overweight or underweight. There was not a significant difference between being obese vs. normal weight in the Aim 1 sensitivity analysis. A more recent last flu shot usually predicted significantly higher screening likelihood, although in both the Aim 2 main and sensitivity analyses, having received a flu shot within the past year did not predict significantly different screening likelihood than having last received a flu shot between one and two years ago. Duration of time insured in the survey year generally was not a significant predictor, although for the Aim 2 main and sensitivity analyses, having been insured for 7-11 months predicted lower screening than having been insured for the full year, although there was not a significant difference for being insured for 1-6 months compared to the full year. In the Aim 1 main analysis, survey years 2011 and 2010 each predicted higher

screening likelihood than survey year 2009, although there were not significant differences between survey years in the other analyses.

Some variables had consistent effects, but were not included in all analyses including race/Hispanic ethnicity, census region, marital status, and whether a person was comfortable speaking English for the sociodemographics block; household income as a percentage of FPL categories for the education and income block; and perceived health status for the health/lifestyle block. By design, Aim 1 analyses had a race/Hispanic ethnicity category, while Aim 2 only had a Hispanic ethnicity indicator. For race/Hispanic ethnicity groups in the Aim 1 analyses, non-Hispanic whites had significantly lower screening likelihood of both CRC screening outcomes than non-Hispanic blacks and significantly higher screening likelihood than non-Hispanic Asians, although screening likelihood did not significantly differ between non-Hispanic and Hispanic whites. In the Aim 1 analyses, Hispanic whites had slightly higher predicted screening likelihood than non-Hispanic whites for screening in the previous year 42.4 vs. 39.4%, while non-Hispanic whites had slightly higher screening likelihood for being up-to-date with recommended screening, 62.3 vs. 61.6%. For the Aim 2 analyses, screening likelihood also did not significantly differ between non-Hispanic and Hispanic whites, although non-Hispanic whites had higher screening likelihood for both the primary outcome (64.1 vs. 59.7% up-to-date with recommended screening) and for having had any screening in the previous year (46.0 vs. 44.1%). By design, census region was only applicable to the Aim 1 analyses and ultimately was non-significant in the main analysis, although was included in the Aim 1 sensitivity analysis. Screening likelihood was similar in the Northeast, Midwest, and South, although was significantly higher in the Western census region. Respondents residing in Urban areas had significantly higher screening likelihood than rural residents in the Aim 1 main analysis by 3.0% points ($p=0.049$) and in the sensitivity analysis sample by 3.3% points ($p=0.042$), although urban vs. rural residence was dropped from the Aim 2 analyses. Marital

status was dropped from the Aim 2 analyses, and in the Aim 1 analyses, those who were married had significantly higher screening likelihood than those who were never married, although there was no significant difference compared to widowed or divorced/separated persons. Whether a person was comfortable speaking English was only included in the Aim 1 analyses and was non-significant. Income was included in all analyses except the Aim 2 sensitivity analyses, and being high income consistently predicted higher screening likelihood than being near poor/low income, but did not predict significantly different screening than being middle income or being poor/having negative income. Perceived health status was only included in the Aim 1 main analyses and having Excellent health predicted significantly greater screening likelihood, 64.1%, than having Good health, 61.7%, or Fair/Poor health, 60.3%.

Aim 1 Multivariate Findings for Binary Insurance Features

Aim 1 Main and Sensitivity Analyses

Figures 4.1-8 report the Aim 1 main multivariate logistic regression and sensitivity analysis findings for binary insurance features. The insurance feature main effect is reported as the multivariate-adjusted percentage change in the predicted likelihood of CRC screening and the 95% confidence interval if a respondent had a binary insurance feature vs. not. Each figure reports the insurance feature effect and confidence interval for eight models: the unadjusted effect (adjusting only for survey year), five models adjusting separately for each of the covariate blocks, the full model with all covariate blocks, and a reduced full model without the prevention history and health care access covariates. If controlling for a covariate block or set of blocks increases an insurance feature effect, the change suggests that the unadjusted insurance feature effect was confounded downward by not having adjusted for the covariates, meaning the respondents with the

insurance feature in aggregate have values of the covariates that are less favorable to their screening likelihood. If controlling for a covariate block decreases an insurance feature effect, the change suggests the opposite is true: the covariates confound upward the insurance feature effect by not having adjusted for the covariates, so respondents with the insurance feature in aggregate have values of the covariates that are more favorable to their screening likelihood.

Figure 4.1 reports the findings for whether a respondent had insurance with a DPN in the Aim 1 main analyses. In the unadjusted model, having a DPN predicted a non-significant 1.4% point reduction (95% CI: -3.4 to 0.6%) in the likelihood of being up-to-date with recommended CRC screening. The adjusted changes in predicted screening likelihood for the separate covariate block models ranged from a high estimate of a significant increase of 3.1% points (95% CI: 0.9 to 5.3%) in screening likelihood if a person had a DPN after controlling for the sociodemographics block (a 4.5% point increase from the effect in the unadjusted model suggesting that respondents who had insurance with a DPN had unfavorable sociodemographics characteristics in aggregate compared to those who did not have insurance with a DPN) to a low estimate of a significant negative 3.6% point reduction (95% CI: -5.6 to -1.6%) in screening likelihood after controlling for the education and income block (a 2.2% point decrease from the effect in the unadjusted model suggesting that respondents who had insurance with a DPN had favorable education and income values in aggregate compared to those who did not have insurance with a DPN). In the fully-adjusted model and the full reduced model without the prevention history and health care access blocks, having insurance with a DPN predicted small non-significant increases in screening likelihood, 0.5% points (95% CI: -1.4 to 2.4%) and 1.8% points (95% CI: -0.3 to 3.9%). In total, the findings suggest whether a person's insurance had a DPN did not strongly influence screening likelihood.

Figure 4.2 reports the findings for whether a respondent had insurance that used gatekeeping in the Aim 1 main analyses. In the unadjusted model, having insurance

Figure 4.1

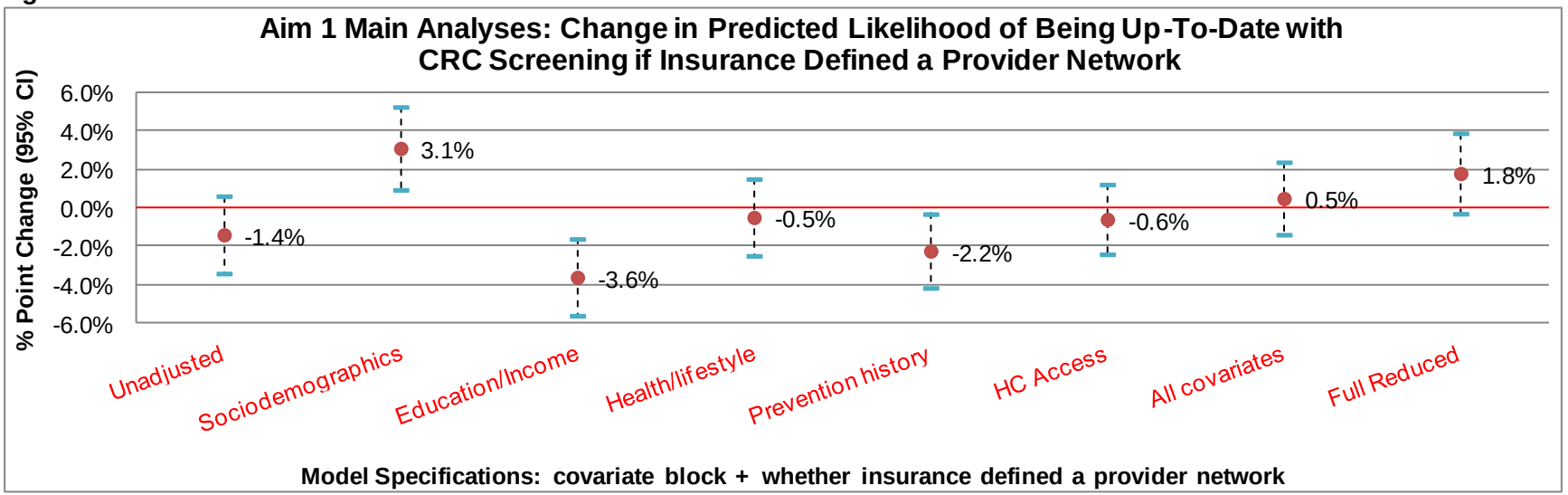
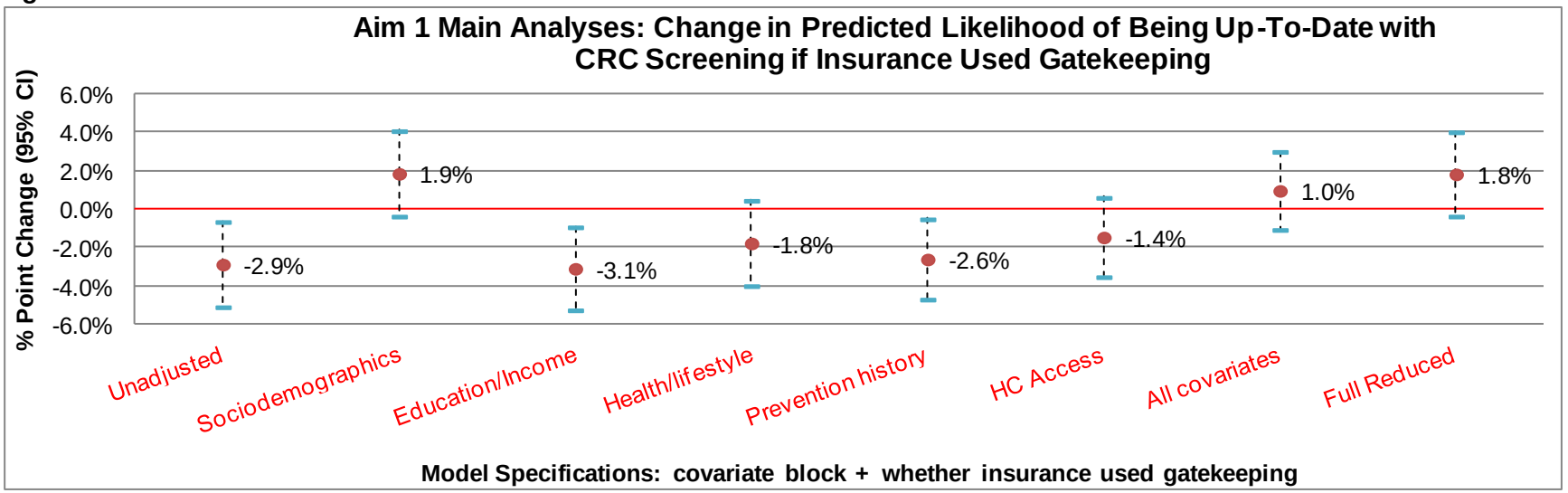


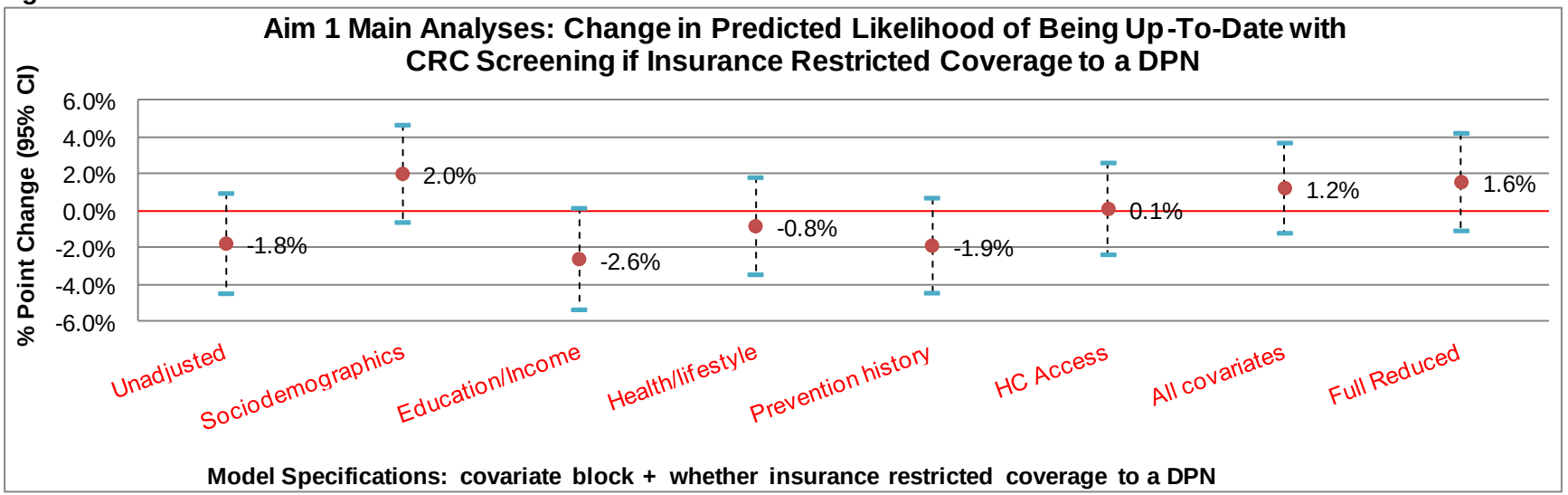
Figure 4.2



that used gatekeeping predicted a significant 2.9% point reduction in screening likelihood (95% CI: -5.1 to -0.6%). The adjusted changes in predicted screening likelihood for the separate covariate block models ranged from a high estimate of a non-significant 1.9% point increase in screening likelihood (95% CI: -0.4% to 4.1%) after adjusting for the sociodemographics block to a low estimate of a significant reduction in screening likelihood of 3.1% points (95% CI: -0.9 to -5.2%) after adjusting for the education and income block. In the fully adjusted model and the full reduced model, having insurance that used gatekeeping predicted small non-significant increases in screening likelihood, 1.0% (95% CI: -1.1 to 3.0%) and 1.8% (95% CI: -0.4 to 4.0%), respectively. In total, the findings suggest that whether a person's health plan used gatekeeping did not strongly influence screening likelihood, and that the significant negative unadjusted effect for gatekeeping is confounded by those who have insurance with gatekeeping tending to have less favorable other characteristics that predict lower screening likelihood.

Figure 4.3 reports the findings for whether a respondent had a health plan that restricted coverage to a DPN in the Aim 1 main analyses. In the unadjusted model, having coverage restricted to a DPN predicted a non-significant 1.8% point reduction in screening likelihood (95% CI: -4.5 to 0.9%). The adjusted changes in predicted screening likelihood for the separate covariate block models ranged from a high estimate of a non-significant 2.0% point increase (95% CI: -0.6 to 4.7%) in screening likelihood if coverage was restricted to a DPN after controlling for the sociodemographics block to a low estimate of a non-significant negative 2.6% point reduction (95% CI: -5.4 to 0.1%) in screening likelihood after controlling for the education and income block. In the fully adjusted model and the full reduced model, having insurance that restricted coverage to a DPN predicted small non-significant increases in screening likelihood, 1.2% points (95% CI: -1.2 to 3.7%) and 1.6% points (95% CI: -1.1 to

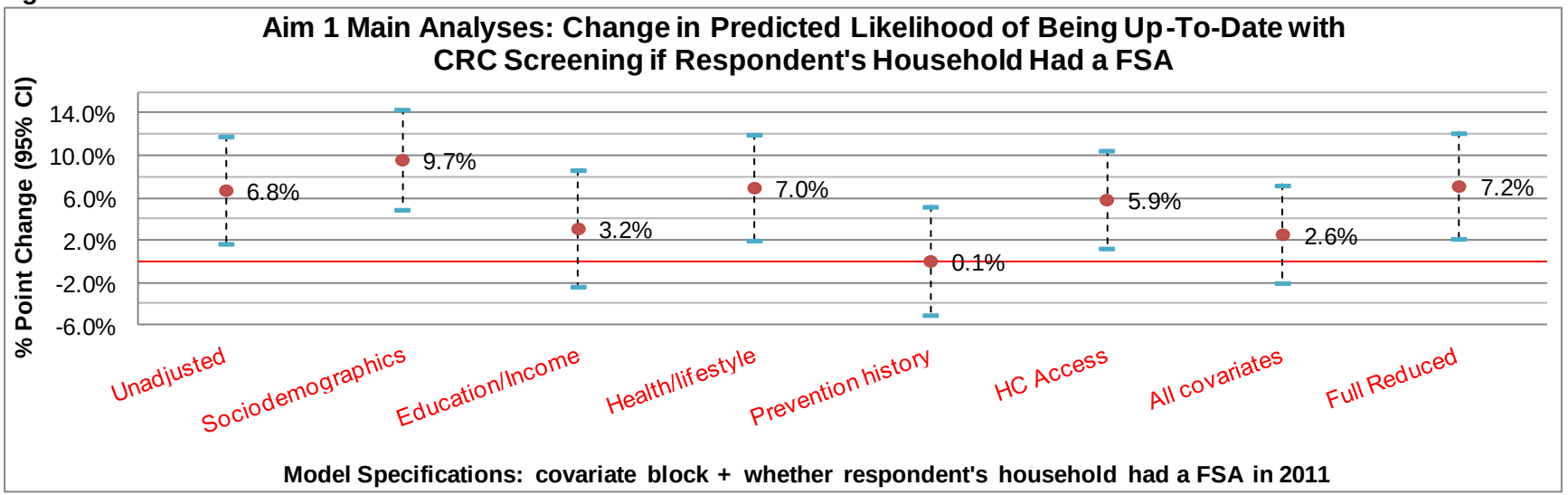
Figure 4.3


Aim 1 Main Analyses: Change in Predicted Likelihood of Being Up-To-Date with CRC Screening if Insurance Restricted Coverage to a DPN
% Point Change (95% CI)
6.0%
4.0%
2.0%
0.0%
-2.0%
-4.0%
-6.0%
-1.8%
2.0%
-2.6%
-0.8%
-1.9%
0.1%
1.2%
1.6%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Model Specifications: covariate block + whether insurance restricted coverage to a DPN

4.2%). In total, the findings suggest whether a person's insurance restricted coverage to a DPN did not influence screening likelihood.

Figure 4.4 reports the findings for whether a respondent's household had a FSA in the Aim 1 main analyses. In the unadjusted model, having a FSA predicted a significant 6.8% point increase in screening likelihood (95% CI: 1.7 to 11.8%). The adjusted changes in predicted screening likelihood for the separate covariate block models ranged from a high estimate of a significant 9.7 % point increase (95% CI: 4.9 to 14.4%) after controlling for the sociodemographics block to a low estimate of a null effect, 0.1% point increase (95% CI: -5.0 to 5.2%), after controlling for the prevention history block. In the fully adjusted model, having an FSA predicted a no longer significant increase in screening likelihood of 2.6% points (95% CI: -2.0 to 7.2%). In the full reduced model without the prevention history and health care access blocks, having an FSA still had a significant positive effect, 7.2% points (95% CI: 2.2 to 12.2%). In total, the findings suggest that having an FSA may have predicted a small increase in CRC screening likelihood. Since the FSA effect was adjusted downward after controlling for each the prevention history block and the education and income block, but did not change after adjusting for the health/lifestyle covariate block, having an FSA may be a marker of being generally more health aware, but not substantively healthier.

Figure 4.4


Aim 1 Main Analyses: Change in Predicted Likelihood of Being Up-To-Date with CRC Screening if Respondent's Household Had a FSA
% Point Change (95% CI)
14.0%
10.0%
6.0%
2.0%
-2.0%
-6.0%
6.8%
9.7%
3.2%
7.0%
0.1%
5.9%
2.6%
7.2%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Model Specifications: covariate block + whether respondent's household had a FSA in 2011

Aim 1 Sensitivity Analyses for Binary Insurance Features

In the Aim 1 sensitivity analyses (Figures 4.5-8), the binary insurance feature effects followed the same pattern across the eight models as in the main analyses, although the overall pattern was shifted upward or downward. The insurance feature effects in the Aim 1 sensitivity analyses were greater than in the main analyses for the organizational insurance features. In the main analyses, the unadjusted effects had been negative and non-significant (except having insurance that used gatekeeping was significant (Figure 4.2)), and the effects in the fully adjusted and full reduced models were positive and non-significant. In the sensitivity analyses, the organizational features' unadjusted effects were slightly positive and still non-significant, although the effects in the fully adjusted and full reduced models were positive and usually significant. Having insurance with a DPN was non-significant in the fully adjusted model (Figure 4.5) (a 1.6% point increase in likelihood of screening in the previous year (95% CI: -0.5 to 3.7%)), although in the full reduced model, significantly predicted 3.2% points greater likelihood of screening in the previous year (95% CI: 0.8 to 5.6%). In the fully adjusted and full reduced models, having insurance with gatekeeping (Table 4.6) significantly predicted greater likelihood of screening in the previous year, respectively, by 3.6% points (95% CI: 1.1 to 6.0%) and 4.6% points (95% CI: 1.9 to 7.4%), respectively. In the fully adjusted and full reduced models, having insurance that restricted coverage to a DPN (Figure 4.7) significantly predicted greater likelihood of screening in the previous year by 3.4% points (95% CI: 0.7 to 6.2%) and 4.0% points (95% CI: 0.9 to 7.0%), respectively. In total, the sensitivity analysis findings suggest that having insurance with a DPN, having insurance with a gatekeeper, and having insurance that restricted coverage to a DPN more strongly predicted recent CRC screening in the previous year than predicted being up-to-date with recommended screening according to the USPSTF recommended time intervals for different techniques.

Figure 4.5

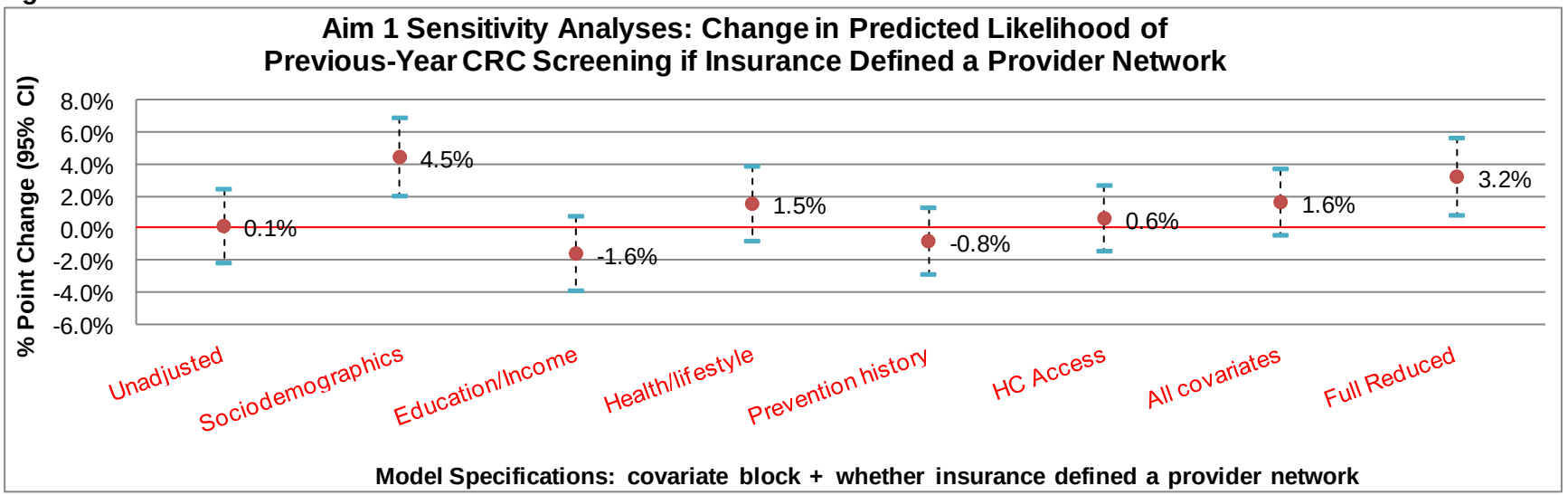


Figure 4.6

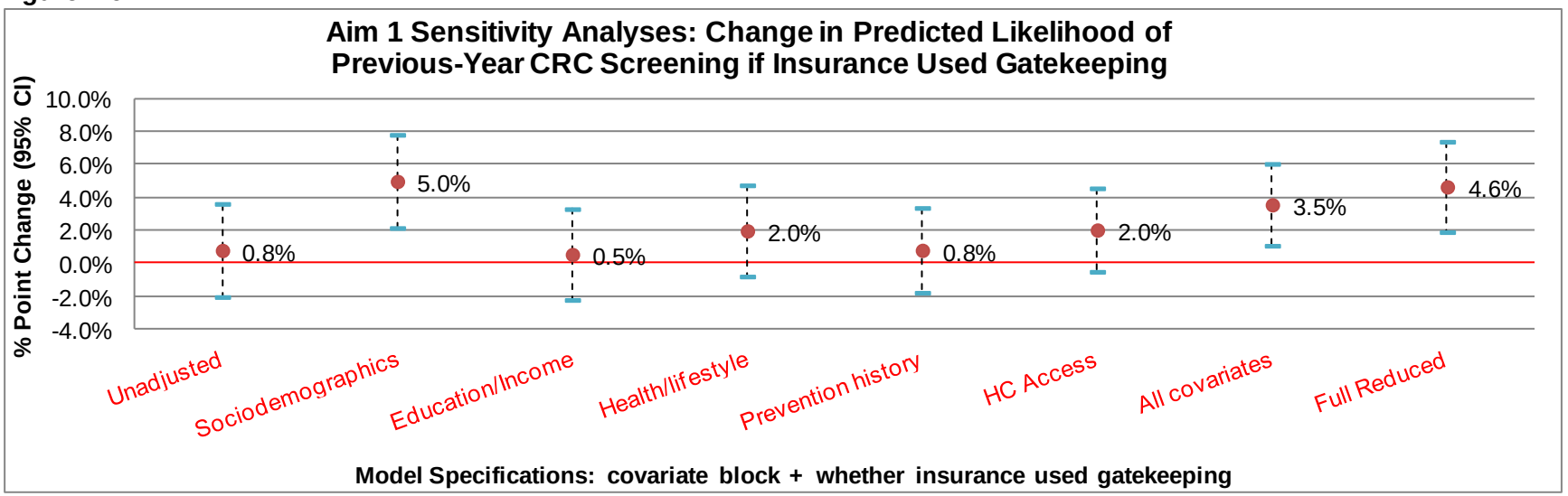
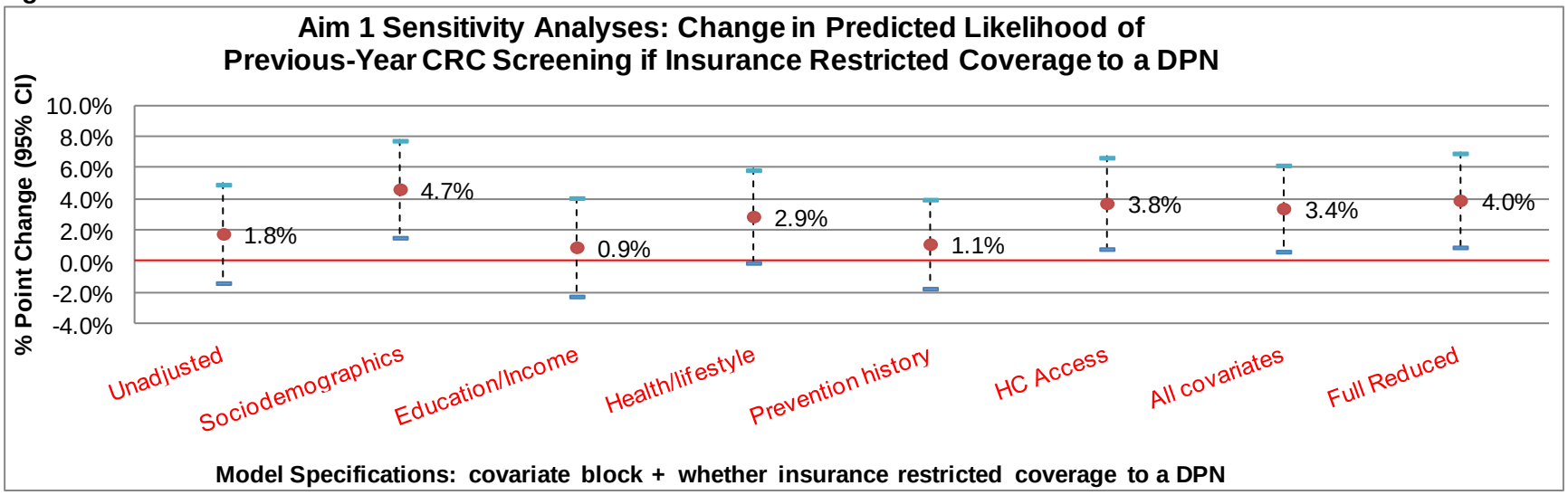
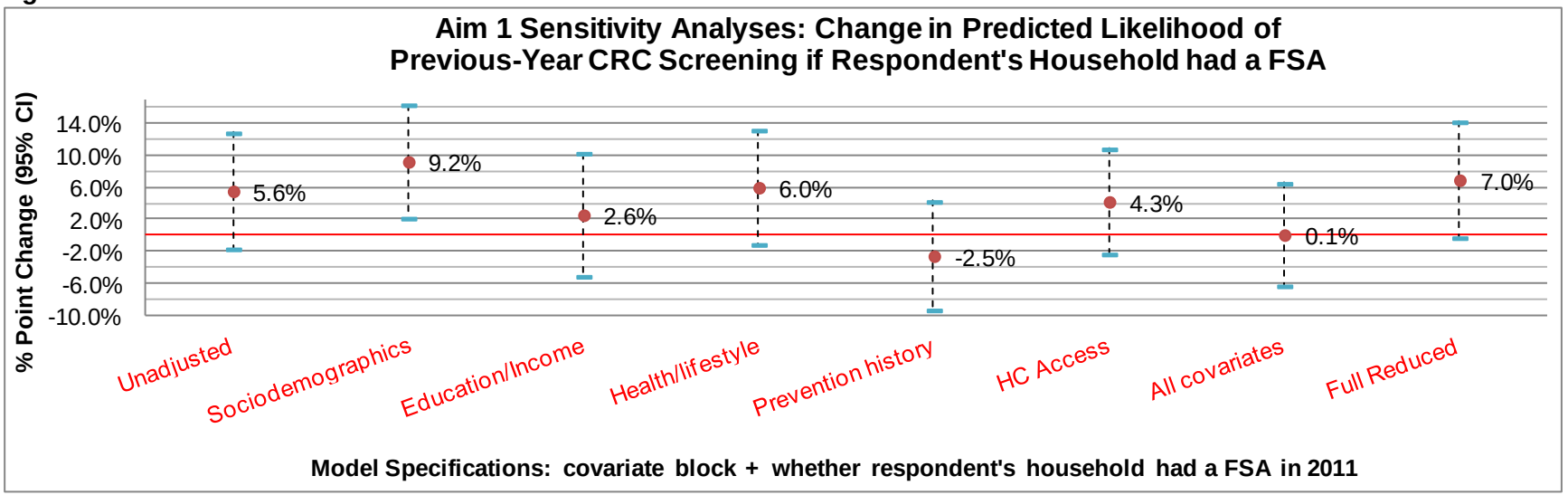


Figure 4.7


Aim 1 Sensitivity Analyses: Change in Predicted Likelihood of Previous-Year CRC Screening if Insurance Restricted Coverage to a DPN
% Point Change (95% CI)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
-2.0%
-4.0%
1.8%
4.7%
0.9%
2.9%
1.1%
3.8%
3.4%
4.0%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Model Specifications: covariate block + whether insurance restricted coverage to a DPN

For having an FSA, in contrast to the other binary insurance features, the pattern of the change in the sensitivity analysis across the eight models was shifted down in comparison to the pattern in the main analysis (Figure 4.8). In the main analysis unadjusted model, having an FSA predicted positive and significantly greater likelihood of being up-to-date with recommended screening (Figure 4.4), and the effects in the fully adjusted and full reduced models were positive and significant for the full reduced model, although non-significant for the fully adjusted model. In the sensitivity analysis, having an FSA in the unadjusted model predicted smaller positive increase in screening likelihood than the main analysis that did not reach significance, 5.6% points (95% CI: -1.7 to 12.8%), and the fully adjusted and full reduced models also had positive non-significant effects 0.1% points (95% CI: -6.3 to 6.5%) and 7.0% points (95% CI: -0.3% to 14.2%). In total, the sensitivity analysis findings suggest that having an FSA less strongly predicted recent CRC screening in the previous year than being up-to-date with recommended screening.

Figure 4.8


Aim 1 Sensitivity Analyses: Change in Predicted Likelihood of Previous-Year CRC Screening if Respondent's Household had a FSA
% Point Change (95% CI)
14.0%
10.0%
6.0%
2.0%
-2.0%
-6.0%
-10.0%
5.6%
9.2%
2.6%
6.0%
-2.5%
4.3%
0.1%
7.0%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Model Specifications: covariate block + whether respondent's household had a FSA in 2011

Aim 2 Multivariate Findings for Binary Insurance Features

Aim 2 Main and Sensitivity Analyses

The Aim 2 main analysis findings for the three binary features (excluding whether a person had an FSA because no Western Hispanic whites had an FSA) reveal consistent patterns of the effects of having each feature for and between Hispanic and non-Hispanic whites (Figures 4.9a, 4.10a, and 4.11a). Four patterns were consistent for each of the three insurance features in all eight models: Hispanic whites that did not have the insurance feature had the lowest predicted likelihood of being up-to-date with recommended CRC screening; Hispanic whites that had an insurance feature had greater screening likelihood than Hispanic whites that did not have the feature; non-Hispanic whites with and without the insurance feature had similar screening likelihood; and Hispanic and non-Hispanic whites with the insurance feature had similar screening likelihood in the fully adjusted and full reduced models, which had changed from non-Hispanic whites with the insurance feature having higher predicted screening than Hispanic whites with the insurance feature in the unadjusted estimates and in the five models adjusted for each covariate block individually.

Figures 4.9b, 10b, and 11b report five contrast tests of selected comparisons of Hispanic vs. non-Hispanic whites and of those with the insurance feature vs. not. These figures and subsequent figures of contrast tests present a set of contrast tests that were repeated in multiple models. On the horizontal axis, a label indicates the covariates adjusted for in each model. Above the model label, the contrast tests performed are numbered, and the legend notes which contrast test each number corresponds to. In figures 4.9b, 10b, and 11b, each of the eight models has the same pattern of point estimates and confidence intervals for the five contrast tests. Tests 1 and 2 are estimates of the disparity in predicted screening likelihood for Hispanics compared to the non-Hispanics in the

subsamples of those without the insurance feature (Test 1) and those with the feature (Test 2). Tests 3 and 4 are estimates of the change in predicted screening likelihood due to having the insurance feature vs. not for non-Hispanic whites (Test 3) and for Hispanic whites (Test 4). Test 5 estimated the double difference contrast, the difference between the marginal effect of Hispanic whites having a feature vs. not and the marginal effect of non-Hispanic

Figure 4.9a

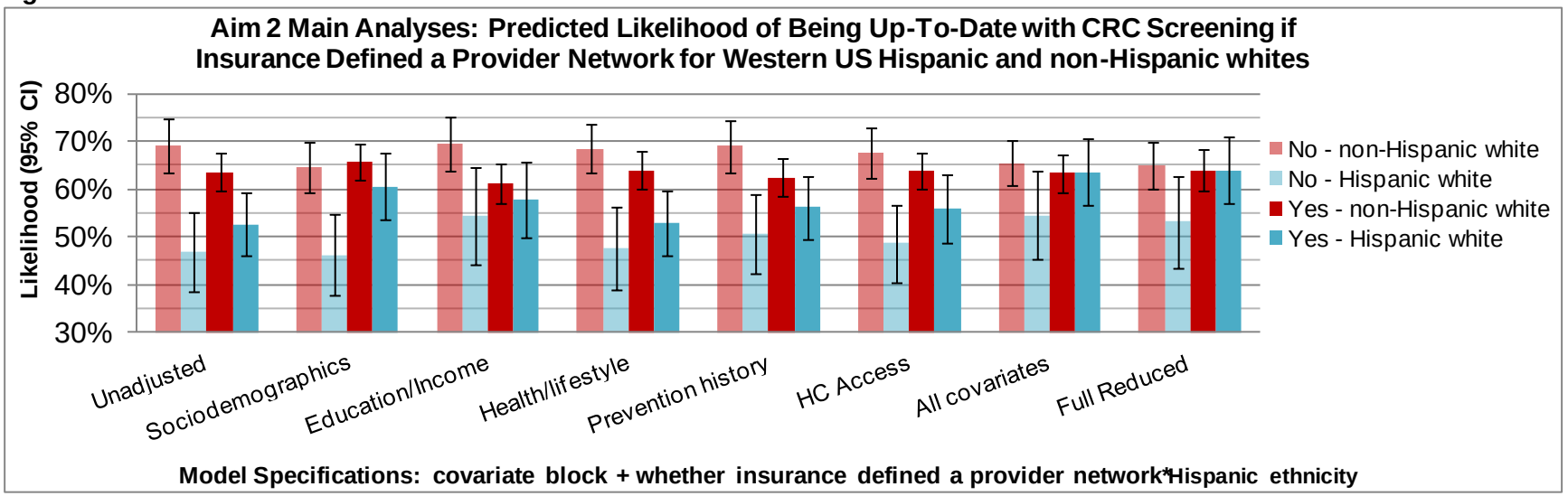

Aim 2 Main Analyses: Predicted Likelihood of Being Up-To-Date with CRC Screening if Insurance Defined a Provider Network for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
80%
70%
60%
50%
40%
30%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance defined a provider network*Hispanic ethnicity

Figure 4.9b

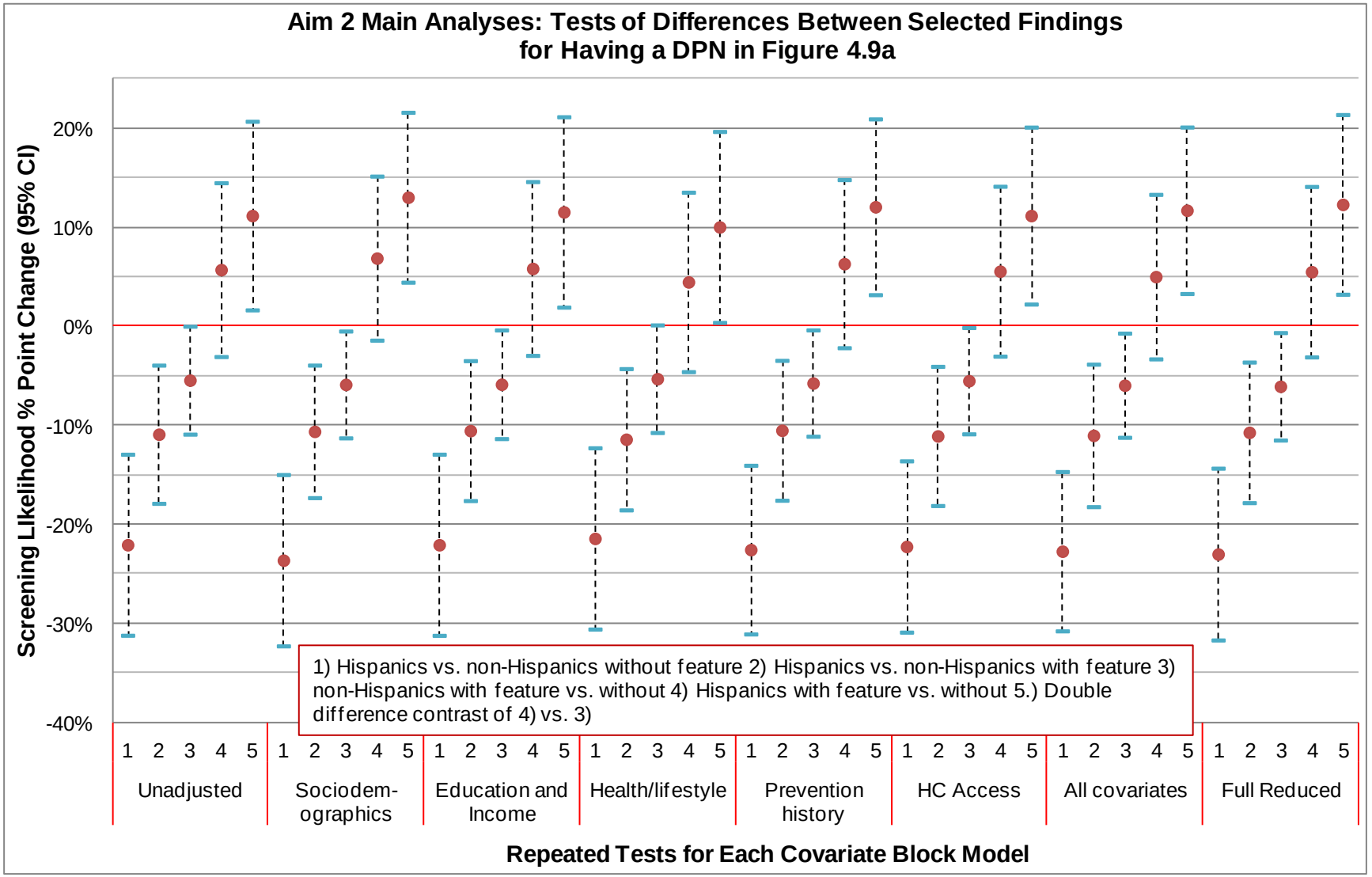

Aim 2 Main Analyses: Tests of Differences Between Selected Findings for Having a DPN in Figure 4.9a
Screening Llkelihood % Point Change (95% CI)
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

Figure 4.10a

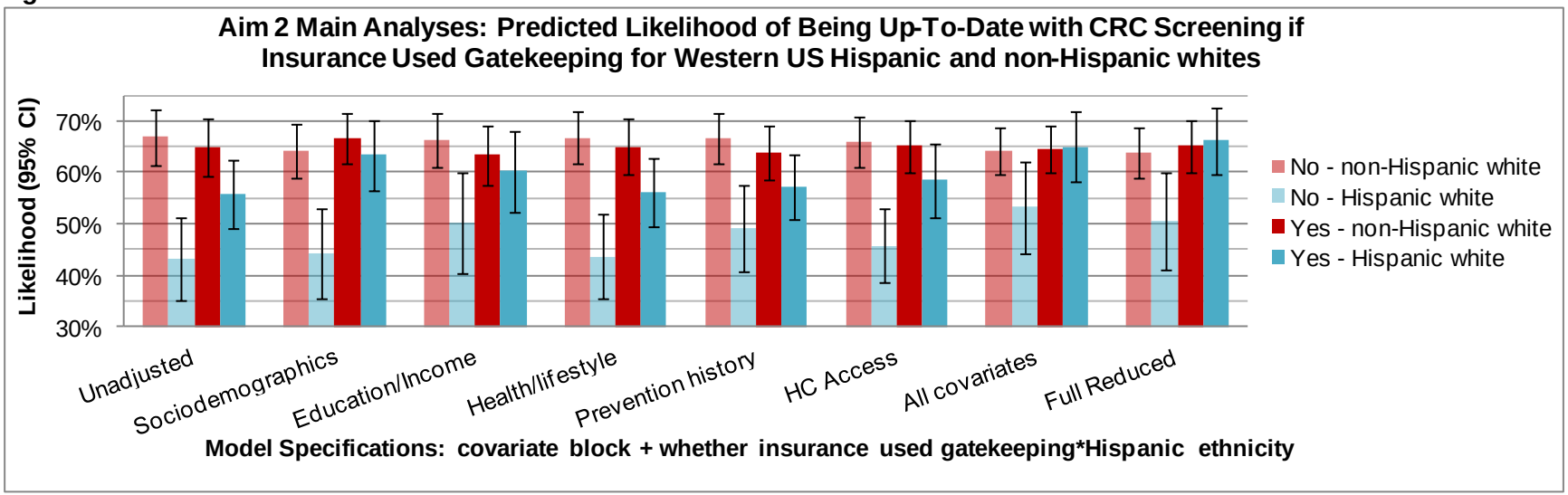

Aim 2 Main Analyses: Predicted Likelihood of Being Up-To-Date with CRC Screening if Insurance Used Gatekeeping for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
70%
60%
50%
40%
30%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance used gatekeeping*Hispanic ethnicity

Figure 4.10b

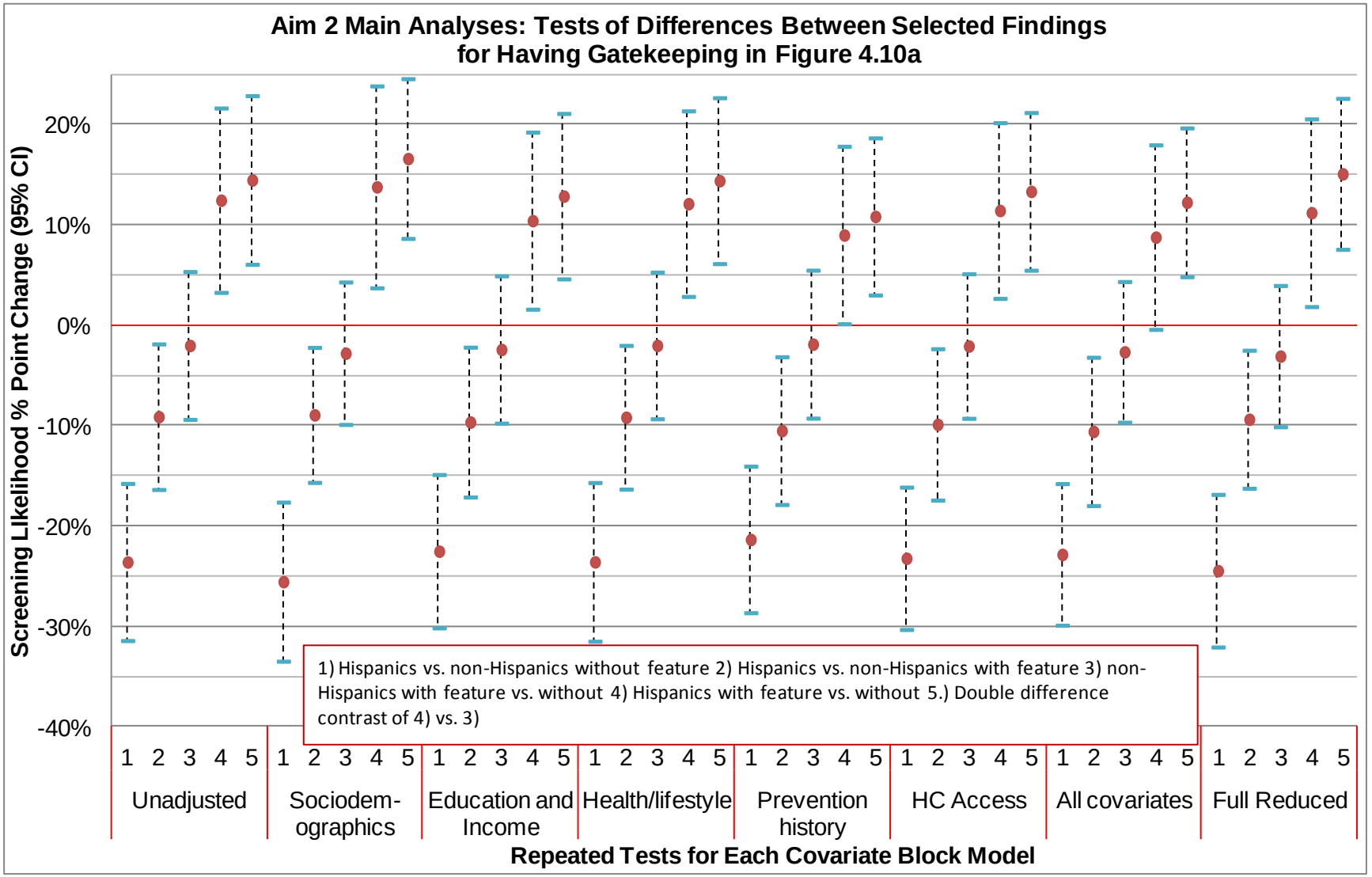

Aim 2 Main Analyses: Tests of Differences Between Selected Findings for Having Gatekeeping in Figure 4.10a
Screening LIkelihood % Point Change (95% CI)
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

Figure 4.11a

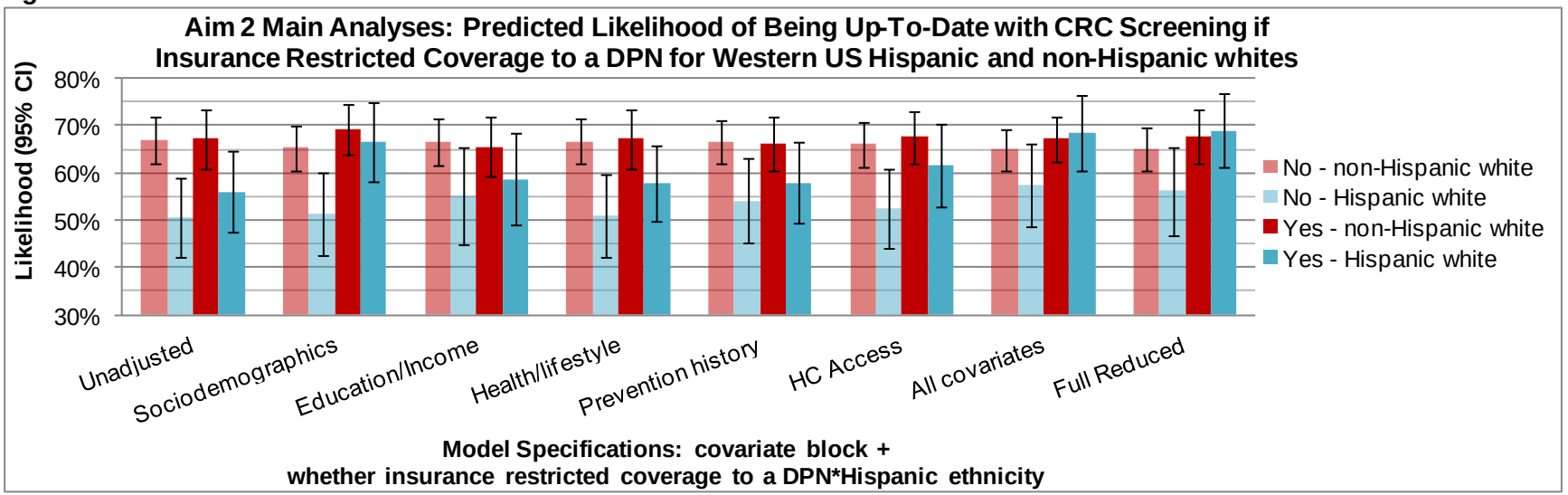
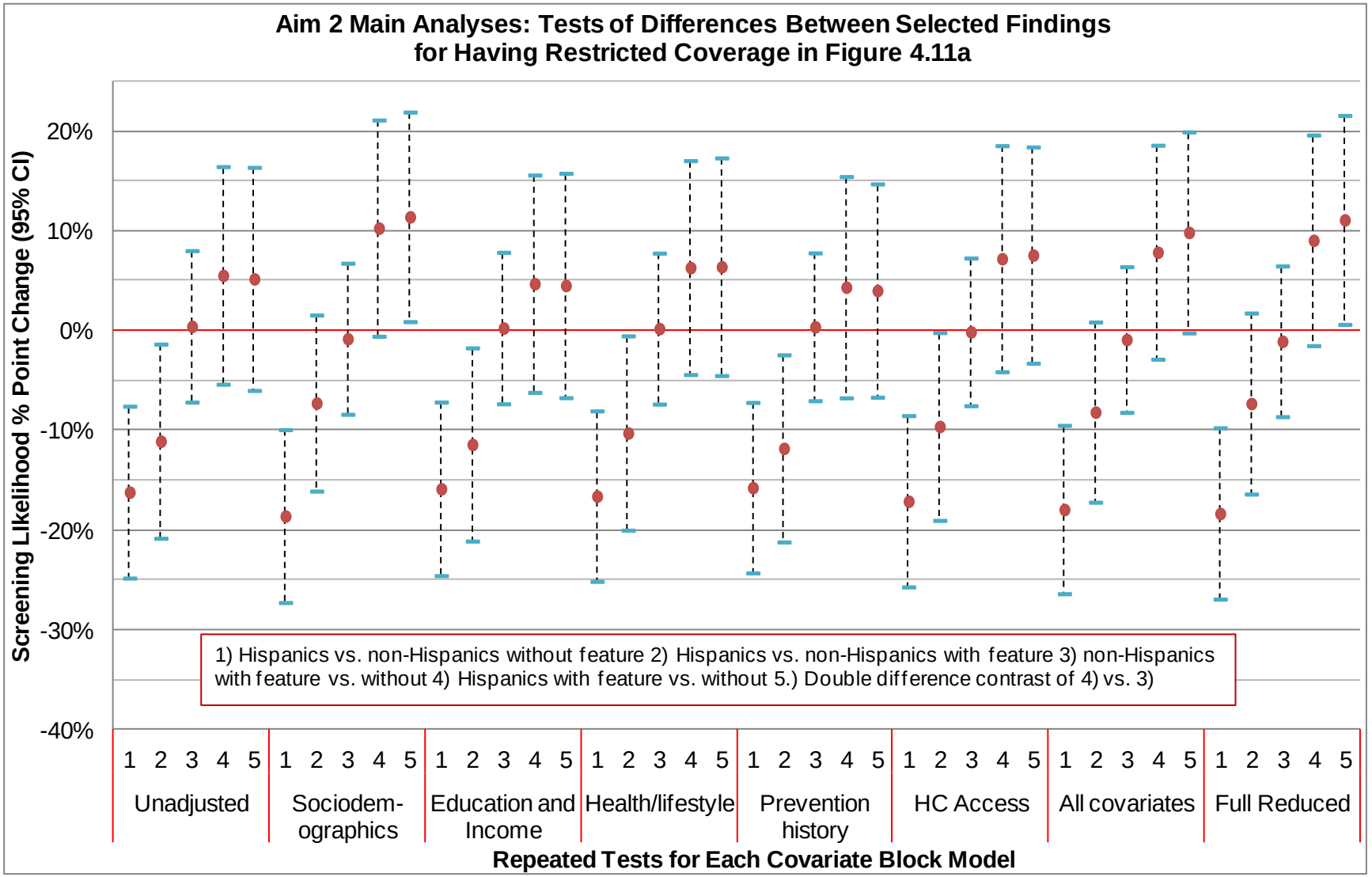

Aim 2 Main Analyses: Predicted Likelihood of Being Up-To-Date with CRC Screening if Insurance Restricted Coverage to a DPN for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
80%
70%
60%
50%
40%
30%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance restricted coverage to a DPN*Hispanic ethnicity

Figure 4.11b


Aim 2 Main Analyses: Tests of Differences Between Selected Findings for Having Restricted Coverage in Figure 4.11a
Screening LIkelihood % Point Change (95% CI)
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5 1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

whites having a feature vs. not (i.e. Test 4 minus Test 3).

Tests 1 and 2 show that each Hispanic whites with and without the insurance features were predicted to have significantly lower screening likelihood than their non-Hispanic white counterparts who also had or did not have the feature, and the disparity was larger for Hispanic whites without the insurance feature. For having insurance with a DPN and having insurance that used gatekeeping, Hispanic whites that did not have the feature had significantly lower screening likelihood than non-Hispanic whites without the feature by more than 20% points in every model, and Hispanic whites who had the feature had significantly lower screening likelihood than non-Hispanic whites with the feature by around 10% points across the models. For having insurance that restricted coverage to a DPN, Hispanic whites that did not have restricted coverage had significantly lower screening likelihood than non-Hispanic whites without restricted coverage by more than 15% points in every model, and Hispanic whites who did have restricted coverage had lower screening likelihood than non-Hispanic whites with restricted coverage by 7.3 to 11.9% points across the models, although the disparity did not reach significance in the full or full reduced model.

The third test estimated the difference in predicted screening likelihood for non-Hispanic whites who had the feature vs. those that did not. For whether a person had insurance with a DPN (Figure 4.9b), non-Hispanic whites with a DPN significantly predicted 5.3-6.1% points lower screening likelihood than non-Hispanic whites without a DPN across the eight models. For whether a person had insurance that used gatekeeping and whether a person's insurance was restricted to a DPN, there were not significant differences in screening likelihood for non-Hispanic whites.

The fourth test estimated the difference in predicted screening likelihood for Hispanic whites who had the feature vs. those that did not. Hispanic whites who had any of the features had higher predicted screening likelihood, although the difference was non-significant for having insurance with a DPN (Figure 4.9b) and having insurance that restricted coverage to a DPN (Figure 4.11b). For whether a persons' insurance used gatekeeping (Figure 4.10b), Hispanic whites had higher screening likelihood by 8.8 to 13.8% points, and the difference was significant in all models except the fully adjusted model.

The fifth test suggests the impact that having the insurance feature vs. not had on the total disparity in CRC screening among Hispanics. The double difference contrast was positive (favorable for Hispanic whites) for all three features and was 10% points or more and consistently significant for two variables, whether a person had insurance with a DPN and whether a person had insurance that used gatekeeping. For whether a person had insurance that restricted coverage to a DPN, the double difference contrast was positive and ranged from 3.9 to 11.3% points. Test 5 did not reach significance in the unadjusted model and five of the adjusted models, although the effect was significant in the full reduced model and nearly significant in the fully adjusted model with a predicted increase in screening likelihood of 9.8% points (95% CI: -0.3 to 19.9%).

Overall, the contrast tests and observed patterns suggest that having the insurance features predicted higher screening likelihood for Hispanic whites, but no change or a reduction in screening likelihood for non-Hispanic whites. The double difference contrasts suggest that these features affect or are associated with other insurance features that affect or predict reduced CRC screening disparities for Western US Hispanic whites vs. non-Hispanic whites.

Aim 2 Sensitivity Analyses for Binary Insurance Features

In the sensitivity analyses for Aim 2 (4.12, 4.13, and 4.14), the patterns of predicted screening likelihood for having had any screening in the previous year appear similar to the main analyses, although the sensitivity analyses have some notable differences in magnitude and significance of effects.

First, in the sensitivity analyses, the magnitude of the disparity between Hispanic and non-Hispanic whites' predicted screening likelihood usually decreased for both those with and without the insurance feature. For those without the insurance feature, the Hispanic disparity decreased, although remained significant for all three insurance features. For those with the insurance feature, the change in the interpretation for each insurance feature was slightly differently. For those who had insurance with a DPN, the Hispanic disparity from the main analysis decreased and changed from being significant in all models to being non-significant in all sensitivity analysis models. For those with insurance that used gatekeeping, the Hispanic disparity decreased and changed from being significant in all models to not reaching significance in most models, although remained significant in the fully adjusted model. For those with insurance that restricted coverage to a DPN, the range of the point estimates did not change from the main analysis to the sensitivity analysis, although those differences had been significant in some of the main analysis models, but were not significant in any of the sensitivity analysis models (the no-longer significant difference likely reflects the reduced sample size).

Figure 4.12a

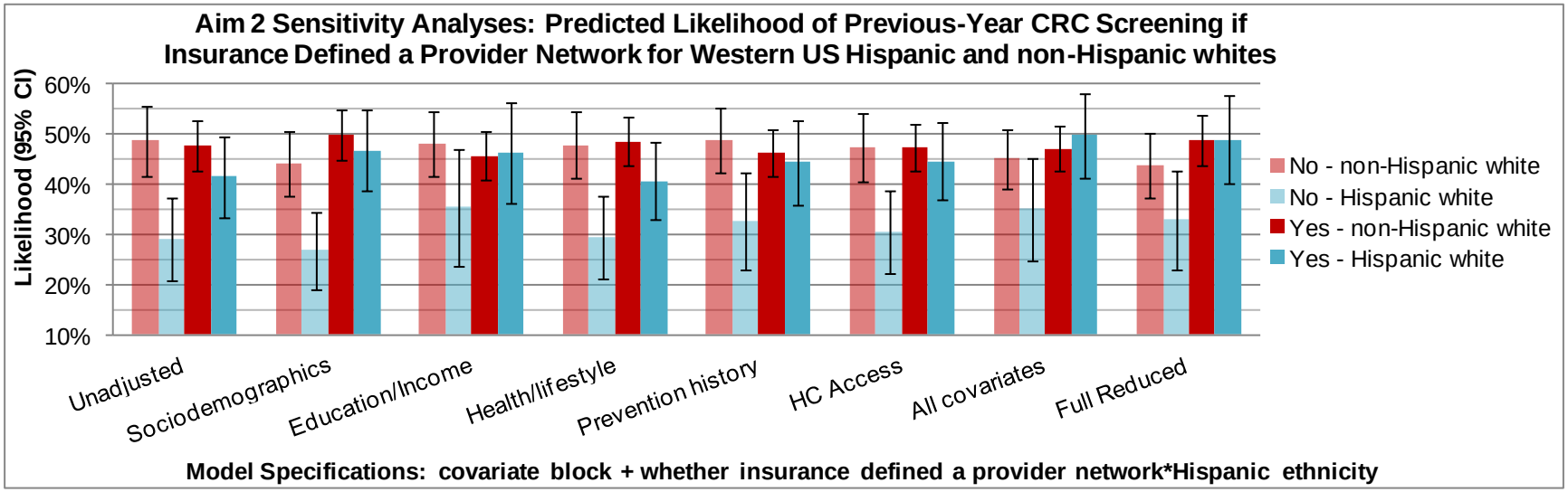

Aim 2 Sensitivity Analyses: Predicted Likelihood of Previous-Year CRC Screening if Insurance Defined a Provider Network for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
60%
50%
40%
30%
20%
10%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance defined a provider network*Hispanic ethnicity

Figure 4.12b

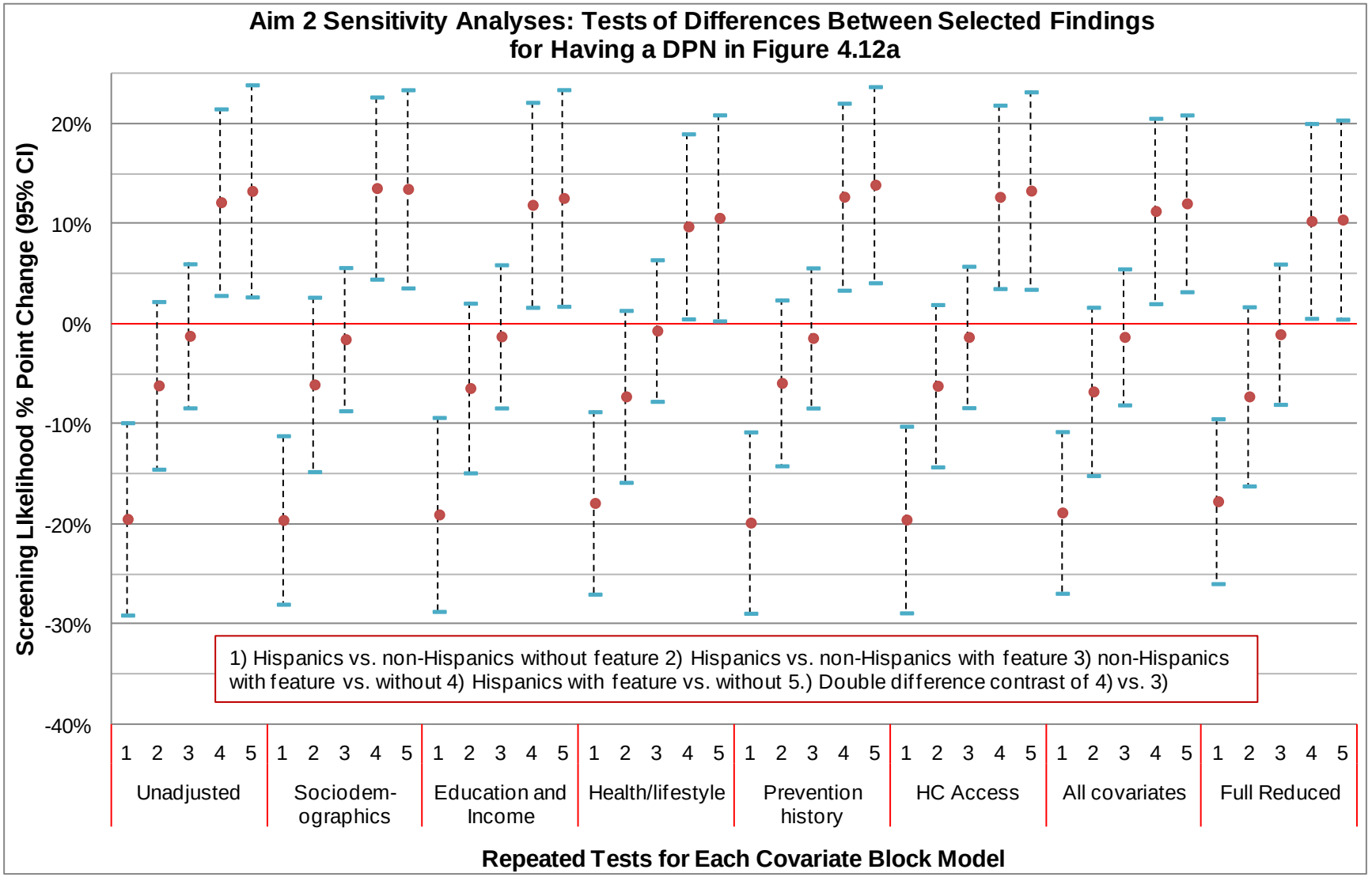

Aim 2 Sensitivity Analyses: Tests of Differences Between Selected Findings for Having a DPN in Figure 4.12a
Screening LIkelihood % Point Change (95% CI)
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

Figure 4.13a

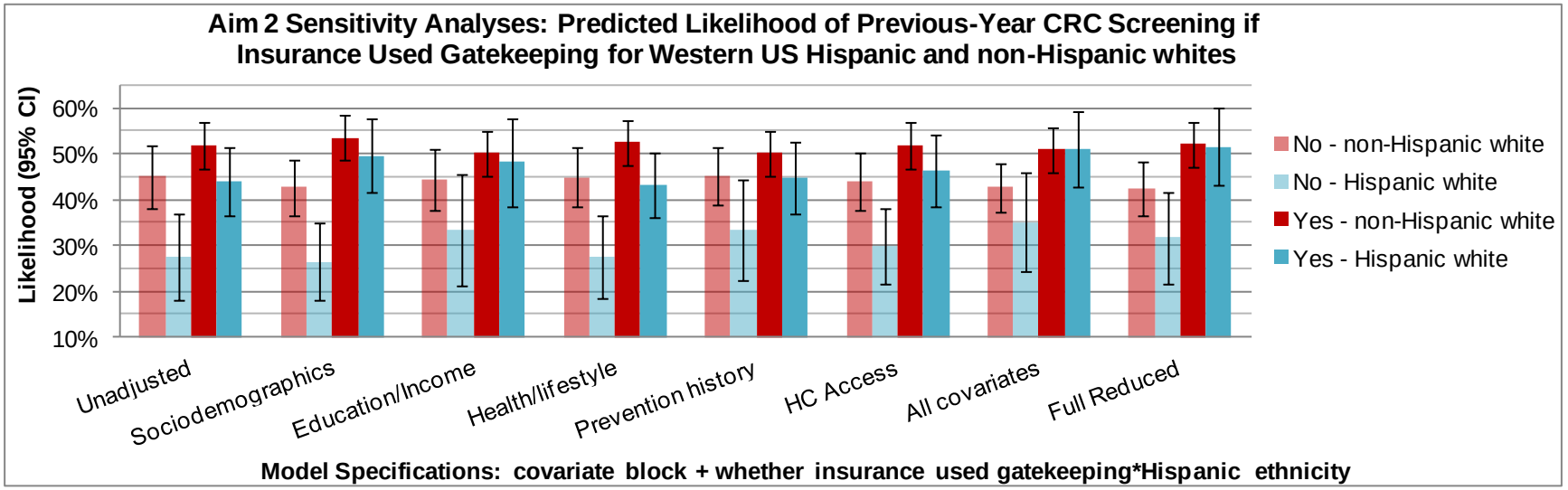

Aim 2 Sensitivity Analyses: Predicted Likelihood of Previous-Year CRC Screening if Insurance Used Gatekeeping for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
60%
50%
40%
30%
20%
10%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance used gatekeeping*Hispanic ethnicity

Figure 4.13b

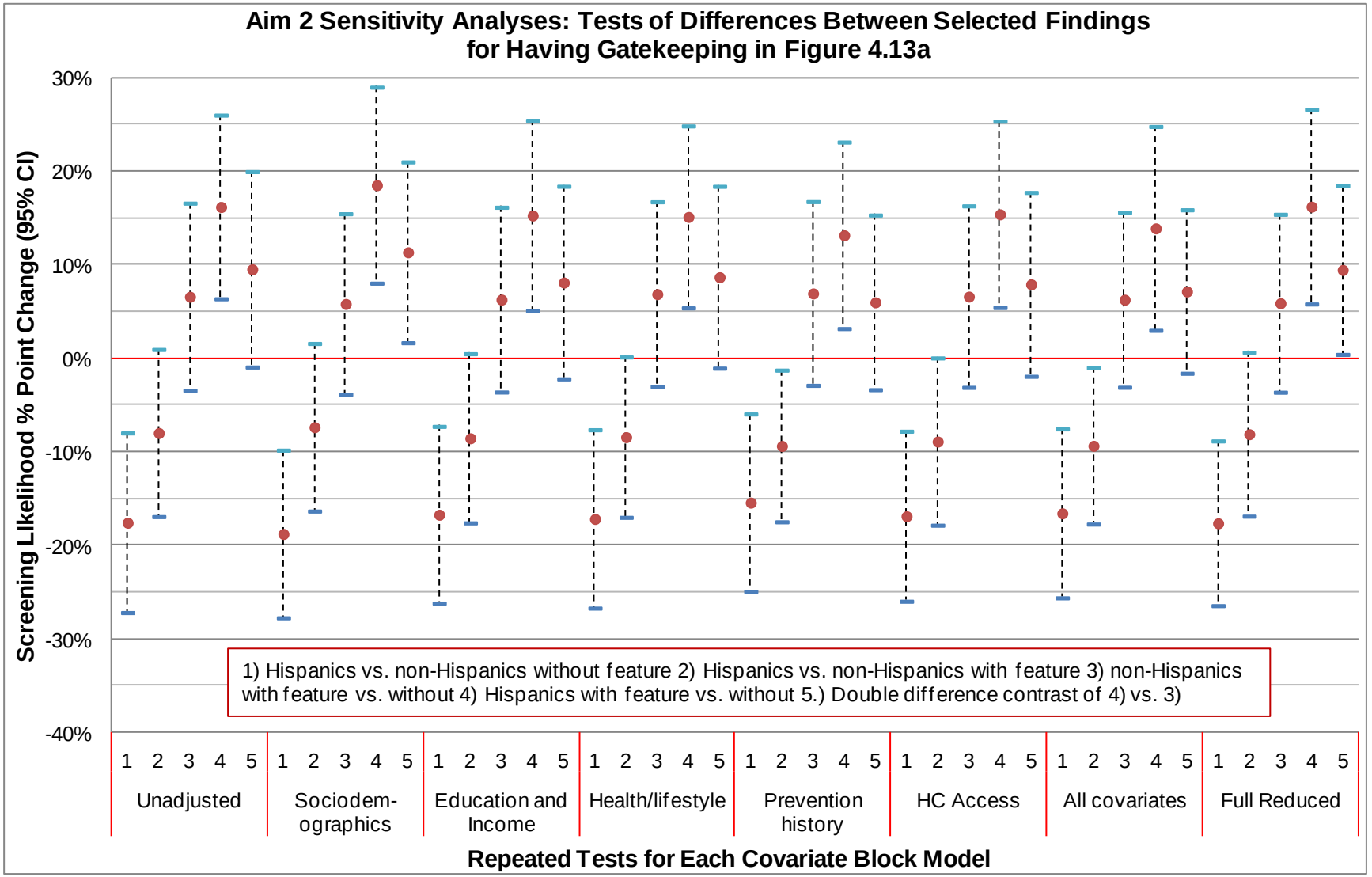

Aim 2 Sensitivity Analyses: Tests of Differences Between Selected Findings for Having Gatekeeping in Figure 4.13a
Screening Likelihood % Point Change (95% CI)
30%
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

Figure 4.14a

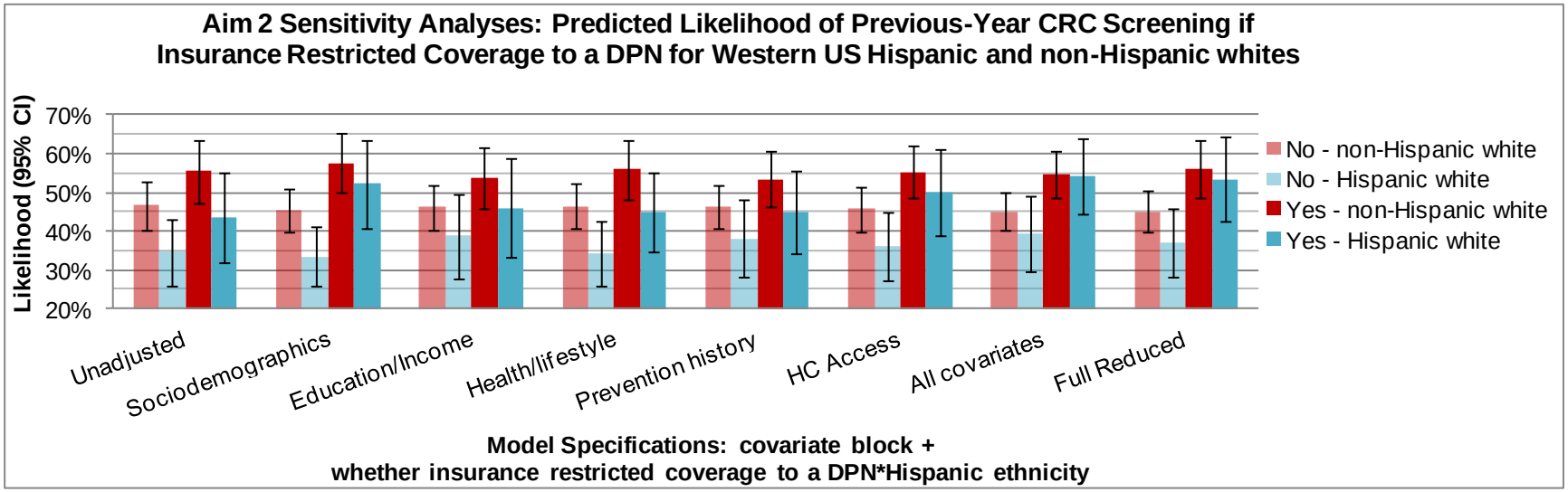
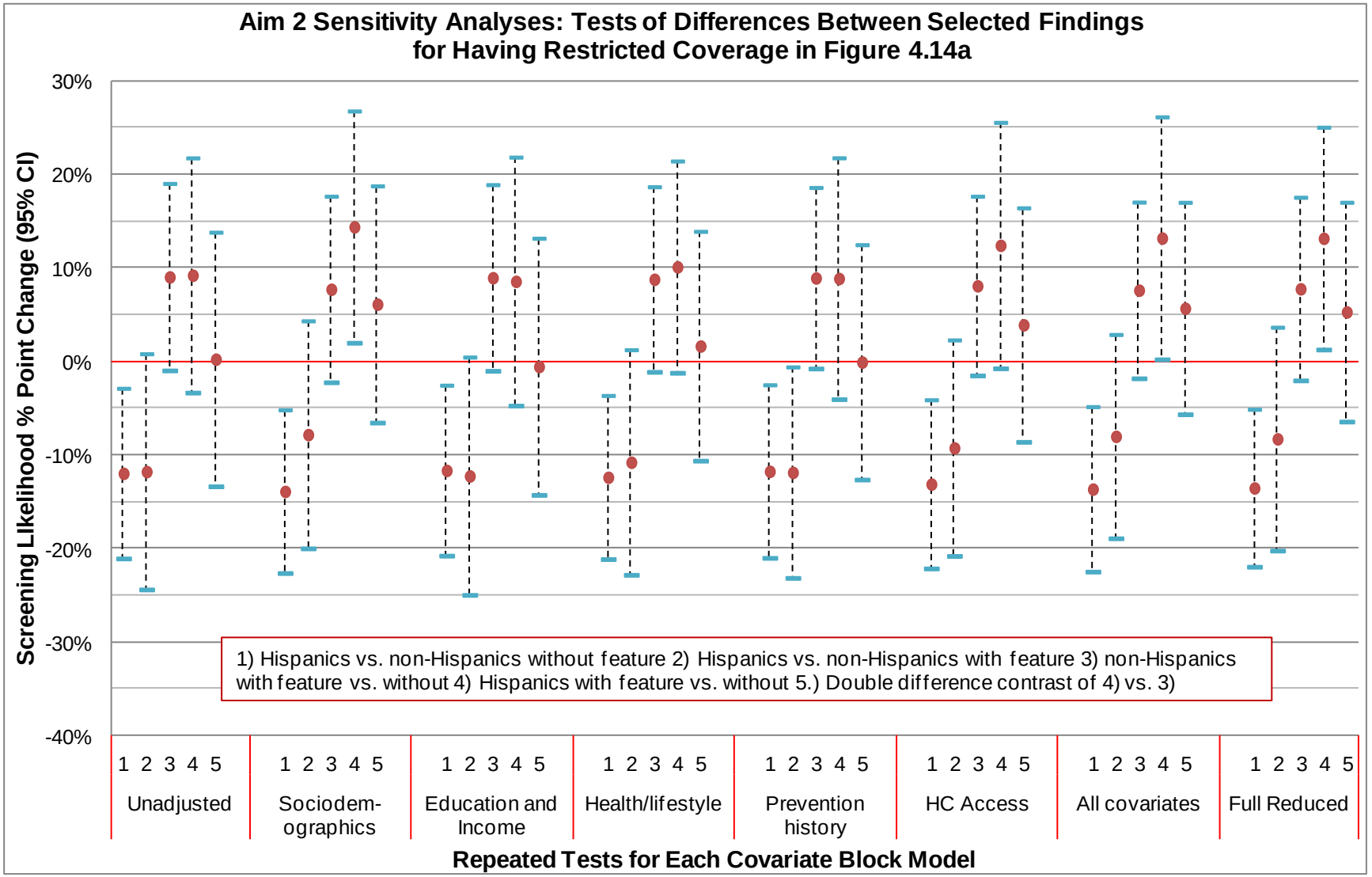

Aim 2 Sensitivity Analyses: Predicted Likelihood of Previous-Year CRC Screening if Insurance Restricted Coverage to a DPN for Western US Hispanic and non-Hispanic whites
Likelihood (95% CI)
70%
60%
50%
40%
30%
20%
Unadjusted
Sociodemographics
Education/Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
No - non-Hispanic white
No - Hispanic white
Yes - non-Hispanic white
Yes - Hispanic white
Model Specifications: covariate block + whether insurance restricted coverage to a DPN*Hispanic ethnicity

Figure 4.14b


Aim 2 Sensitivity Analyses: Tests of Differences Between Selected Findings for Having Restricted Coverage in Figure 4.14a
Screening Likelihood % Point Change (95% CI)
30%
20%
10%
0%
-10%
-20%
-30%
-40%
1) Hispanics vs. non-Hispanics without feature 2) Hispanics vs. non-Hispanics with feature 3) non-Hispanics with feature vs. without 4) Hispanics with feature vs. without 5.) Double difference contrast of 4) vs. 3)
1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

Next, for each Hispanic and non-Hispanic whites, having the insurance feature vs. not predicted a more positive change in screening likelihood in the sensitivity analysis than had been found in the main analysis. The positive change from the main analysis to the sensitivity analysis was usually accompanied by a change in significance toward a positive and significant effect for having the feature. For non-Hispanic whites in the main analysis, having insurance with a DPN predicted a significant reduction in screening likelihood, and in the sensitivity analysis, there was still a reduction, but it was much smaller and consistently non-significant. For non-Hispanic whites in the main analysis, having insurance that used gatekeeping vs. not predicted a non-significant reduction in screening likelihood, but predicted a significant increase in screening likelihood in the sensitivity analysis. For non-Hispanic whites in the main analysis, having insurance that restricted coverage to a DPN vs. not predicted a negligible non-significant change in screening likelihood, while in the sensitivity analysis, the magnitude of the change increased, but did not quite reach significance.

Similar changes were found for Hispanic whites in the sensitivity analyses. For Hispanic whites in the main analysis, having insurance with a DPN predicted a non-significant increase in screening likelihood, although the change was greater and significant in the sensitivity analysis. For Hispanic whites in the main analysis, having insurance that used gatekeeping vs. not predicted a positive and usually significant (except for the fully adjusted model) change in screening likelihood, and in the sensitivity analysis, the predicted change in screening likelihood was greater and always significant. For Hispanic whites, having insurance that restricted coverage to a DPN vs. not predicted a positive, although non-significant change in screening likelihood in the main analysis, and in the sensitivity analysis, that effect was larger and sometimes significant including the fully adjusted and full reduced models.

Last, two features had a change in the double difference contrast in the sensitivity analysis, while one did not. In the sensitivity analysis, the double difference contrast was essentially unchanged for having insurance with a DPN, so it was still positive and significant in the sensitivity analysis. The double difference contrast decreased and was less often significant in the sensitivity analyses for having insurance that used gatekeeping (a change from being always significant in the main analysis to sometimes significant or nearly significant in the sensitivity analysis) and having insurance that restricted coverage to a DPN (a change from sometimes significant in the main analysis to always non-significant in the sensitivity analysis). The reductions in the double difference contrasts reflects the greater changes in predicted screening likelihood from the main analysis to the sensitivity analysis for non-Hispanic whites than Hispanic whites.

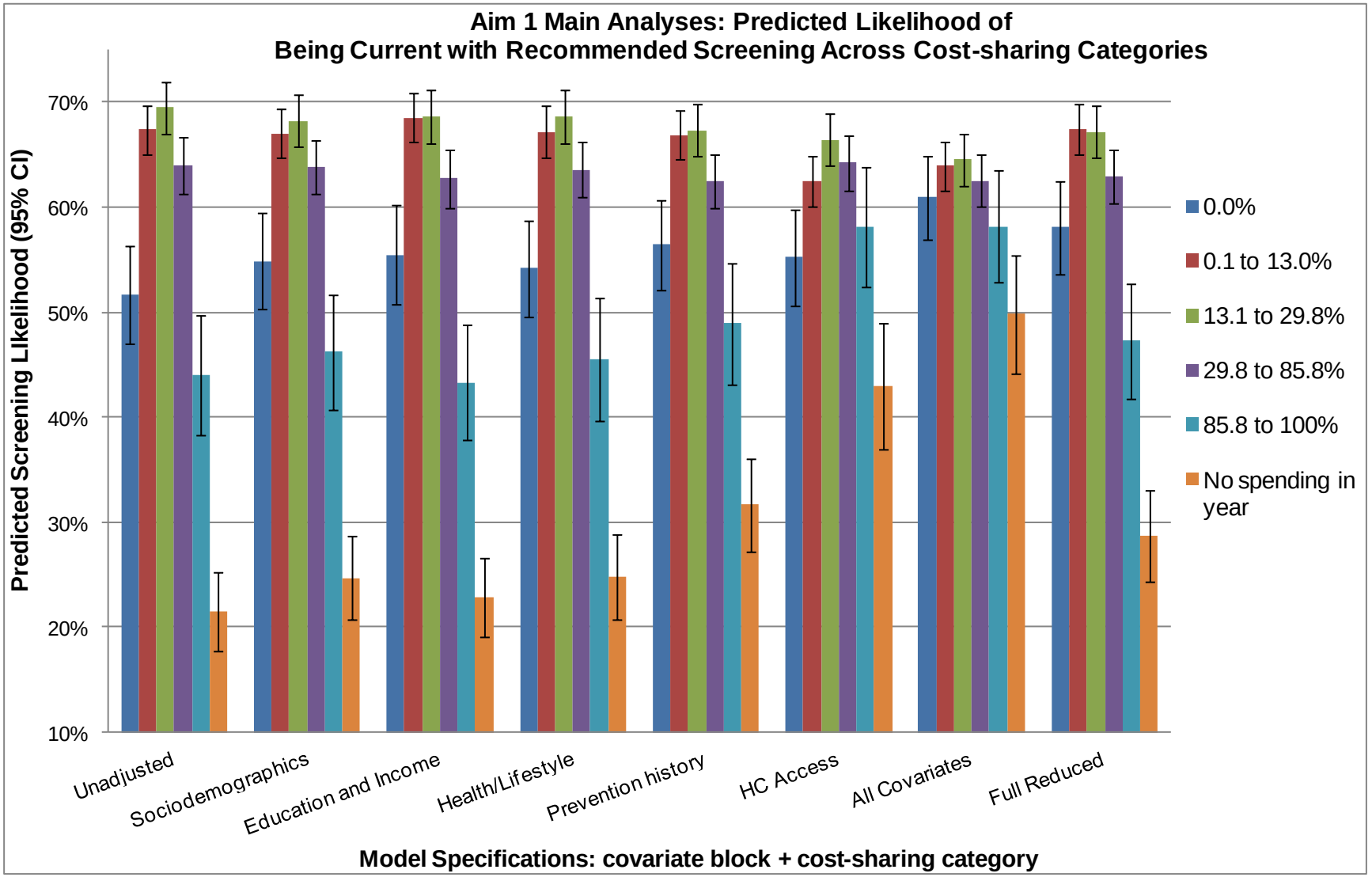
Multivariate Findings for Cost-Sharing Categories

Aim 1 main and sensitivity analyses

Figure 4.15 reports the Aim 1 main analysis findings of the predicted screening likelihoods across the cost-sharing categories. In the unadjusted analysis, predicted screening likelihood is highest and similar for the three internal tertiles of the cost-sharing distribution; is lower for those with 0% cost-sharing; is lower for those in the top 5th percentile of cost-sharing, which overlaps the confidence interval for the 0% cost-sharing group; and is much lower among those with no spending in the survey year. In three of the covariate block models (sociodemographics, education and income, and health/lifestyle), the pattern of the cost-sharing categories is very similar to the unadjusted model, suggesting that those factors did not substantively correlate with the cost-sharing categories. In the prevention history block model, predicted screening likelihood for the first

five cost-sharing categories did not change very much from the unadjusted model, although screening likelihood increased noticeably for those with no spending in the survey year by ~10% points suggesting that those people tend to

Figure 4.15


Aim 1 Main Analyses: Predicted Likelihood of
Being Current with Recommended Screening Across Cost-sharing Categories
Predicted Screening LIkelihood (95% CI)
70%
60%
50%
40%
30%
20%
10%
0.0%
0.1 to 13.0%
13.1 to 29.8%
29.8 to 85.8%
85.8 to 100%
No spending in year
Unadjusted
Sociodemographics
Education and Income
Health/Lifestyle
Prevention history
HC Access
All Covariates
Full Reduced
Model Specifications: covariate block + cost-sharing category

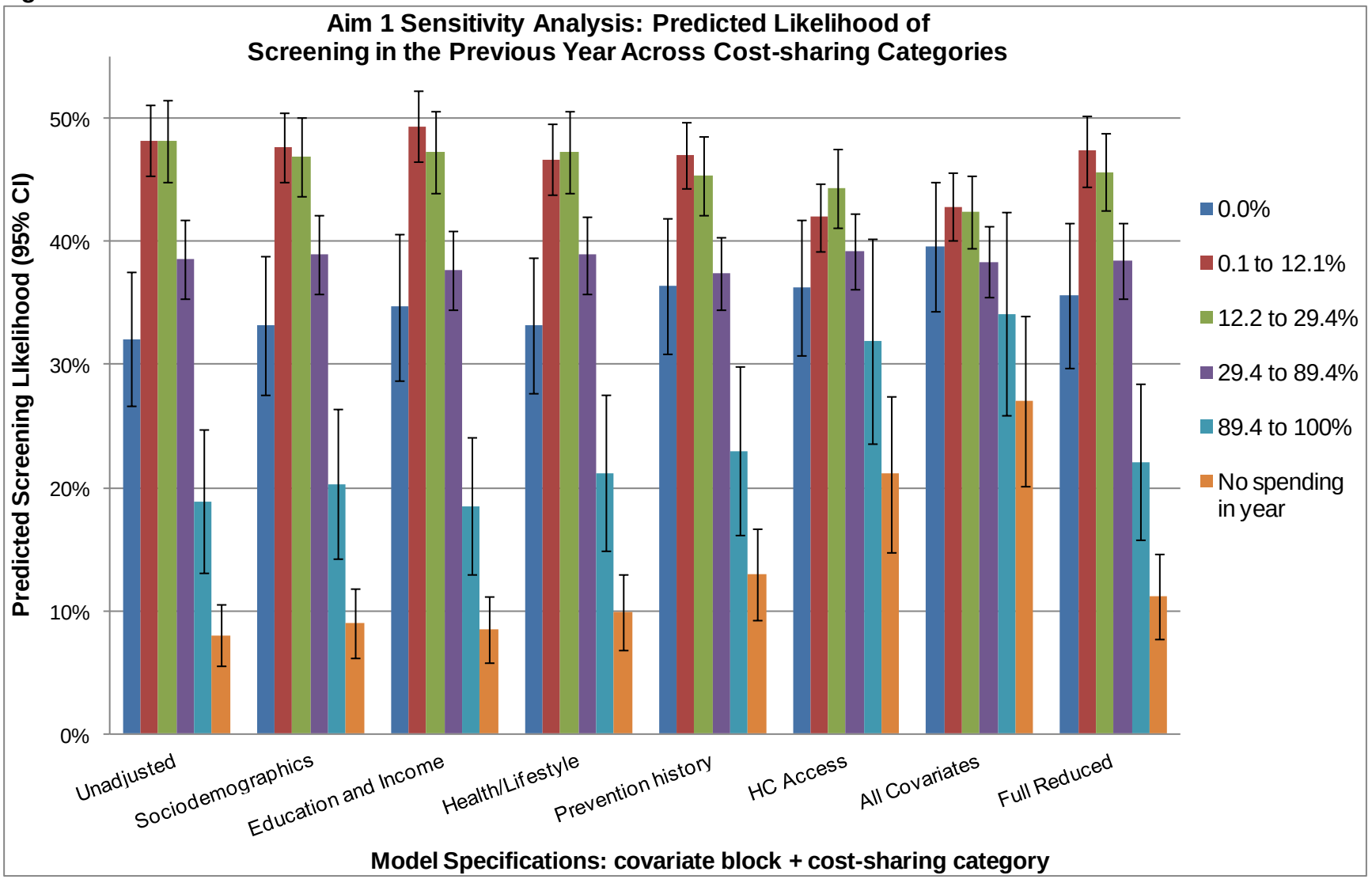
have an unfavorable history of having received the preventive services covariates, which consistently were strong predictors of screening likelihood. In the health care access model, predicted screening likelihood for the first four cost-sharing categories did not change very much from the unadjusted model, although screening likelihood increased substantially for the top 5th percentile of cost-sharing by >10% points and for the no spending category by >20% points. After adjusting for the health care access factors, the top fifth percentile category had a predicted screening likelihood that was slightly greater than the 0% cost-sharing category and the overlapping confidence interval indicates that it was not significantly different from the 0% cost-sharing category and the first and third internal tertiles of the cost-sharing distribution. The change in the HC access block model is consistent with the known inverse relationship between cost-sharing and health care utilization.

The patterns in the fully adjusted and full reduced models are consistent with the changes in the individual covariate block models. In the fully adjusted model, controlling for all covariates balanced predicted screening likelihood across the cost-sharing categories. The five cost-sharing categories have overlapping confidence intervals, while the no-spending group overlaps with the top fifth percentile of cost-sharing category. In contrast, the full reduced model retains the pattern of the unadjusted model and the covariate block models controlling for each the sociodemographics, education and income, and health/lifestyle blocks.

Predicted Screening Likelihood Depending on Cost-Sharing Categories for Aim 1 Sensitivity Analysis

The sensitivity analysis findings for Aim 1 (Figure 4.16) are consistent with the main analysis findings. One noticeable difference is that the third tertile of the internal part of the cost-sharing distribution had consistently lower predicted screening likelihood than the first and second tertiles in the sensitivity analysis,

Figure 4.16


Aim 1 Sensitivity Analysis: Predicted Likelihood of Screening in the Previous Year Across Cost-sharing Categories
Predicted Screening LIkelihood (95% CI)
50%
40%
30%
20%
10%
0%
Unadjusted
Sociodemographics
Education and Income
Health/Lifestyle
Prevention history
HC Access
All Covariates
Full Reduced
Model Specifications: covariate block + cost-sharing category
0.0%
0.1 to 12.1%
12.2 to 29.4%
29.4 to 89.4%
89.4 to 100%
No spending in year

although three internal tertiles had similar predicted screening likelihood in all models of the main analysis.

Predicted Screening Likelihood Depending on Cost-Sharing Categories for Aim 2

In the Aim 2 analysis of the cost-sharing variable, Hispanic and non-Hispanic whites had distinct patterns of predicted screening likelihood over the cost-sharing categories (Figure 4.17). The pattern for non-Hispanic whites was consistent with the pattern observed in the Aim 1 analysis. For Hispanic whites, the predicted screening likelihoods were less for the internal tertiles of the cost-sharing distribution and for the no-spending group than for the same categories for non-Hispanic whites, while the ends of the cost-sharing distribution (0% cost-sharing and the top fifth percentile of cost-sharing) had greater point estimates than the same categories for non-Hispanic whites. The Aim 2 individual covariate block adjustments had similar effects as in the Aim 1 analyses. For both Hispanic and non-Hispanic whites, the prevention history block model predicted noticeably higher screening likelihood for the no-spending group than was predicted in the unadjusted model. For each Hispanic and non-Hispanic whites, the health care access block model predicted substantially increased screening likelihood for the top fifth percentile group and the no spending group than was predicted in the unadjusted model. The Aim 2 fully adjusted and full reduced cost-sharing models (Figure 4.17b) changed the pattern of predicted screening likelihood in comparison to the unadjusted model similar to the change in the Aim 1 analyses. The fully adjusted model balanced the predicted screening likelihoods across cost-sharing categories for both Hispanic and non-Hispanic whites. The full reduced model did not substantially change the pattern of predicted screening likelihoods compared to the unadjusted model.

Because the Aim 2 cost-sharing analysis had a much smaller sample size than the Aim 1 analysis, confidence intervals are large for most estimates and it is not

Figure 4.17a

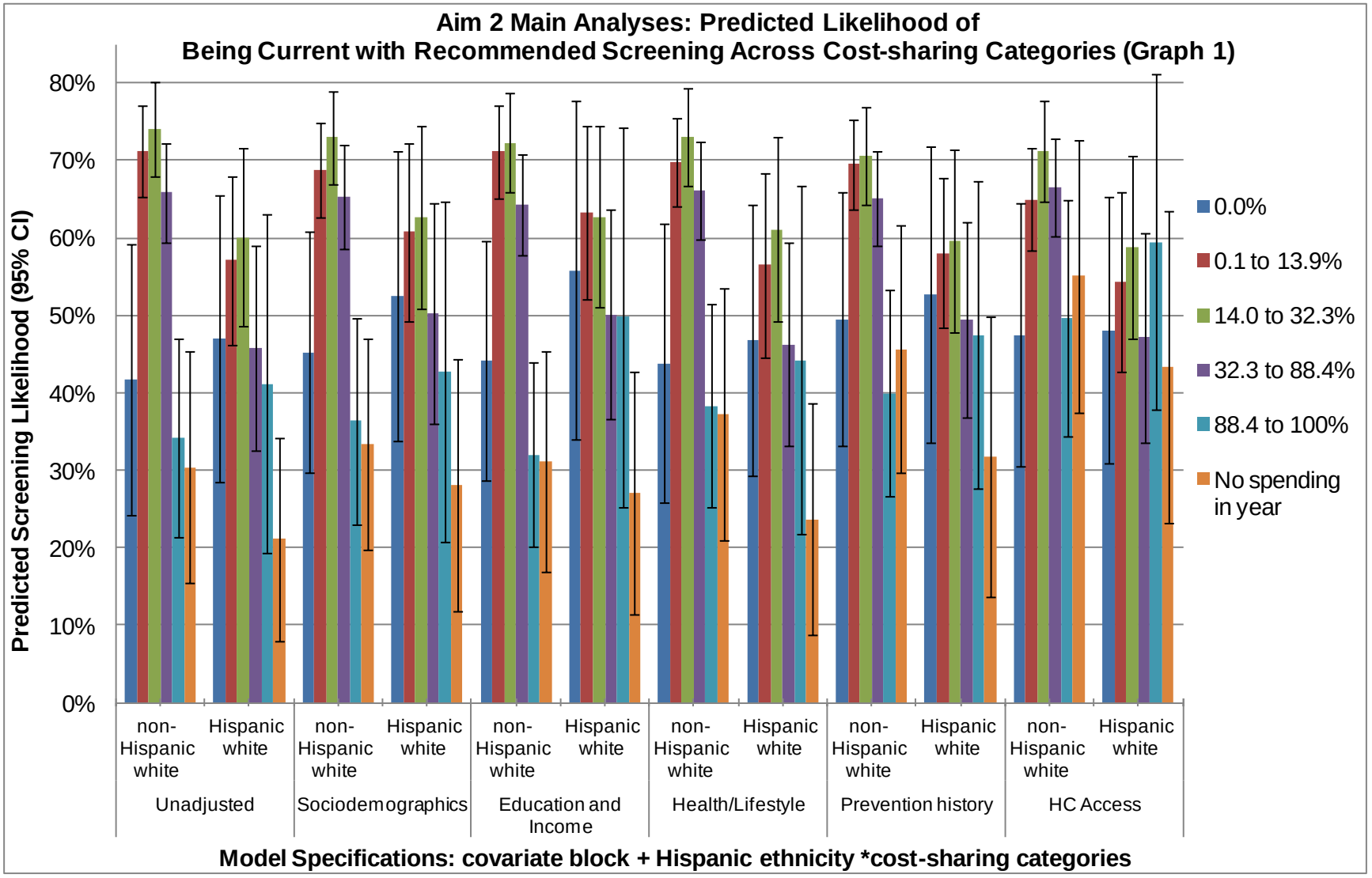

Aim 2 Main Analyses: Predicted Likelihood of
Being Current with Recommended Screening Across Cost-sharing Categories (Graph 1)
Predicted Screening LIkelihood (95% CI)
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.0%
0.1 to 13.9%
14.0 to 32.3%
32.3 to 88.4%
88.4 to 100%
No spending in year
non-Hispanic white
Hispanic white
Unadjusted
Sociodemographics
Education and Income
Health/Lifestyle
Prevention history
HC Access
Model Specifications: covariate block + Hispanic ethnicity *cost-sharing categories

Figure 4.17b

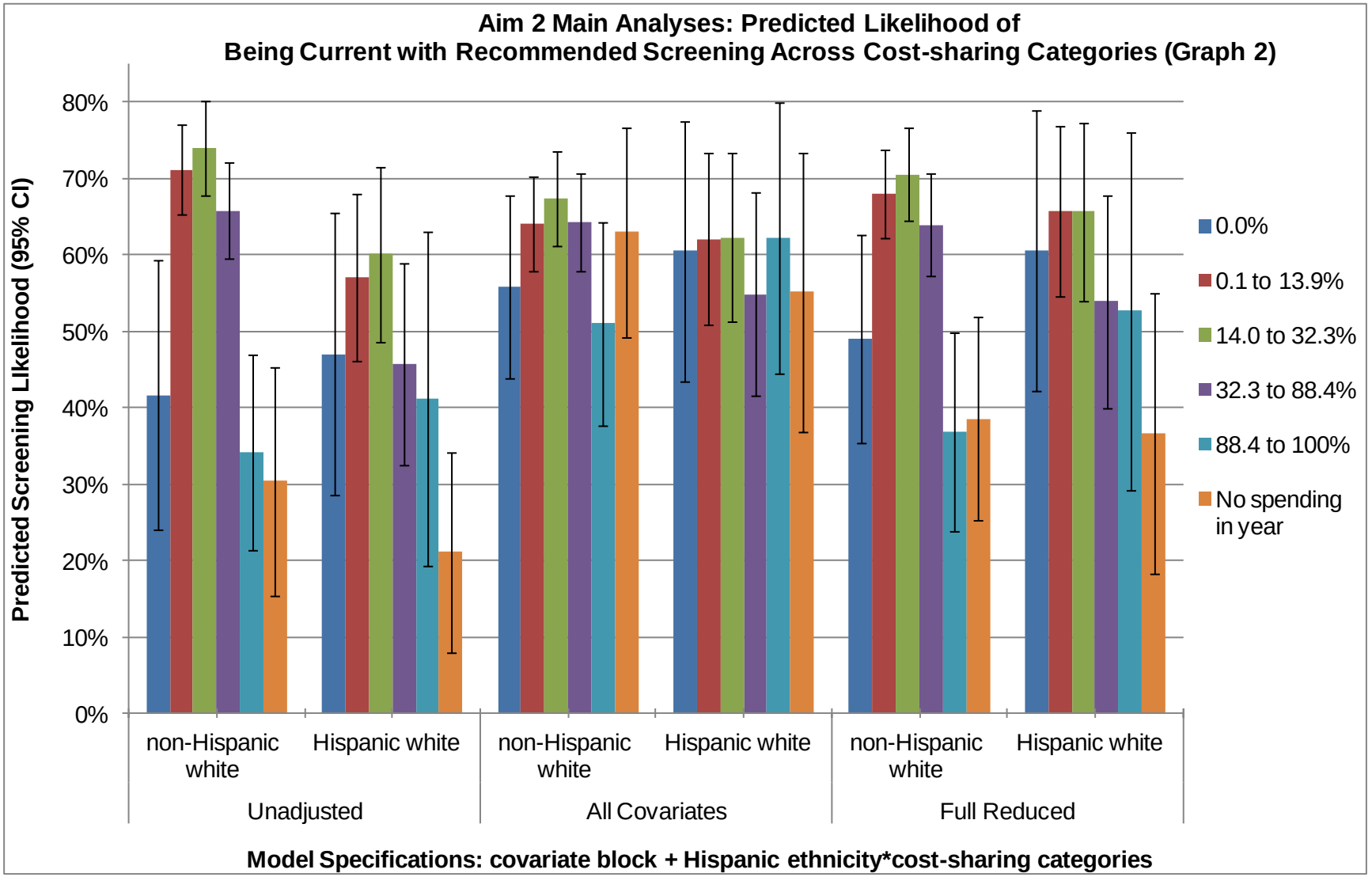
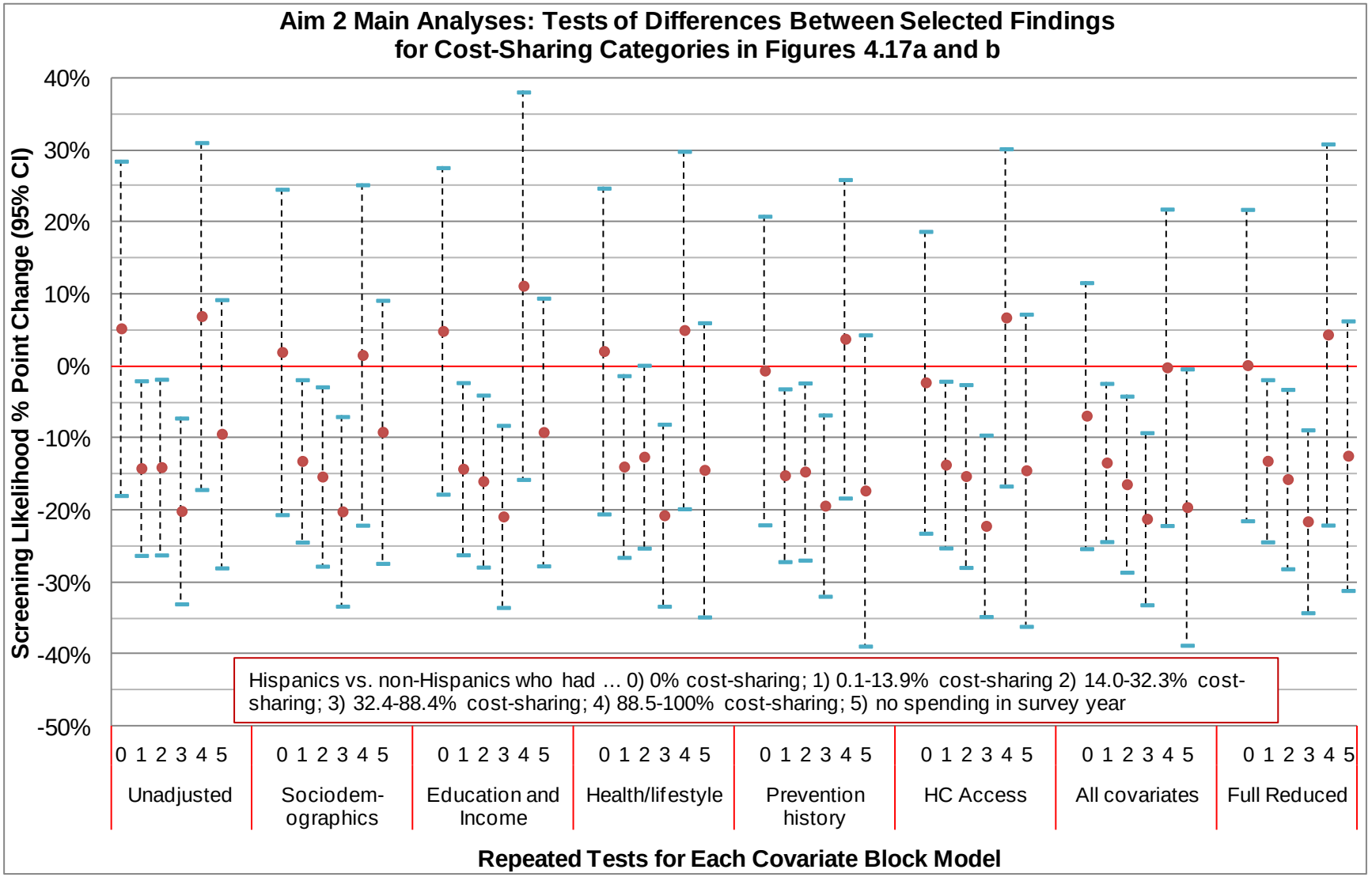

Aim 2 Main Analyses: Predicted Likelihood of
Being Current with Recommended Screening Across Cost-sharing Categories (Graph 2)
Predicted Screening LIkelihood (95% CI)
80%
70%
60%
50%
40%
30%
20%
10%
0%
non-Hispanic white
Hispanic white
non-Hispanic white
Hispanic white
non-Hispanic white
Hispanic white
Unadjusted
All Covariates
Full Reduced
0.0%
0.1 to 13.9%
14.0 to 32.3%
32.3 to 88.4%
88.4 to 100%
No spending in year
Model Specifications: covariate block + Hispanic ethnicity*cost-sharing categories

Figure 4.17c


Aim 2 Main Analyses: Tests of Differences Between Selected Findings for Cost-Sharing Categories in Figures 4.17a and b
Screening Likelihood % Point Change (95% CI)
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
Hispanics vs. non-Hispanics who had … 0) 0% cost-sharing; 1) 0.1-13.9% cost-sharing 2) 14.0-32.3% cost-sharing; 3) 32.4-88.4% cost-sharing; 4) 88.5-100% cost-sharing; 5) no spending in survey year
0 1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

clear if Hispanic and non-Hispanic whites significantly differed in screening likelihood across cost-sharing categories. Figure 4.17c reports the contrast tests for the difference between the predicted screening likelihoods for Hispanic and non-Hispanic whites in each cost-sharing category. For the internal tertiles of the cost-sharing distribution, Hispanic whites consistently had significantly lower predicted screening likelihood than their non-Hispanic white counterparts in each tertile. Differences between Hispanic and non-Hispanic whites for the other cost-sharing categories were non-significant in all models except that in the fully adjusted model, Hispanics in the no spending category had 19.5% points significantly lower predicted screening likelihood than non-Hispanic whites. Hispanics with no spending in the survey year had lower predicted screening likelihood than non-Hispanics in all the other models, although the differences did not reach significance. Although also never a significant difference, Hispanics in the top fifth percentile of cost-sharing category consistently had higher predicted screening likelihood than non-Hispanic whites in the top fifth percentile of cost-sharing. For the 0% cost-sharing category, Hispanic whites sometimes had higher and sometimes lower predicted screening likelihood than non-Hispanic whites.

In total, these findings suggest that Hispanics with some cost-sharing (including most of the cost-sharing distribution) had decreased predicted screening likelihood than non-Hispanic whites with equivalent cost-sharing, although there are not differences in screening likelihood for Hispanic and non-Hispanic whites at the extremes of the cost-sharing distribution. Hispanics with no spending likely have lower screening likelihood than their non-Hispanic white counterparts.

Aim 2 Sensitivity Analysis Findings

The Aim 2 sensitivity analysis findings for the cost-sharing variable overall exhibit very similar patterns to the main analysis of screening likelihood across the categories and between Hispanic and non-Hispanic whites (Figure 4.18). Figure

Figure 4.18a

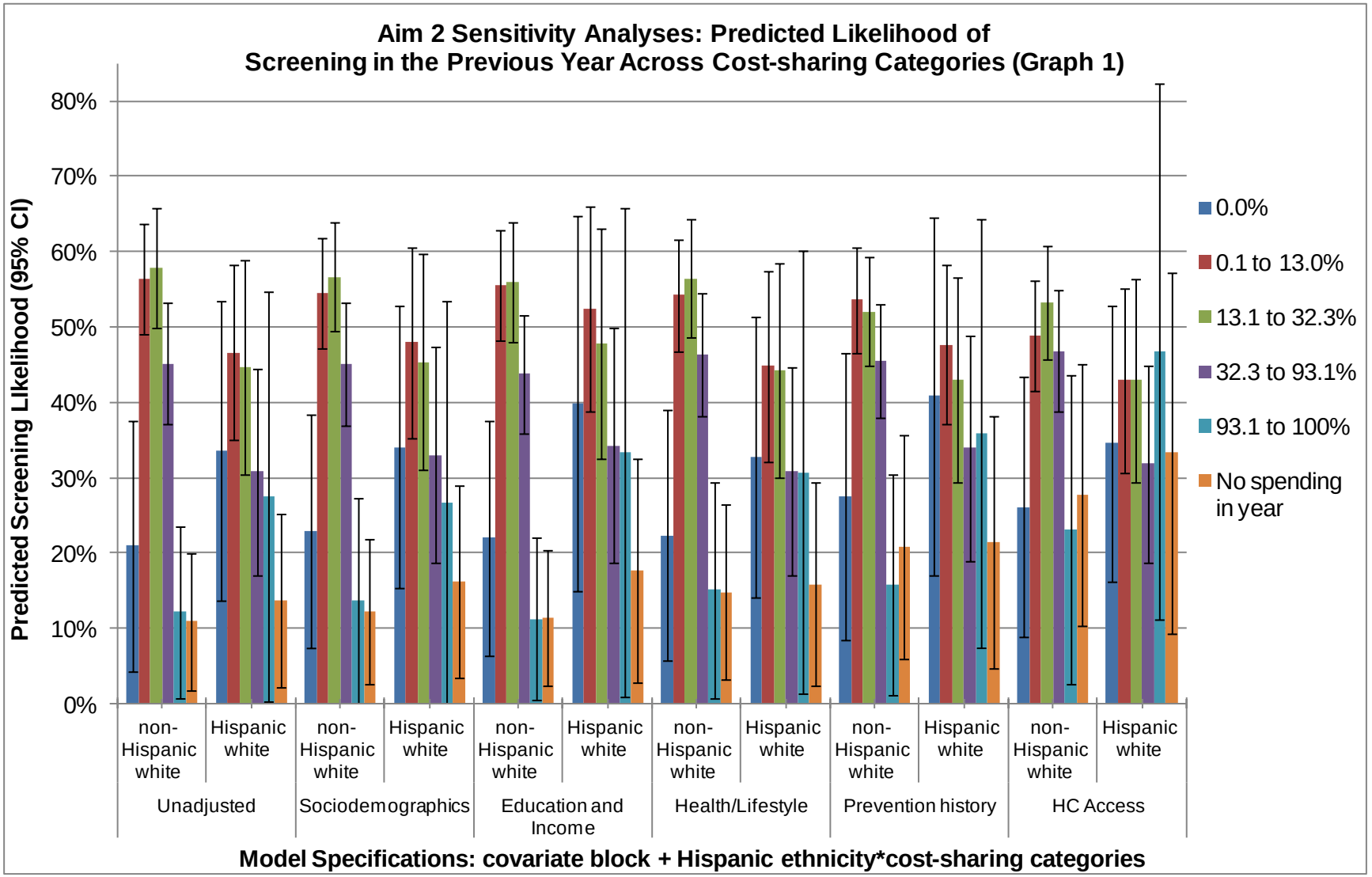

Aim 2 Sensitivity Analyses: Predicted Likelihood of Screening in the Previous Year Across Cost-sharing Categories (Graph 1)
Predicted Screening LIkelihood (95% CI)
80%
70%
60%
50%
40%
30%
20%
10%
0%
non-Hispanic white
Hispanic white
Unadjusted
Sociodemographics
Education and Income
Health/Lifestyle
Prevention history
HC Access
0.0%
0.1 to 13.0%
13.1 to 32.3%
32.3 to 93.1%
93.1 to 100%
No spending in year
Model Specifications: covariate block + Hispanic ethnicity*cost-sharing categories

Figure 4.18b

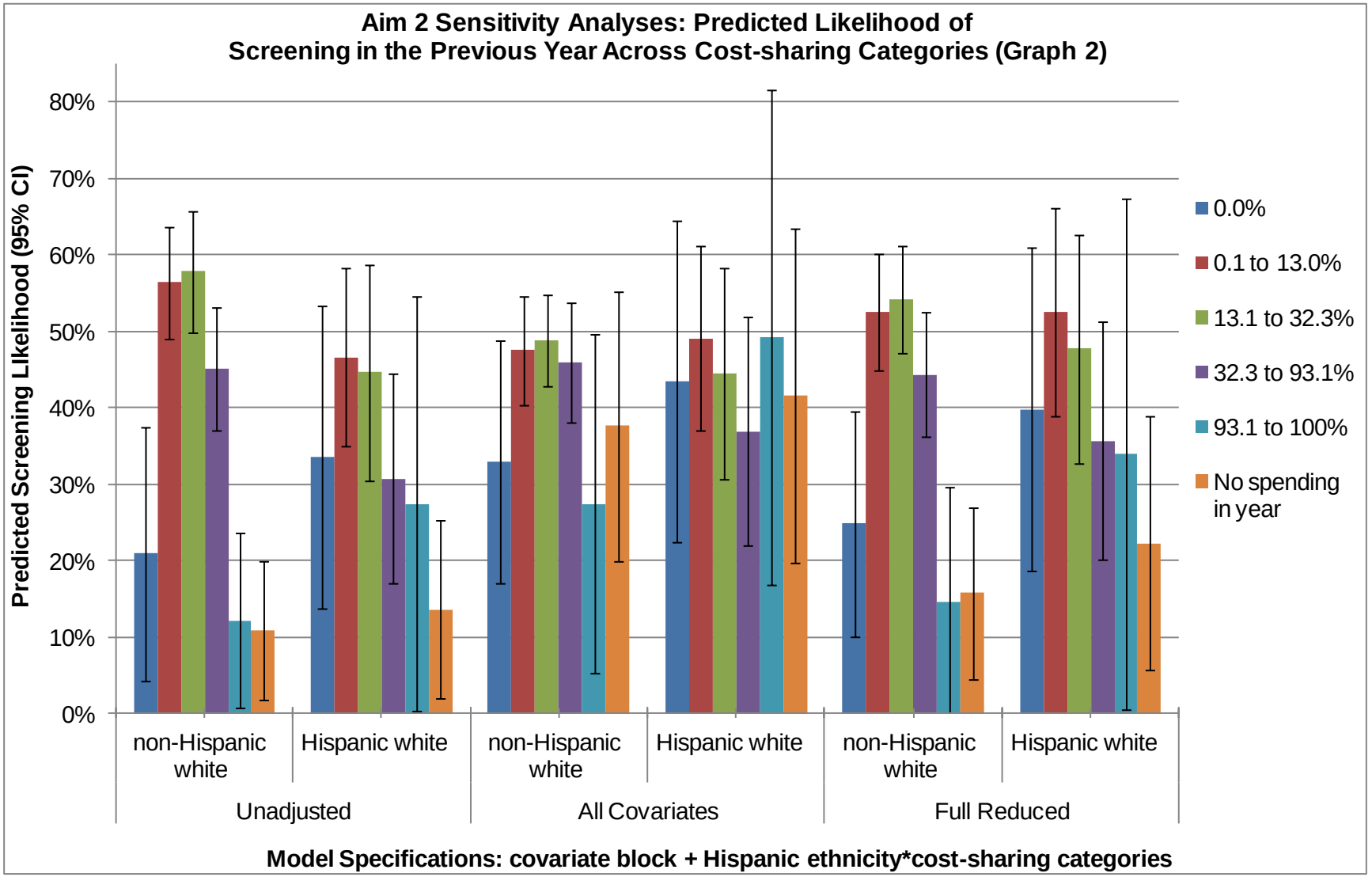
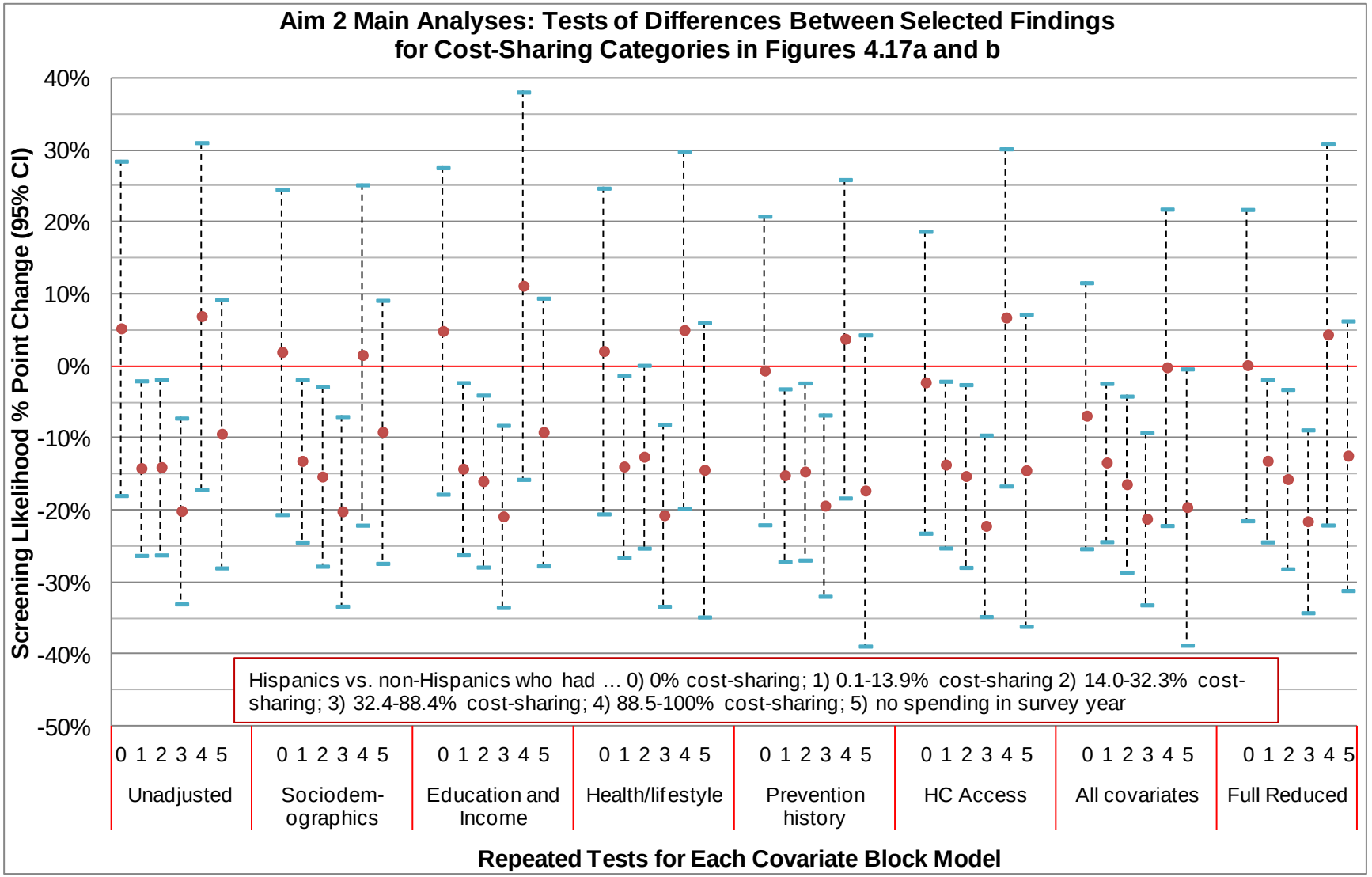

Aim 2 Sensitivity Analyses: Predicted Likelihood of Screening in the Previous Year Across Cost-sharing Categories (Graph 2)
Predicted Screening LIkelihood (95% CI)
80%
70%
60%
50%
40%
30%
20%
10%
0%
non-Hispanic white
Hispanic white
non-Hispanic white
Hispanic white
non-Hispanic white
Hispanic white
Unadjusted
All Covariates
Full Reduced
0.0%
0.1 to 13.0%
13.1 to 32.3%
32.3 to 93.1%
93.1 to 100%
No spending in year
Model Specifications: covariate block + Hispanic ethnicity*cost-sharing categories

Figure 4.18c


Aim 2 Main Analyses: Tests of Differences Between Selected Findings for Cost-Sharing Categories in Figures 4.17a and b
Screening Likelihood % Point Change (95% CI)
40%
30%
20%
10%
0%
-10%
-20%
-30%
-40%
-50%
Hispanics vs. non-Hispanics who had … 0) 0% cost-sharing; 1) 0.1-13.9% cost-sharing 2) 14.0-32.3% cost-sharing; 3) 32.4-88.4% cost-sharing; 4) 88.5-100% cost-sharing; 5) no spending in survey year
0 1 2 3 4 5
Unadjusted
Sociodem-ographics
Education and Income
Health/lifestyle
Prevention history
HC Access
All covariates
Full Reduced
Repeated Tests for Each Covariate Block Model

4.18c reports the contrast tests for the difference between the predicted likelihood of any screening in the previous year for Hispanic and non-Hispanic whites in each cost-sharing category. The estimated differences are more positive across all models than in the main analysis and only Hispanics vs. non-Hispanics in the third tertile of cost-sharing still had a consistent significant disparity in screening likelihood. The difference consistently did not reach significance for the first tertile, and only reached significance in three of eight models for the second tertile, which included significant differences for the fully adjusted and full reduced models. For the 0% cost-sharing category and the top fifth percentile, the differences are more favorable to Hispanics, although did not reach significance. Hispanics may have higher predicted screening likelihood for screening in the previous year than non-Hispanic whites at the extremes of the cost-sharing distribution.

Chapter 5

Discussion

This section contains a discussion of key findings, limitations, policy issues, and the conclusion.

Key Findings

This study investigated the influence of a person's health insurance features, including organizational and financial features, on whether they obtain CRC screening and whether there is a difference in insurance feature effects for Western US Hispanic whites vs. non-Hispanic whites. The analyses found that the multiple insurance features studied predicted varying use of CRC screening, which suggests insurance design may have public health importance for CRC screening. If insurance features even modestly affect CRC screening use, the population health implications would be large considering that more than 75 million Americans are eligible for CRC screening and only around 60% of eligible persons are up-to-date with recommended CRC screening. To the best of my knowledge, this is the first study to assess these potential relationships, which is relevant to insurers', providers' and policymakers' efforts to increase use of recommended CRC screening, a notably underused highly effective cancer screening, and is relevant to efforts to increase use of other preventive services. This section discusses the key findings for each analysis, relevant evidence from other studies, and implications of the findings. Notable limitations and policy issues are discussed before concluding.

Aim 1 Organizational Insurance Features

Two of the three organizational features (using gatekeeping and restricting coverage to a DPN) predicted significantly greater CRC screening in the previous-year in the sensitivity analyses after controlling for covariates, although none of the three features significantly predicted being up-to-date with recommended CRC screening in the main analyses. The sensitivity analysis findings may support the hypothesis that an insurer will achieve greater screening use if they have a greater capacity to communicate appropriate CRC screening to providers and enrollees. Whether a person had insurance with a DPN may not have been significant in both analyses because it did not substantially increase an insurer's capacity to communicate appropriate screening, in contrast to the seemingly greater administrative controls of restricting coverage to a DPN and using gatekeeping. The significant sensitivity analyses findings and non-significant main analyses findings supports the rationale for the sensitivity analyses: insurers may be less able or not able to influence being up-to-date with recommended screening because enrollees could be up-to-date with CRC screening due to having been screened prior to gaining their current insurance. Overall, these findings indicate that certain organizational insurance features may support increasing use of CRC screening and that further research is needed particularly with study designs that are able to estimate a causal effect of the significant associations found here.

The same organizational features were assessed in Tye et al.'s evaluation of insurance features as predictors of having received mammography in the previous two years using 1996 MEPS data. Tye et al. found that women who had insurance with a DPN had a multivariate adjusted predicted probability of screening of 78%, in comparison to 75% for women with plans that did not have a DPN (OR: 1.21, 95% CI = 1.07-1.36). Tye et al. also found that women whose insurance used gatekeeping had a multivariate adjusted predicted probability of

screening of 78% vs. 75% for women with insurance that did not use gatekeeping (OR: 1.18, 95% CI = 1.03-1.36). No other health insurance features significantly predicted mammography use including whether coverage was restricted to a DPN, which was also assessed here, and several financial features that were not available to be evaluated in this study. While the studies are not comparable in many ways (including outcomes, the year(s) of data and sample sizes, covariates controlled for, and eligibility criteria), Tye et al.'s significant findings for two organizational features are consistent with this study's sensitivity analysis findings suggesting a potential modest positive influence of certain insurance organizational features on likelihood of having recently received cancer screening.

Other studies provide evidence regarding the influence of types of insurance and features on use of CRC screening, although the findings are not easily comparable or relatable to this study's findings. Pertaining to types of insurance, HMOs have consistently achieved higher screening use than PPOs on the HEDIS CRC screening measure since they were first measured for both insurance types in 2005 (National Committee for Quality Assurance 2013), which may be partially attributable to favorable organizational features including the ones here that more commonly occur in HMOs than PPOs. O'Malley et al. found that Medicare beneficiaries who had specialists available when the patient thought they were needed had a higher likelihood of recent CRC screening, which may be inconsistent with the positive effects for this study's organizational features including using gatekeepers and restricting coverage to a DPN. These conjectures comparing this study's findings to other evidence reflect the fundamental difficulties that inhibit comparing and making connections between studies of insurance effects on CRC screening use and studies of insurance effects on health services use more generally.

Aim 1 Financial Insurance Features

Regarding the Aim 1 findings for financial insurance features, the evaluated financial features (whether a person's household had a FSA and categories of cost-sharing) had substantial unadjusted differences in predicted screening likelihood, which mostly did not remain significant in fully adjusted analyses. Whether a person had a FSA may have been a proxy for being health aware, since adjusting for the education and income covariate block and the prevention history block each pushed downward the estimated change in predicted screening likelihood due to having an FSA. In order to have a FSA, the respondent or someone in the respondent's household had to have been employed. If people with a FSA were employed and therefore generally younger, this employment criterion may have biased downward the effect of having an FSA since younger people tend to have a lower screening likelihood and if being employed creates a barrier to a person having the time to seek CRC screening. Ultimately, whether a person has an FSA does not seem to be an independently significant predictor of CRC screening and it is not clear what proxy effects it represents.

Cost-sharing levels may be proxies for adequacy of health care access and inclination to seek needed care, although may not be independently significant factors, since significant unadjusted differences for these variables were largely mitigated after adjusting for the prevention history and health care access covariate blocks. The effect of categories of cost-sharing on use of CRC screening may be mediated by health care access factors (e.g. number of outpatient provider visits), so it may be inappropriate to include health care access factors as covariates in the model. In addition, although dental checkup frequency or time of most recent flu shot would not seem to mediate the influence of cost-sharing on CRC screening use, those prevention history variables may be correlated with other factors on the causal pathway, which

would make it also inappropriate to control for the prevention history covariate block. The Aim 1 sensitivity analysis for the cost-sharing categories was essentially equivalent to the main analysis findings.

Notably, respondents with 0% cost-sharing had lower screening likelihood than respondents from the three internal tertiles of the cost-sharing distribution (greater than 0% and less than the 95th percentile). When the distribution of cost-sharing values was broken up into 20 approximately equally populated quantiles (respondents with 0% cost-sharing are the first quantile), the finding remained: 0% cost-sharing had lower likelihood of screening than every quantile except the highest, 95th to 100th. Even in comparison to respondents in the quantile with the smallest non-zero cost sharing (0.1-2.1%), who would be expected to be similar to the 0% subgroup, the 0% subgroup had substantially lower likelihood of being up-to-date with recommended screening, 54.0 vs. 66.3%.

A comparison of respondent characteristics revealed that the 0% and 0.1-2.1% cost-sharing subgroups were similar for many characteristics (socioeconomics, acculturation, the organizational health insurance features and some other health care access factors), although had notable differences. The 0% subgroup was significantly >1.3 years younger, more male, more likely Hispanic or non-Hispanic Black and was more likely from the Western Census region than the South or Midwest. The 0% cost-sharing group was significantly healthier than the 0.1-2.1% cost-sharing subgroup across many health measures including having a lower rate of obesity, lower Charlson comorbidity index scores, better perceived health status and less personal non-CRC cancer history. The 0% subgroup also had significantly lower health services utilization across multiple measures including having last received a flu shot further in the past, having fewer outpatient provider visits in the survey year, and being less likely to have a usual source of care. Source of health insurance was similar except for the 0% cost-sharing subgroup had a larger composition of persons aged <65 years with any private insurance 42.5% vs. 36.0% in the 0.1-2.1% subgroup (although both

subgroups have a substantially smaller proportion of the subgroup aged <65 years with private insurance than the full sample, 62.5%).

The different characteristics in the 0% and 0.1-2.1% cost-sharing subgroups suggest that relatively good health and less interaction with the health care system result in the 0% subgroup avoiding out-of-pocket health care expenses and also not obtaining CRC screening. The increased likelihood of CRC screening for someone with 0.1-2.1% cost-sharing could plausibly be the result of someone with 0% cost-sharing having a sudden health shock or electively deciding to seek care, and as a result, both incurring out-of-pocket costs and have increased probability of obtaining CRC screening due to increased interaction with the health care system.

In total, the Aim 1 cost-sharing findings indicate further research is needed particularly with study designs that are able to eliminate residual confounding in order to estimate a causal effect of level of cost-sharing on CRC screening use. Cost-sharing categories may be a useful unadjusted proxy in other data sources such as administrative data that do not include detailed personal characteristics to adjust as covariates.

Aim 2 Organizational Features

The Aim 2 findings indicated that organizational insurance features might influence screening use differently for Hispanic whites than non-Hispanic whites in the Western US. The main analyses found that having the organizational features predicted decreased or unchanged screening likelihood for non-Hispanic whites, while Hispanic whites had unchanged or increased predicted screening likelihood. Hispanic whites had more positive effects of having an organizational insurance feature vs. not than non-Hispanic whites, and the differences of the effect for Hispanic whites minus the effect for non-Hispanic whites were usually significant, which suggests that some insurance features may contribute to reducing disparate screening among Hispanic whites. In the Aim 2 sensitivity

analyses compared to the main analyses, Hispanics whites did not benefit as much due to having two of the organizational features (insurance with gatekeeping or coverage restricted to a DPN) in comparison to non-Hispanic whites, and the differences of the effect for Hispanic whites minus the effect for non-Hispanic whites were less likely to be significant in the sensitivity analysis, which suggests organizational features may affect reduced disparities in being up-to-date with recommended CRC screening although not reduce disparities for having been screened in the previous year. In the Aim 2 sensitivity analysis, whether a person had a DPN equally predicted a reduced screening disparity for Hispanics in the sensitivity analysis as in the main analysis. The Aim 2 main and sensitivity analysis findings largely agree and contradict the hypothesis that Hispanic whites would benefit less due to having the insurance features than non-Hispanic whites. The organizational features may mitigate an access deficiency that is more of an issue for Hispanic whites than non-Hispanic whites (Singal 2013).

Aim 2 Financial Insurance Features

For the cost-sharing variable in the Aim 2 main analyses, non-Hispanic whites had a pattern of predicted screening likelihoods across the cost-sharing categories that was similar to the Aim 1 findings for the cost-sharing variable. Hispanic whites had a less varied pattern in a narrower range than non-Hispanic whites did. Variation in predicted screening likelihood was essentially eliminated for Hispanic whites and largely mitigated for non-Hispanic whites in the fully-adjusted model. Hispanic whites in the internal tertiles of the cost-sharing distribution usually had significantly lower predicted screening likelihood than non-Hispanic whites by greater than 10% points in most models. For those who had no spending in the survey year, those with 0% cost-sharing and those in the top fifth percentile of the cost-sharing distribution, Hispanic and non-Hispanic whites did not have significantly differing screening likelihood. In the sensitivity

analysis, findings were similar although there were no longer significant differences for Hispanics vs. non-Hispanics in the first internal tertile of the cost-sharing distribution. There is not an obvious explanation for why cost-sharing categories predicted less variation in screening likelihood for Hispanic whites than non-Hispanic whites or why Hispanic whites in the internal tertiles of the cost-sharing distribution had lower predicted screening likelihood than non-Hispanic whites. Since there was not a significant difference for Hispanic whites vs. non-Hispanic whites among those who had no spending in the survey year, those with 0% cost-sharing and those in the top fifth percentile of the cost-sharing distribution, the most disadvantaged Hispanic whites may not have disparate CRC screening use compared to their non-Hispanic white counterparts.

Limitations

The study has some notable limitations. First, estimates of insurance feature effects may be biased by unobserved differences between those with and without the insurance features (i.e. residual confounding/endogeneity (Levy and Meltzer 2008)) as is a potential threat in all cross-sectional studies of observational studies where the independent variable of interest is not known to vary randomly**.** By adjusting for a broad set of covariates in eight models for each analysis, this study made a substantial effort to mitigate residual confounding. In addition, the threat of residual confounding may be small for the evaluated organizational insurance features because those administrative features would prima facie only weakly have any association with other personal characteristics that influence use of CRC screening including health care access factors and other predisposing and enabling factors. On the other hand, the financial features, categories of cost-sharing and whether a person has an FSA, may more strongly reflect a person's other health care access factors and other predisposing and

enabling factors, so the threat of residual confounding may be greater. The range of estimates generated in each analysis provide valuable evidence regarding how certain clusters of covariates and larger groups of covariates were correlated with and influenced estimates of insurance feature effects.

A study design that isolates the exogenous effect of insurance features on CRC screening use is needed to estimate an unbiased causal effect. Suitable study designs could include a natural or quasi-experiment where some exogenous event results in variation in insurance coverage and suitable analyses are performed such as difference-in-difference estimation or instrumental variables, or could use a randomized controlled experiment where insurance features are randomly assigned to a sample. Substantial challenges impede carrying out these study designs. A natural experiment may be feasible in the context of a large employer that randomly varied insurance design for some of its employees, although such a study would likely exclude retired persons aged 65-75 who are eligible for CRC screening. A state-level policy that constrained insurance design could possibly permit comparing those in the state to those in a neighboring state without the insurance design constraint, although again it may be unlikely such a situation would apply to those aged 65-75 who are almost completely federally insured by Medicare. To date, the RAND Health Insurance Experiment (Manning 1987) and the Oregon Medicaid lottery (Baicker and Finkelstein 2011) are the only true social experiments where insurance plans were randomly allocated to individuals. A true randomized experiment would be an expensive and in other ways resource-intensive undertaking, and it is highly unlikely that such an undertaking would be worthwhile solely to identify the effects of insurance features on CRC screening use. It is possible that a larger experiment of insurance design could be worthwhile including CRC screening as one of several outcomes. Future research should use natural and quasi-experiments to generate evidence regarding insurance feature effects on use of

CRC screening and other health services, which would likely need to focus on either the 50-64 year age group or the 65-75 year age group considering the notable difference in insurance provision before and after Medicare eligibility.

A second notable limitation is the data limitations of the evaluated insurance features including known inaccuracies in the MEPS source variables, how the variables were constructed in this study, and the features' limited capacity to measure meaningful variation in insurance design. The source MEPS managed care variables are known to be biased by respondent error in household-reported information, which, for instance, results in MEPS overestimating the number of persons in HMOs in comparison to estimates from industry sources (Agency for Healthcare Research and Quality 2013b). In addition, a person's insurance features reported in MEPS correspond to the last insurance held by a person, although the person could have had different insurance at an earlier point in the interview period.

In addition to the limitations of MEPS's source variables, the construction of the insurance features for this study has a potential for bias. First, two of the organizational features, whether a person's insurance had a DPN and whether a person's insurance used gatekeeping, had overlapping definitions, since a person was identified as having either of those two features by having been enrolled in an HMO (either a private HMO or a Medicaid HMO) in addition to unique criteria for each variable using MEPS variables that directly asked if the respondent's insurance used gatekeeping or if the respondents' insurance defined a provider network. The overlapping constructions mean that the two variables are partially evaluating the same effect of being enrolled in an HMO. There was also a limitation for the construction of the variable of whether a person's insurance restricted coverage to a DPN as was noted in the Methods section. MEPS only had specific information to construct the variable for persons with private insurance. Medicare beneficiaries without any private insurance

(16.7% of the full Aim 1 sample) were assumed not to have coverage restricted to a DPN. This assumption may be somewhat inaccurate. Lower payment rates for Medicare than the commercial market inherently restricts coverage to a DPN, since Medicare beneficiaries can only see providers who are willing to accept those lower payment rates. This issue may be more salient for some beneficiaries than others. The local panel of providers who will see Medicare beneficiaries might be large and offer a large amount of provider choice in some places, but not others. For instance, such a discrepancy may occur in urban vs. rural areas or suburban vs. inner city areas. Last, as noted in the methods, those under age 65 with only public insurance were excluded from the analysis of whether a person's insurance restricted coverage to a DPN. A large portion of those under age 65 with only public insurance may have had restricted coverage by having Medicaid or other public insurance that is directly administered by managed care organizations or may have de facto restricted coverage to the providers that are willing to accept lower payment rates from public insurance. The aforementioned data construction limitations have a potential to bias the evaluated effects of the organizational insurance features and indicate a need for better information about insurance characteristics in publically available datasets.

Last, the evaluated insurance features had limited capacity to measure meaningful variation in insurance design in several ways. Insurance features were evaluated in this study rather than insurance types to avoid the problem of evaluating binary categorizations of health insurance types that are too general to have precise meaning and yield actionable evidence. Ideally, features that directly pertained to use of CRC screening would have been studied although none were available. Of the available measures, the organizational insurance features were very general with a breadth of possible meanings for each having a DPN, having gatekeeping insurance, and having insurance that restricted coverage to a DPN, so they suffer from the same problem as binary categories of

health insurance types. The financial features are specific constructs related to a person's health insurance and health care experience, although are only proxies for more suitable variables. Whether or not a person has a FSA relates to a specific health savings account that is tied to employment, although persons may have other types of savings accounts for medical expenses. Categories of cost-sharing are a proxy for burden of health care expenses, although they do not specifically reflect cost-sharing for CRC screening. Thus, the limited relevance of the evaluated insurance features also indicates a need for better information about insurance characteristics in publically available datasets.

A third limitation is the accuracy of self-reported CRC screening history in MEPS, which may be inaccurate with respect to type of screening used and time since last screening. Meta-analysis findings have found that cancer-screening prevalence estimates from national health surveys are likely overestimated and that differences in reporting accuracy between whites, blacks, and Hispanics likely bias estimates of disparities in screening use (Rauscher 2008). The meta-analysis findings suggested that Hispanics might tend to underreport CRC screening history while African Americans tend to over-report CRC screening history. A key reason for over-reporting of CRC screening use for all respondents in study's using survey data is non-response bias, since non-responders are less likely to have been screened (Schneider 2008a). Indeed, the aggregate estimate of the proportion of the population up-to-date with recommended CRC screening was 62.5% in this study for the full US population from 2009-2011. That estimate is less than the estimate for the 2010 BRFSS (Joseph 2012), 64.5%, which has a lower response rate than MEPS, and is greater than the estimate for the 2010 NHIS (Shapiro 2012), 58.3%, which has a higher response rate than MEPS. Another issue affecting the accuracy of self-reported CRC screening history is question phrasing. Comparing the EARTH study of an AIAN sample and the Alaska BRFSS, it was noted that question

phrasing might have contributed to overestimates of screening use in the Alaska BRFSS (Schumacher 2008). The EARTH study asked respondents "how old were you at your last screening", while BRFSS asks "how long has it been since your last test", which people tend to underestimate, thereby making persons noted as up-to-date with screening when they were not. MEPS uses the same phrasing as BRFSS. National health surveys should strive to optimize response rates to yield accurate estimates of health services use and accurately estimate disparities.

A fourth limitation is that the study does not explore varying use of the distinct CRC screening techniques. In the summary of univariate counts and percentages (Table 4.1), the Aim 2 sample of Western US Hispanic and non-Hispanic whites had lower use of colonoscopy within the past ten years than the Aim 1 sample 56.2 vs. 58.8%, higher use of FSIG in the past five year with FOBT in the past three years 5.1% vs. 2.7%, and higher use of FOBT in the previous year 16.7 vs. 12.2%. Higher use of FSIG and FOBT resulted in the Aim 2 sample having a higher percentage of respondents up-to-date with screening by any technique despite having a lower rate of colonoscopy, 63.3 vs. 62.5%. The differences in screening by specific technique between the full US Aim 1 sample and the Western US Aim 2 sample suggest regional differences in screening preferences that are driven by the preferences of providers, of persons receiving screening, and of insurers.

With respect to insurers' preferences, if certain insurance features correlated with a preference for a particular screening technique, those preferences could influence estimates of aggregate screening use differently for the different screening outcomes in the main and sensitivity analyses. Indeed, a previous study noted in the literature review found that Medicare managed care plans predicted greater FOBT use (Schneider 2008b). Having each of the organizational insurance features did not significantly predict being up-to-date

with recommended screening in the fully adjusted main analyses, although If insurers having a certain organizational insurance feature corresponded with a greater preference for low cost FOBT, persons with insurance with the organizational feature would seem to have greater screening likelihood in the sensitivity analysis for the outcome of any screening in the previous year. This situation could explain that discrepant significance between the Aim 1 main and sensitivity analysis findings for organizational insurance features.

Differential preference for screening techniques may also potentially alter the influence of financial insurance features on the different outcomes in the main and sensitivity analyses. Having an FSA had a reduced effect in the sensitivity analysis compared to the main analysis, which could reflect less preference for FOBT among FSA holders than non-holders. For the cost-sharing categories, the main and sensitivity analysis findings are similar and do not suggest a differential preference for distinct screening techniques across the cost-sharing categories. Future research could evaluate an alternative sensitivity analysis outcome of only colonoscopy in the previous year (in comparison to a main analysis of colonoscopy within the past ten years), which would eliminate the threat of bias due to a correlation between organizational insurance features and screening technique preference.

Last, the study's analytic strategy has notable limitations. A repeated regressions approach with separate analyses for each insurance feature was employed in order to isolate effects of distinct insurance features, although that strategy does not reflect the reality of many insurance features operating simultaneously in concert. In a study evaluating the effects of managed care characteristics on health services use among children with special healthcare needs, principal components analysis was used to cluster managed care characteristics into managed care indices, although the authors noted the limitation that the findings did not identify specific influential features (Shenkman

2003). Ultimately, isolating insurance feature effects and modeling reality as fully as possible are opposing interests that it may not be possible to reconcile. Another important pair of analytic limitations was the decision not to conduct analyses stratified by gender and age. Stratified analyses have shown that many covariates have different effects for females compared to males (Gonzales 2012), which likely applies to this study and possible to the insurance feature effects. Also, Medicare eligibility at age 65 meaningfully divides the population that is eligible for CRC screening, so stratified analyses of those aged 50-64 and those aged 65-75 would have likely yielded different covariate effects and possibly insurance feature effects. In the interest of preserving sample size to permit modest insurance feature effects to be identified as significant, stratified analyses were not conducted. As noted before, more rigorous natural and quasi-experimental study designs of insurance features are needed. Studies focusing on subpopulations or conducting stratified analyses may be necessary.

Policy Issues

CRC screening insurance coverage had a major change when the ACA mandated that private insurers cover all services recommended by the USPSTF with an “A” or “B” recommendation with zero cost-sharing, which includes CRC screening at guideline-consistent time intervals (Pollitz 2013). Although the rule was implemented September 23, 2010, grandfathered plans were (and are still) not required to comply with the rule and patients supposedly in plans with the rule were (and are still) not assured a zero cost-sharing screening because certain circumstances negate the rule including screening for diagnostic purposes and screening that becomes therapeutic if a polyp is removed. For Medicare beneficiaries as well, cost-sharing is not waived in the case that a polyp is removed. Ultimately, full financial coverage for CRC screening is not assured

for either Medicare beneficiaries or privately insured persons and is uncertain before the procedure is completed. Considering the highly invasive nature of the colonoscopy and FSIG procedures, gaps in insurance coverage and uncertainty about whether one's insurer will waive cost-sharing mean that substantial financial barriers to CRC screening persist. The potentially large expense of cost-sharing may inhibit people from receiving screening and particularly may dissuade low income persons from receiving screening and therefore widen disparities. This barrier may be eliminated soon as existing legislation before Congress would truly eliminate cost-sharing for CRC screening ¹²². In light of uncertainty about cost-sharing being waived, other aspects of insurance design are still relevant factors to study in order to understand the myriad influences on whether people receive CRC screening.

Conclusion

This study found that insurance features sometimes modestly predicted significantly varied use of CRC screening, which sometimes was mitigated by adjusting for covariates and depended on whether the outcome was being up-to-date with recommended CRC screening or was having recently received CRC screening in the previous year. In the analyses pertaining to the study's first aim, the organizational insurance features did not predict significantly different likelihood of being up-to-date with recommended CRC screening in the main analyses, although in the sensitivity analyses, having insurance that used gatekeeping and having insurance that restricted coverage to a DPN each predicted a greater than 3% point increase in likelihood of having received CRC screening in the previous year. For the financial features, effects for each having an FSA and categories of cost-sharing were each largely mitigated after adjusting for covariates, although such financial features may be valuable proxies

in other studies. In the analyses pertaining to the study's second aim, findings suggest that having each of the three organizational features predicted increased likelihood of being up-to-date with recommended screening for Hispanic whites, although did not change or decreased screening likelihood for non-Hispanic whites. In total, the organizational insurance features may have the effect of reducing disparate screening use among Western US Hispanic whites. In the Aim 2 sensitivity analysis, having insurance with a DPN suggested the same reduced disparity as in the main analysis, although for each having insurance that used gatekeeping and having insurance that restricted coverage to a DPN, the effect was smaller and less likely to be significant. For the Aim 2 main and sensitivity analyses of cost-sharing, screening likelihood for Hispanic whites varied less than for non-Hispanic whites, and Hispanics whites had significantly lower screening likelihood than non-Hispanic whites for some cost-sharing categories.

The findings of this study suggest a potentially meaningful, modest influence of specific insurance features on use of CRC screening although do not provide strong enough evidence to support any action by insurers or through policy to change insurance design in the interest of increasing CRC screening use. Sufficient evidence for such an administrative or policy change would require experimental evidence and in consideration of any change's influence on use of other health services. Modifying insurance design in a targeted way that is specific to CRC screening would probably be a better approach for specifically increasing CRC screening use. MEPS has a limited offering of insurance features, so it was not possible to evaluate any features that pertained directly to CRC screening. Despite that limitation, the modest predicted 3% point increase in predicted screening likelihood for some insurance features is still notable. If such an insurance feature was adopted by the entire eligible population and increased screening use by a few percentage points, it could correspond to more

than a million additional persons having received screening and a substantial reduction in CRC incidence, morbidity, and mortality.

Appendix National Cancer Institute's Cancer Topic Search for "Digestive System Cancer: Screening and Prevention" Modified to Exclude Non-Colorectal Cancers

(((digestive system neoplasms/prevention[majr] OR (digestive system neoplasms[mesh] AND (mass screening[mesh] OR preventive medicine[mesh] OR preventive health services[mesh] OR chemoprevention[mesh] OR cancer vaccines[mesh]))) AND human[mh] AND english[la]) OR ((intestine[ti] OR intestines[ti] OR intestinal[ti] OR bowel[ti] OR bowels[ti] OR duodenal[ti] OR duodenum[ti] OR ileal[ti] OR ileum[ti] OR jejunal[ti] OR jejunum[ti] OR colorectal[ti] OR colon[ti] OR colonic[ti] OR rectal[ti] OR rectum[ti] OR rectosigmoid[ti] OR anal[ti] OR anus[ti] OR perianal[ti]) AND (cancer*[ti] OR carcinoma*[ti] OR adenocarcinoma*[ti] OR malignan*[ti] OR tumor*[ti] OR tumour*[ti] OR neoplasm*[ti]) AND (prevention[ti] OR prevent[ti] OR screen[ti] OR screening[ti] OR chemoprevent*[ti] OR surveillance[ti])))

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