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## The Association of Type and Number of Chronic Diseases with Breast, Cervical and Colorectal Cancer Screening in Rural Primary Care Practices

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### Abstract

**Purpose**—To examine associations between the number and types of patients' chronic diseases and being up-to-date for breast, cervical and colorectal cancer screening.

**Methods**—Data were abstracted from medical charts at four primary care clinics located in two rural Oregon communities. Eligibility criteria included being at least 55 years of age, having had at least one clinic visit in the last two years.

**Results**—Of 3,433 included patients, 503 (15%) had no chronic illness, 646 (19%) had one, 786 (23%) had two, and 1,498 (44%) had three or more chronic conditions. Women with asthma/chronic lung disease and with cardiovascular disease were *less* likely to be up-to-date for mammography screening (OR 0.59, 95%CI 0.43–0.80), and those with chronic digestive disorders were *more* likely to be up-to-date for mammography (OR 1.31, 95%CI 1.03–1.66) compared to

those without chronic conditions. Women with arthritis, diabetes mellitus, and hypertension were less likely to be up-to-date for cervical cancer screening (OR 0.38, 95%CI 0.21–0.68) compared to those without chronic conditions. Men with cardiovascular disease were less likely to be up-to-date for colorectal cancer screening (adjusted OR 0.59, 95%CI 0.44–0.80), and women with depression were *less* likely to be up-to-date (OR 0.71, 95%CI 0.56–0.91) compared to men and women without chronic conditions.

**Conclusion**—Specific chronic conditions were found to be associated with up-to-date status for cancer screening. This finding may help practices to identify patients who need to receive cancer screening.

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## Introduction

Although the benefits of breast, cervical and colorectal cancer screening have been widely established (1–3) utilization of screening continues to be suboptimal (4–10). Data from the National Health Interview Survey showed that breast and cervical cancer screening steadily declined between 2000 and 2010 (11). Colorectal cancer screening increased slightly (from 43.1% to 50.2%) between 2005 and 2008, primarily due to the rise in colonoscopies (10). Along with a decline or only a slight rise in screening rates, health disparities exist among different populations that require attention, such as rural residents (12–17). Distance from metropolitan areas, underserved race or ethnicity and other socioeconomic factors all influence receipt of cancer screening (8, 16, 18). Even when access is not a problem, lack of health maintenance visits and lack of physician recommendations are barriers to cancer screening tests (19).

The presence of one or more chronic diseases may make receipt of cancer screening even more complex. Some chronic illnesses, such as diabetes, serve as independent risk factors for certain cancers (20–22) and may be associated with cancer mortality (23), while also serving as barriers to receipt of screening (24–26). Conversely, other studies have found the presence of chronic diseases is associated with better cancer screening utilization. Patients with hypertension have been reported to have more breast exams, pap tests and fecal occult blood tests (FOBT) compared to those without it, and mammography, breast exams, and pap tests have been found to be higher in women with three or more chronic conditions (27–30).

How chronic diseases affect screening of breast, cervical and colorectal cancers remains controversial. Managing chronic illnesses and providing cancer screening may compete for clinicians' limited time in busy primary care settings (31, 32), while more frequent clinic visits for chronic conditions may present opportunities for cancer screening. Work is still needed to achieve the Healthy People 2020 goals of colorectal, breast, and cervical cancer screening rates of 70.5%, 81.1%, and 93%, respectively (33). We studied the association of any of 16 different chronic conditions with up-to-date screening status for breast, cervical and colorectal cancer, while adjusting for potential confounders.

## Methods

### Study Design, Setting and Population

We performed a medical record review with the Oregon Rural Practice-based Research Network. Study design and data collection are detailed in a recent publication (16). Briefly, data were collected from medical charts at four primary care clinics located in two rural Oregon communities. Eligibility criteria for patients included: being at least 55 years of age (to ensure they met screening criteria); having had at least one clinic visit in the last two years; and having medical records extending up to ten years prior to the date of the review. All study activities were approved by the Institutional Review Board of Oregon Health & Science University and conducted under a HIPAA waiver for collection of personal health information without consent.

### Data Collection/Medical Record Review

Medical records were reviewed between October 2008 and August 2009. We collected dates when eligible patients received colorectal, breast, and cervical cancer screening for up to ten years. Colorectal cancer screening tests included FOBT, colonoscopy, flexible sigmoidoscopy, and double contrast barium enema (DCBE); breast cancer screening included mammography; and cervical cancer screening included the Papanicolaou test (Pap).

We collected patients' demographic information; health insurance status; personal and family history of cancers and type of cancer; prior abnormal screening test results for colorectal, breast or cervical cancers; numbers and types of chronic conditions; years of care received by clinic; total clinic visit counts; and type of clinic visit (health maintenance versus acute care or chronic care). The 16 chronic conditions were collapsed into the following 10 categories for analysis: 1) arthritis/musculoskeletal disease/degenerative joint disease, 2) asthma/emphysema /COPD/chronic lung disease, 3) cardiovascular disease, 4) hypertension, 5) chronic digestive disease, 6) chronic pain, 7) low back pain, 8) diabetes mellitus, 9) depression/anxiety, and 10) substance abuse. We grouped these diseases into a discrete variable. Unlike the Charlson index (34), our variable for number of chronic conditions is not an aggregated predictor of mortality risk from chronic conditions.

For up-to-date status of cancer screenings, we used the USPSTF guidelines (35–37) in effect during the chart review period. Subjects were considered up-to-date if the most recent screening mammography, Pap test, or colorectal cancer screening test was recorded to have been within the appropriate screening time interval for their risk status (e.g., family history in a first degree relative).

### Data Exclusions and Statistical Analysis

The initial data abstraction included 3,593 patients, of which we excluded 160 for a total of 3,433. We excluded patients whose age was missing (n=5), and those with any prior personal history of breast, cervical, ovarian, or colorectal cancer (n=155). In our analyses of breast cancer screening, we also excluded women with a recent history of an abnormal mammogram because we could not be certain whether a patient had returned for screening or diagnostic mammography. Similarly, for analyses of cervical cancer screening we

excluded women with recent abnormal pap tests, as the follow-up could include other pap, invasive sampling or HPV testing and there is uncertainty of a diagnosis of cancer. We excluded patients with a history of prior abnormal colorectal screening exam, as these circumstances could also indicate an impending cancer diagnosis, making these patients more similar to those we excluded because of a prior personal history of cancer. For colorectal cancer screening, we did not exclude those for whom a polyp had been removed, because the return to surveillance or screening is clearer than it is for mammography and the time interval for return is longer than it is for abnormal mammography and Pap tests.

We calculated kappa coefficients for agreement between the two medical record reviewers for all abstracted variables. We excluded two chronic conditions with kappa values (38, 39) below 0.4, substance abuse and chronic pain; agreement for other chronic diseases ranged from 0.5 and 0.9. BMI was divided into four categories according to WHO guidelines: less than 25 kg/m<sup>2</sup>, between 25 and 30 kg/m<sup>2</sup>, greater than or equal to 30 kg/m<sup>2</sup>, and not noted. The underweight category of less than 18.5 kg/m<sup>2</sup> had only 30 individuals, considered too small for accurate estimation in the regression model. A sensitivity analysis done with regressions that included and excluded those 30 individuals did not alter the ORs or p-values of any of the variables; thus, we collapsed the underweight individuals into the category of less than 25 kg/m<sup>2</sup> to preserve the overall sample size. We divided age into four categories according to its distribution: 50–59, 60–64, 65–75, and greater than 75 years. For cervical cancer screening, the age categories were limited to 50–59 and 60–64, as the guidelines do not include recommendations for women over 65. We categorized the number of clinic visits within the audit period and the total length of patient contact with a clinic. Visit counts were divided into four categories: <5 visits, 5 to 10 visits, 11–20 visits and >20 visits. Patient's overall length of contact with a clinic was divided into five categories: <6 months, 6 months to <1 year, 1 year to <2 years, 2 years to <5 years, 5 years and greater.

We used a chi square test to examine possible associations between various patient characteristics and the number of chronic conditions present. The assessed characteristics included demographics, health behaviors, clinic utilization, presence of specific chronic diseases, and up-to-date status for cancer screening. We then used multivariate logistic regression modeling to assess the association of both the total number of chronic conditions and specific chronic diseases with up-to-date cancer screening status. These models adjusted for a standard set of potential confounders that included: age, marital status, ethnicity, BMI class, occupation, insurance status, alcohol history, smoking history, length of contact with clinic, number and type of clinic visits, and other chronic diseases. Because screening practices can vary by clinician within each clinical practice, we treated the clinics as a random effect in our models. We used a stepwise selection procedure to develop a logistic regression model for each screening status outcome. Colorectal cancer modeling was stratified by gender. We also explored possible interactions between insurance type, ethnicity, visit count and length of contact and each chronic disease, but no significant effect modifications were found. We used STATA statistical software version 11.2 for these analyses.

## Results

### Study Population

We identified 503 (15%) patients who had no chronic illness, 646 (19%) with one, 786 (23%) with two, and 1,498 (44%) with three or more conditions (Table 1). The mean and median numbers of chronic conditions were 2.44 and 2, respectively (range 0–10) (data not shown). Forty-nine percent of patients were up-to-date for breast cancer screening, 52% for cervical cancer screening, and 37% for colorectal cancer (using any screening test). The number of chronic disease conditions was significantly different for many patient characteristics, including community of residence, patient age, race and ethnicity, marital status, occupation, insurance coverage, body mass index and other health habits, such as smoking history, alcohol use, and types of chronic illnesses (Table 1). The mean length of contact with a clinic and the mean number of clinic visits both increased with increasing number of conditions.

The most common chronic disease was hypertension, which was present in 48% of all patients and 27% of patients with only one chronic disease (Table 1). Of those patients with two conditions, many had arthritis or other joint diseases (26%), and hypertension (53%). Of those patients with three or more conditions, most had hypertension (71%) or arthritis/joint diseases (59%), and many had cardiovascular disease (40%), chronic digestive disorders (40%), depression (45%), and/or low back pain (42%).

### Breast Cancer Screening

Of the 1,870 women identified for the study, 1,859 were included in the analysis of breast cancer screening status. Six women were excluded due to having an abnormal mammogram within 2 years of the chart review, four women had bilateral mastectomies, and one woman was transgendered. The unadjusted odds of being up-to-date for mammography increased with one or more chronic diseases (Table 2). Analyses that adjusted only for the total number of visits indicated that women with three or more chronic conditions were less likely to be up-to-date compared to those with no chronic conditions, (OR 0.62, 95% C.I. 0.45–0.87) (Table 2). In the fully adjusted model, the negative association of 3 or more chronic diseases with mammography decreased in magnitude and was not statistically significant. Because having a digestive disorder was consistently associated with being up-to-date for mammography screening (Table 3), we also tested the association in women without chronic digestive disorders. Excluding patients with digestive disorders reduced the odds of being up-to-date for mammography for women with two chronic conditions and women with three or more conditions (Table 2).

Logistic regression modeling found that asthma/COPD/chronic lung disease, cardiovascular disease and chronic digestive disorder were all significantly associated breast cancer screening status (Table 3). In our final adjusted models, women with asthma/chronic lung disease (OR 0.59, 95%CI 0.43–0.80) and with cardiovascular disease (OR 0.71, 95%CI 0.54–0.94) were *less* likely to be up-to-date for mammography screening, and those with chronic digestive disorders were *more* likely to be up-to-date (OR 1.31, 95%CI 1.03–1.66).

### Cervical Cancer Screening

Of the 1,870 women in the study, 1103 were under aged 65. Of these women, 373 were excluded from the analysis due to a history of hysterectomy (n=350) or abnormal cervical cancer screenings within the last 2 years (n=23), leaving 740 women in the analysis. The unadjusted odds of being up-to-date for cervical cancer screening were not significantly different according to the number of chronic conditions (Table 4). When adjusted for the number of clinic visits alone or for numerous patient characteristics, women with two chronic conditions (OR 0.55, 95% CI 0.31–0.95) or three or more chronic conditions (OR 0.38, 95% CI 0.21–0.68) were less likely to be up-to-date for cervical cancer screening than women with no chronic conditions. When the analysis was limited to women with no digestive disorders, the negative association of having 2 chronic conditions with cervical cancer screening status was not statistically significant.

In unadjusted models, hypertension was the only chronic disease significantly associated with cervical cancer screening status. Three chronic diseases – arthritis/degenerative joint disease, diabetes mellitus, and hypertension – were significantly associated with lower odds of being up-to-date for cervical cancer screening in analyses that adjusted for marital status, BMI, number of visits and other chronic diseases (Table 5).

### Colorectal Cancer Screening

In unadjusted analyses, males and females with three or more chronic diseases were significantly more likely to be up-to-date for colorectal cancer screening than those with no chronic conditions (males: OR 1.44, 95% CI 1.03–2.02; females: OR 1.37, 95% CI 1.02–1.84) (Table 6). However, when adjusted for the number of visits in the last 5 years these patients were significantly *less* likely to be up-to-date (males: OR 0.61, 95% CI 0.41–0.91; females: OR 0.62, 95% CI 0.44–0.89). When fully adjusted for covariates, the negative association of colorectal screening with number of chronic conditions lost statistical significance; however when patients with chronic digestive disorders were excluded from the analysis the negative association with 3 or more chronic conditions was statistically significant (Table 6).

Male patients with cardiovascular disease were significantly *less* likely to be up-to-date for colorectal cancer screening (adjusted OR 0.59, 95% CI 0.44–0.80), while men with chronic digestive disorders were *more* likely to be up-to-date (adjusted OR 1.88, 95% CI 1.40–2.52) (Table 7). In an unadjusted analysis, men with low back pain were *more* likely to be up-to-date, however no association was observed in the adjusted analysis. Female patients with depression or anxiety were significantly *less* likely to be up-to-date for colorectal cancer screening (adjusted OR 0.71, 95% CI 0.56–0.91), and patients with chronic digestive disorders were *more* likely to be up-to-date (adjusted OR 1.72, 95% CI 1.34–2.19) (Table 7). As with the male patients, an unadjusted analysis found that women with low back pain were *more* likely to be up-to-date, however no association was observed in the adjusted analysis.

## Discussion

In general, we found that an increase in the number of chronic conditions was associated with decreased screening rates, as has been reported elsewhere (26, 40). The magnitude and statistical significance of this effect was most pronounced for cervical cancer screening. In addition, we also found that certain chronic diseases have an effect on up-to-date screening status for different cancers; with the particular types of diseases that demonstrated this effect varying between the three types of cancer. Of the seven types of chronic disease associated with up-to-date status, all but one was associated with decreased odds of being up-to-date. One category of chronic disease, digestive disorders, was associated with increased odds of being up-to-date for breast cancer screening and for colorectal cancer screening. The specific reasons for these associations cannot be determined from this study, but a number of possibilities can be considered.

For cervical cancer screening, we found arthritis/musculoskeletal disease/degenerative joint disease, diabetes mellitus, and hypertension each to be associated with lower likelihood of being up-to-date for Pap tests. This may be due to the fact that Pap tests are in-office procedures, which would compete for time with other health priorities at a clinic visit. Also, women with arthritis might experience pain and movement difficulties for the Pap test procedure. The lower odds ratios persisted after our adjustments for length of contact and number of clinic visits, which suggests that the type of health care visit may be more important than the number of health care visits.

The likelihood of being up-to-date for colorectal cancer screening was lower among men, but not among women, with cardiovascular disease. In women, we found diabetes and depression/anxiety to be associated with a lower likelihood of being up-to-date for colorectal cancer screening. For both men and women, having a chronic digestive disorder increased the likelihood of being up-to-date. Past studies have shown that having heart disease is associated with lower colorectal cancer screening (32). Because men generally have higher rates of heart disease, we postulate that physicians spend more time counseling and managing heart disease among men than women. Fitting cancer screening into health care visits may be more difficult when the visits are for conditions that require alterations in medication management, as occurs with cardiovascular disease, diabetes and anxiety/depression. Also, colonoscopy, whether used as a primary screening tool or as a follow-up to an abnormal less invasive test, is perceived to carry greater risk for those with certain chronic diseases. This could affect provider and patient willingness to screen in these populations. On the other hand, our finding that patients with a digestive disorder are more likely to be up-to-date, especially with colonoscopy, may be because colonoscopy is used both as a screening test and a diagnostic test to rule out any potential areas of concern related to the large bowel.

We found it interesting that women with depression were less likely to be up-to-date for colorectal cancer screening, but not for breast or cervical cancer screenings. Counseling for depression in primary care can be time consuming and may be of a higher and more urgent priority for patients than preventive care, which might have caused a delay in addressing cancer screening needs. Colorectal screening, which requires bowel preparation and occurs

outside of the primary care clinic, tends to be perceived as a more unpleasant and time consuming experience than breast or cervical cancer screening, involving extra barriers for patients to overcome (8). These barriers may be particularly challenging for depressed patients.

We found in unadjusted analyses that low back pain was significantly associated with being more likely to be up-to-date for colorectal cancer screening for both men and women. Low back pain is a common diagnosis and often difficult to manage. Low back pain is sometimes related to the presence of tumors, which might prompt conversations of colorectal cancer screening. Importantly, this finding did not persist after multivariable adjustments for patient and healthcare visit characteristics, suggesting that the finding is related to one or more of the covariates included in the analysis, such as patient age or body mass index.

Physicians should consider the potential benefits of screening for these three cancers as is suggested by the USPSTF (1–3). However, decisions about cancer screening should weigh the benefits and harms for individual patients, rather than reflexively disregarding screening for those with substantial chronic disease burden. Similarly, physicians should be mindful of having conversations about cancer screening with their patients who have chronic diseases with the goal of shared decision making about the relative benefits and harms of screening. Clinics could also consider programs that utilize all staff to remind patients about relevant cancer screening, lessening the burden on the provider-patient interaction.

The strengths of our study include our focus on both individual and total number of chronic diseases. Past studies often used a combined comorbidity index, such as the Charlson index (34), or focused on a specific disease, such as patients with diabetes or cardiovascular disease (22, 23, 25, 30, 41). Our findings showed that individual chronic conditions have varied impact on one's up-to-date status for cancer screening. Understanding why this occurs would facilitate more appropriate screenings and meeting the goals of Healthy People 2020.

Other strengths include our use of medical chart review rather than patient self-report, which suffers from social response bias and recall bias (42). By recording actual completion of screening tests rather than physician recommendations, we could obtain more accurate, objective records of if and when screening tests were done. In addition, our study included screening for three relatively common cancers that all have specific screening recommendations for primary care clinicians. Lastly, we focused this study on rural underserved and understudied patients. Because prior studies have shown that access to physicians plays a significant role in receiving appropriate cancer screening, we tried to eliminate this factor by abstracting charts at primary care clinics, where patients have an established relationship (41).

Potential limitations of our study included missing patient information, such as insurance and ethnicity, and that we did not collect information on specific patient and physician perspectives on the impact chronic diseases can have on cancer screening. The latter would further elucidate potential barriers to screening. Missing information regarding patient characteristics and demographics could lead to information bias; however, we included in



our analysis a category of “not noted” to account for any impact this category would have on screening status. We used patients with “no disease” as our referent group, which might have resulted in lower ORs than what might be found in those who are sick. However, we saw that the screening rates for those with “no disease” under the categories that we examined were low, below 50%, despite the opportunity for more preventive visits for those patients. For our cervical cancer screening analysis, we only included women between 55–65 years old, which precluded understanding cervical cancer screening among patients under age 55. We were not able to collect information regarding patients’ functional status and quality of life, which would help us further assess relationships of chronic disease with cancer screening.

In the future, it would be useful to gather information on patients’ and physicians’ perspectives on cancer screenings, and determine how best to fit cancer screening into opportunistic visits for those with multiple chronic conditions. Real-time observations might capture discussions about the risks, benefits and overall value of screening in patients whose life expectancy might be uncertain. Interventional studies could also be done to evaluate how to best improve screening among those patients with conditions that bare less risk on mortality, such as depression and low back pain, as well as for those patients with multiple high-risk diseases in the context of their other health priorities.

In conclusion, we found that specific types of chronic conditions have a larger impact on being up-to-date for cancer screening than the total number of conditions. Although, when the number of conditions reached three or more, they also had an impact on screening status, especially for cervical cancer screening. Chronic diseases that demand significant physician time in the clinic for management, such as diabetes or heart disease, appear to reduce the likelihood of being up-to-date for screening.

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**Table 1**

Patient Characteristics by Number of Chronic Disease Conditions

| Characteristics           | No Conditions<br>n (%) | One Condition<br>n (%) | Two Conditions<br>n (%) | Three Conditions<br>n (%) | p-value |
|---------------------------|------------------------|------------------------|-------------------------|---------------------------|---------|
| <b>Total N (Row%)</b>     | <b>503 (15%)</b>       | <b>646 (19%)</b>       | <b>786 (23%)</b>        | <b>1498 (44%)</b>         |         |
| <b>Community N (Col%)</b> |                        |                        |                         |                           |         |
| A                         | 121 (24%)              | 182 (28%)              | 302 (38%)               | 624 (42%)                 | <0.001  |
| B                         | 382 (76%)              | 464 (72%)              | 484 (62%)               | 874 (58%)                 |         |
| <b>Gender</b>             |                        |                        |                         |                           |         |
| Female                    | 268 (53%)              | 346 (54%)              | 419 (53%)               | 837 (56%)                 | 0.55    |
| Male                      | 235 (47%)              | 300 (46%)              | 367 (47%)               | 661 (44%)                 |         |
| <b>Age Category</b>       |                        |                        |                         |                           |         |
| 50–59                     | 291 (58%)              | 287 (44%)              | 303 (39%)               | 465 (31%)                 | <0.001  |
| 60–64                     | 94 (19%)               | 150 (23%)              | 159 (20%)               | 321 (21%)                 |         |
| 65–75                     | 85 (17%)               | 138 (21%)              | 201 (26%)               | 382 (26%)                 |         |
| 75+                       | 33 (7%)                | 71 (11%)               | 123 (16%)               | 330 (22%)                 |         |
| <b>Ethnicity</b>          |                        |                        |                         |                           |         |
| Hispanic                  | 42 (8%)                | 92 (14%)               | 109 (14%)               | 180 (12%)                 | 0.02    |
| Non-Hispanic              | 154 (31%)              | 199 (31%)              | 224 (29%)               | 491 (33%)                 |         |
| Unspecified               | 307 (61%)              | 355 (55%)              | 453 (58%)               | 827 (55%)                 |         |
| <b>Race</b>               |                        |                        |                         |                           |         |
| White                     | 228 (45%)              | 332 (51%)              | 444 (56%)               | 1016 (68%)                | <0.001  |
| Other                     | 14 (3%)                | 21 (3%)                | 25 (3%)                 | 40 (3%)                   |         |
| Unspecified               | 261 (52%)              | 293 (45%)              | 317 (40%)               | 442 (30%)                 |         |
| <b>Marital Status</b>     |                        |                        |                         |                           |         |
| Partnered                 | 336 (67%)              | 423 (65%)              | 490 (62%)               | 890 (59%)                 | <0.001  |
| Not partnered             | 99 (20%)               | 150 (23%)              | 223 (28%)               | 510 (34%)                 |         |
| Unknown                   | 68 (14%)               | 73 (11%)               | 73 (9%)                 | 98 (7%)                   |         |
| <b>Occupation</b>         |                        |                        |                         |                           |         |
| Employed                  | 288 (57%)              | 343 (53%)              | 342 (44%)               | 456 (30%)                 | <0.001  |

| Characteristics                             | No Conditions<br>n (%) | One Condition<br>n (%) | Two Conditions<br>n (%) | Three Conditions<br>n (%) | p-value |
|---|------------------------|------------------------|-------------------------|---------------------------|---------|
| Unemployed/ disabled                        | 21 (4%)                | 48 (7%)                | 75 (10%)                | 256 (17%)                 |         |
| Retired                                     | 104 (21%)              | 144 (22%)              | 237 (30%)               | 566 (38%)                 |         |
| Unknown                                     | 90 (18%)               | 111 (17%)              | 132 (17%)               | 220 (15%)                 |         |
| <b>Insurance</b>                            |                        |                        |                         |                           |         |
| Private                                     | 317 (63%)              | 363 (56%)              | 404 (51%)               | 756 (50%)                 | <0.001  |
| Medicare or<br>Medicare/Private             | 33 (7%)                | 93 (14%)               | 136 (17%)               | 311 (21%)                 |         |
| Medicaid or<br>Medicaid/Medicare            | 15 (3%)                | 19 (3%)                | 34 (4%)                 | 122 (8%)                  |         |
| Uninsured                                   | 34 (7%)                | 48 (7%)                | 81 (10%)                | 120 (8%)                  |         |
| Unknown                                     | 104 (21%)              | 123 (19%)              | 131 (17%)               | 189 (13%)                 |         |
| <b>Body Mass Index</b>                      |                        |                        |                         |                           |         |
| <25   | 151 (30%)              | 133 (21%)              | 126 (16%)               | 215 (14%)                 | <0.001  |
| 25 to 29                                    | 138 (27%)              | 176 (27%)              | 211 (27%)               | 348 (23%)                 |         |
| 30  | 65 (13%)               | 165 (26%)              | 237 (30%)               | 522 (35%)                 |         |
| Unknown                                     | 149 (30%)              | 172 (27%)              | 212 (27%)               | 413 (28%)                 |         |
| <b>Smoking History</b>                      |                        |                        |                         |                           |         |
| Non-smoker                                  | 350 (70%)              | 407 (63%)              | 451 (57%)               | 689 (46%)                 | <0.001  |
| Former smoker                               | 82 (16%)               | 143 (22%)              | 187 (24%)               | 454 (30%)                 |         |
| Current smoker                              | 20 (4%)                | 50 (8%)                | 105 (13%)               | 305 (20%)                 |         |
| Unknown                                     | 51 (10%)               | 46 (7%)                | 43 (5%)                 | 50 (3%)                   |         |
| <b>Alcohol Use</b>                          |                        |                        |                         |                           |         |
| Non-user                                    | 170 (34%)              | 256 (40%)              | 331 (42%)               | 697 (47%)                 | <0.001  |
| Former user                                 | 20 (4%)                | 32 (5%)                | 58 (7%)                 | 136 (9%)                  |         |
| Current user                                | 245 (49%)              | 293 (45%)              | 329 (42%)               | 570 (38%)                 |         |
| Unknown                                     | 68 (14%)               | 65 (10%)               | 68 (9%)                 | 95 (6%)                   |         |
| <b>Length of Contact with Clinic</b>        |                        |                        |                         |                           |         |
| Mean (st. dv) in years                      | 10.4 (10.1)            | 11.7 (11.0)            | 12.7 (11.1)             | 14.3 (10.9)               | 0.13    |
| <b>Health Care Visit Count (Past 5 Yrs)</b> |                        |                        |                         |                           |         |

| Characteristics                                   | No Conditions<br>n (%) | One Condition<br>n (%) | Two Conditions<br>n (%) | Three Conditions<br>n (%) | p-value |
|---|------------------------|------------------------|-------------------------|---------------------------|---------|
| Mean (st. dev)                                    | 5.2 (4.9)              | 8.4 (7.0)              | 12.5 (13.7)             | 24.0 (24.3)               | <0.001  |
| <b>Chronic Diseases</b>                           |                        |                        |                         |                           |         |
| Arthritis/MS/Joint Disease<br>No Disease          | 0 (0%)<br>503 (100%)   | 76 (12%)<br>570 (88%)  | 207 (26%)<br>579 (74%)  | 884 (59%)<br>614 (41%)    | <0.001  |
| Asthma/COPD/<br>Chronic Respiratory<br>No Disease | 0 (0%)<br>503 (100%)   | 22 (3%)<br>624 (97%)   | 58 (7%)<br>728 (93%)    | 353 (24%)<br>1145 (76%)   | <0.001  |
| Cardiovascular Disease<br>No Disease              | 0 (0%)<br>503 (100%)   | 49 (8%)<br>597 (92%)   | 118 (15%)<br>668 (85%)  | 598 (40%)<br>900 (60%)    | <0.001  |
| Chronic Digestive Disorders<br>No Disease         | 0 (0%)<br>503 (100%)   | 67 (10%)<br>579 (90%)  | 153 (19%)<br>633 (81%)  | 596 (40%)<br>902 (60%)    | <0.001  |
| Diabetes Mellitus Type 1 or 2<br>No Disease       | 0 (0%)<br>503 (100%)   | 44 (7%)<br>602 (93%)   | 116 (15%)<br>670 (85%)  | 436 (29%)<br>1062 (71%)   | <0.001  |
| Depression/Anxiety<br>No Disease                  | 0 (0%)<br>503 (100%)   | 81 (13%)<br>565 (87%)  | 162 (21%)<br>624 (79%)  | 673 (45%)<br>825 (55%)    | <0.001  |
| Hypertension<br>No Disease                        | 0 (0%)<br>503 (100%)   | 173 (27%)<br>473 (73%) | 413 (53%)<br>373 (47%)  | 1068 (71%)<br>430 (29%)   | <0.001  |
| Low Back Pain<br>No Disease                       | 0 (0%)<br>503 (100%)   | 58 (9%)<br>588 (91%)   | 129 (16%)<br>657 (84%)  | 626 (42%)<br>872 (58%)    | <0.001  |
| <b>Up-to-Date status</b>                          |                        |                        |                         |                           |         |
| Colorectal Ca:<br>Males<br>Not up-to-date         | 77 (33%)<br>158 (67%)  | 103 (34%)<br>197 (66%) | 146 (40%)<br>221 (60%)  | 271 (41%)<br>390 (59%)    | 0.06    |
| Colorectal Ca:<br>Females<br>Not up-to-date       | 96 (36%)<br>172 (64%)  | 128 (37%)<br>218 (63%) | 132 (32%)<br>287 (69%)  | 331 (40%)<br>506 (60%)    | 0.05    |
| Breast Cancer<br>Not up-to-date                   | 125 (47%)<br>142 (53%) | 176 (51%)<br>170 (49%) | 199 (48%)<br>217 (52%)  | 420 (51%)<br>410 (49%)    | 0.60    |
| Cervical Cancer<br>Not up-to-date                 | 87 (53%)<br>76 (47%)   | 90 (54%)<br>76 (46%)   | 77 (50%)<br>78 (50%)    | 130 (51%)<br>126 (49%)    | 0.82    |

**Table 2**  
 Unadjusted and Adjusted Odds Ratios for Up-to-Date Breast Cancer Screening Status According to USPSTF Guidelines by Number of Chronic Conditions

| Number of Conditions | Up-to-date Mammography Status      |         |                                   |   |                                   |         |
|----------------------|------------------------------------|---------|-----------------------------------|---|-----------------------------------|---------|
|                      | All Chronic Conditions             |         |                                   | Excluding Patients with Digestive Disorders |                                   |         |
|                      | Bivariate Odds Ratio (OR) (95% CI) | p value | Adjusted OR <sup>1</sup> (95% CI) | p value                                     | Adjusted OR <sup>2</sup> (95% CI) | p value |
| None                 | 1.00 (Referent)                    |         | 1.00 (Referent)                   |   | 1.00 (Referent)                   |         |
| One                  | 1.23 (0.89–1.71)                   | 0.21    | 0.94 (0.66–1.33)                  | 0.72  | 1.09 (0.75–1.58)                  | 0.66    |
| Two                  | 1.15 (0.84–1.57)                   | 0.39    | 0.74 (0.52–1.04)                  | 0.08  | 0.93 (0.64–1.35)                  | 0.70    |
| Three                | 1.30 (0.98–1.73)                   | 0.07    | <b>0.62 (0.45–0.87)</b>           | <b>0.005</b>                                | 0.83 (0.57–1.22)                  | 0.35    |
|                      |                                    |         |                                   |   | 0.68 (0.44–1.03)                  | 0.07    |

Analyses limited to women with no history of bilateral mastectomy or prior abnormal mammogram, n=1859. All models included clinic as a random effect.

<sup>1</sup> Adjusted for total visit count in last 5 years only.

<sup>2</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years.

<sup>3</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years and limited to women with no digestive disease (n=1379).

**Table 3**  
Unadjusted and Adjusted Individual Chronic Condition's Association with Being Up-to-Date for Breast Cancer Screening According to USPSTF Guidelines

|                          | Up-to-date Mammography Status         |                  |  |              |                          |              |
|--------------------------|---------------------------------------|------------------|--|--------------|--------------------------|--------------|
|                          | Unadjusted Bivariate Odds Ratios (OR) |                  | OR Adjusted for Demographics and Chronic Diseases <sup>1</sup> |              | Final Model <sup>2</sup> |              |
|                          | OR (95% CI)                           | p value          | OR (95% CI)  | p value      | OR (95% CI)              | p value      |
| Chronic Disease          |                                       |                  |  |              |                          |              |
| None                     | 1.00 (Referent)                       |                  | 1.00 (Referent)  |              | 1.00 (Referent)          |              |
| Arthritis                | 1.10 (0.91–1.34)                      | 0.33             | 0.94 (0.74–1.18)   | 0.58         | <i>dropped</i>           |              |
| Respiratory Disease      | <b>0.71 (0.54–0.94)</b>               | <b>0.02</b>      | <b>0.60 (0.44–0.81)</b>  | <b>0.001</b> | <b>0.59 (0.43–0.80)</b>  | <b>0.001</b> |
| Cardiovascular Disease   | <b>0.71 (0.56–0.91)</b>               | <b>0.006</b>     | <b>0.71 (0.54–0.94)</b>  | <b>0.02</b>  | <b>0.71 (0.54–0.94)</b>  | <b>0.02</b>  |
| Digestive Disorders      | <b>1.64 (1.32–2.04)</b>               | <b>&lt;0.001</b> | <b>1.33 (1.04–1.70)</b>  | <b>0.02</b>  | <b>1.31 (1.03–1.66)</b>  | <b>0.03</b>  |
| Diabetes Mellitus 1 or 2 | 0.94 (0.72–1.21)                      | 0.61             | 0.83 (0.62–1.13)   | 0.23         | <i>dropped</i>           |              |
| Depression/Anxiety       | 1.19 (0.98–1.45)                      | 0.09             | 0.89 (0.71–1.13)   | 0.34         | <i>dropped</i>           |              |
| Hypertension             | 1.06 (0.87–1.27)                      | 0.58             | 1.11 (0.88–1.40)   | 0.38         | <i>dropped</i>           |              |
| Low Back Pain            | 1.23 (0.98–1.53)                      | 0.07             | 0.92 (0.71–1.19)   | 0.51         | <i>dropped</i>           |              |

Analysis limited to women with no history of bilateral mastectomy or prior abnormal mammogram, n=1859. All models included clinic as a random effect.

- <sup>1</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years, and rest of the chronic diseases.
- <sup>2</sup> Adjusted for age, marital status, BMI class, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years, asthma, cardiovascular disease and digestive disorders.



**Table 4**  
 Unadjusted and Adjusted Odds Ratios for Up-to-Date Cervical Cancer Screening Status According to USPSTF Guidelines by Number of Chronic Conditions

| Number of Conditions | Up-to-date for Cervical Cancer Screening |         |                                   |                  |   |              |                                   |              |
|----------------------|--|---------|-----------------------------------|------------------|---|--------------|-----------------------------------|--------------|
|                      | All Chronic Conditions                   |         |                                   |                  | Excluding Patients with Digestive Disorders |              |                                   |              |
|                      | Bivariate Odds Ratio (OR) (95% CI)       | p value | Adjusted OR <sup>1</sup> (95% CI) | p value          | Adjusted OR <sup>2</sup> (95% CI)           | p value      | Adjusted OR <sup>3</sup> (95% CI) | p value      |
| None                 | 1.00 (Referent)                          |         | 1.00 (Referent)                   |                  | 1.00 (Referent)                             |              | 1.00 (Referent)                   |              |
| One                  | 1.05 (0.68–1.63)                         | 0.81    | 0.79 (0.49–1.26)                  | 0.32             | 0.75 (0.44–1.27)                            | 0.28         | 0.79 (0.46–1.36)                  | 0.40         |
| Two                  | 0.89 (0.57–1.40)                         | 0.62    | <b>0.58 (0.36–0.95)</b>           | <b>0.03</b>      | <b>0.55 (0.31–0.95)</b>                     | <b>0.03</b>  | 0.56 (0.30–1.03)                  | 0.06         |
| Three                | 0.94 (0.63–1.40)                         | 0.75    | <b>0.42 (0.26–0.68)</b>           | <b>&lt;0.001</b> | <b>0.38 (0.21–0.68)</b>                     | <b>0.001</b> | <b>0.36 (0.19–0.69)</b>           | <b>0.002</b> |

Analysis limited to women less than 65 years old with no history of hysterectomy, n=740. All models included clinic as a random effect.

<sup>1</sup> Adjusted for total visit count in last 5 years only.

<sup>2</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years.

<sup>3</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years and limited to women with no digestive disease (n=582).

**Table 5**  
Individual Chronic Disease's Effects on Being Up-to-Date for Cervical Cancer Screening According to USPSTF Guidelines

|                          | Up-to-date Cervical Cancer Screening Status |              |  |              |                          |              |
|--------------------------|---|--------------|--|--------------|--------------------------|--------------|
|                          | Unadjusted Bivariate Odds Ratios (OR)       | p value      | OR Adjusted for Demographics and Chronic Diseases <sup>1</sup> |              | Final Model <sup>2</sup> |              |
|                          |   |              | OR (95% CI)  | p value      | OR (95% CI)              | p value      |
| Chronic Diseases         |   |              |  |              |                          |              |
| None                     | 1.00 (Referent)                             |              | 1.00 (Referent)  |              | 1.00 (Referent)          |              |
| Arthritis                | 0.84 (0.60–1.18)                            | 0.32         | 0.69 (0.46–1.03)   | 0.07         | <b>0.66 (0.45–0.97)</b>  | <b>0.04</b>  |
| Asthma                   | 1.06 (0.65–1.70)                            | 0.82         | 0.90 (0.50–1.59)   | 0.71         | <i>dropped</i>           |              |
| Cardiovascular Disease   | 0.71 (0.43–1.19)                            | 0.19         | 0.59 (0.32–1.08)   | 0.09         | <i>dropped</i>           |              |
| Digestive Disorders      | 1.04 (0.73–1.49)                            | 0.81         | 0.70 (0.45–1.07)   | 0.10         | <i>dropped</i>           |              |
| Diabetes Mellitus 1 or 2 | 0.70 (0.47–1.07)                            | 0.10         | 0.69 (0.39–1.20)   | 0.19         | <b>0.60 (0.36–0.98)</b>  | <b>0.04</b>  |
| Depression/Anxiety       | 1.24 (0.90–1.70)                            | 0.18         | 1.07 (0.72–1.58)   | 0.74         | <i>dropped</i>           |              |
| Hypertension             | <b>0.65 (0.48–0.88)</b>                     | <b>0.006</b> | <b>0.57 (0.39–0.84)</b>  | <b>0.004</b> | <b>0.53 (0.37–0.76)</b>  | <b>0.001</b> |
| Low Back Pain            | 1.05 (0.73–1.50)                            | 0.80         | 0.72 (0.47–1.12)   | 0.15         | <i>dropped</i>           |              |

Analysis limited to women less than 65 years old with no history of hysterectomy, n=740. All models included clinic as a random effect.

<sup>1</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years and the other chronic diseases.

<sup>2</sup> Adjusted for marital status, BMI class, total visit counts in last 5 years, asthma, cardiovascular disease and digestive disorders.

**Table 6**  
Unadjusted and Adjusted Odds Ratios for Up-to-Date Colorectal Cancer Screening Status According to USPSTF Guidelines by Number of Chronic Conditions

| Males N=1563         | Up-to-date for Colorectal Cancer Screening |             |                                   |              |                                   |             | Excluding Patients with Digestive Disorders |             |
|----------------------|--|-------------|-----------------------------------|--------------|-----------------------------------|-------------|---|-------------|
|                      | All Chronic Conditions                     |             |                                   |              |                                   |             | Adjusted OR <sup>3</sup> (95% CI)           | p value     |
| Number of Conditions | Bivariate Odds Ratio (OR) (95% CI)         | p value     | Adjusted OR <sup>1</sup> (95% CI) | p value      | Adjusted OR <sup>2</sup> (95% CI) | p value     | Adjusted OR <sup>3</sup> (95% CI)           | p value     |
| None                 | 1.00 (Referent)                            |             | 1.00 (Referent)                   |              | 1.00 (Referent)                   |             | 1.00 (Referent)                             |             |
| One                  | 1.07 (0.73–1.56)                           | 0.75        | 0.72 (0.47–1.10)                  | 0.125        | 0.75 (0.48–1.18)                  | 0.21        | 0.56 (0.41–1.05)                            | 0.08        |
| Two                  | 1.34 (0.93–1.93)                           | 0.11        | 0.73 (0.48–1.09)                  | 0.124        | 0.84 (0.53–1.31)                  | 0.43        | 0.74 (0.46–1.20)                            | 0.22        |
| Three                | <b>1.44 (1.03–2.02)</b>                    | <b>0.03</b> | <b>0.61 (0.41–0.91)</b>           | <b>0.016</b> | 0.75 (0.47–1.17)                  | 0.20        | <b>0.54 (0.33–0.89)</b>                     | <b>0.02</b> |
| Females N=1870       |  |             |                                   |              |                                   |             |   |             |
| None                 | 1.00 (Referent)                            |             | 1.00 (Referent)                   |              | 1.00 (Referent)                   |             | 1.00 (Referent)                             |             |
| One                  | 1.11 (0.79–1.56)                           | 0.56        | 0.81 (0.57–1.17)                  | 0.27         | 0.86 (0.58–1.26)                  | 0.43        | 0.82 (0.54–1.23)                            | 0.33        |
| Two                  | 0.94 (0.67–1.31)                           | 0.70        | <b>0.58 (0.40–0.83)</b>           | <b>0.003</b> | <b>0.64 (0.43–0.95)</b>           | <b>0.03</b> | 0.65 (0.42–0.99)                            | 0.05        |
| Three                | <b>1.37 (1.02–1.84)</b>                    | <b>0.04</b> | <b>0.62 (0.44–0.89)</b>           | <b>0.008</b> | 0.69 (0.46–1.02)                  | 0.06        | <b>0.60 (0.38–0.94)</b>                     | <b>0.03</b> |

<sup>1</sup> Adjusted for total visit count in last 5 years only. All models included clinic as a random effect.

<sup>2</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years.

<sup>3</sup> Adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years and limited to patients with no digestive disorders (n males=1232, n females=1385).

**Table 7**

Unadjusted and Adjusted Individual Chronic Condition's Effect on Being Up-to-Date for Colorectal Cancer Screening According to USPSTF Guidelines

|                          | Up-to-date Colorectal Cancer Screening Status |                  |  |                  |                          |                  |
|--------------------------|---|------------------|--|------------------|--------------------------|------------------|
|                          | Unadjusted Bivariate Odds Ratios (OR)         |                  | OR Adjusted for Demographics and Chronic Diseases <sup>1</sup> |                  | Final Model <sup>2</sup> |                  |
|                          | OR (95% CI)                                   | p-value          | OR (95% CI)  | p-value          | OR (95% CI)              | p-value          |
| <b>Males (N= 1563)</b>   |   |                  |  |                  |                          |                  |
| <i>No disease</i>        | <i>1.0 (Referent)</i>                         |                  | <i>1.0 (Referent)</i>  |                  | <i>1.0 (Referent)</i>    |                  |
| Arthritis                | 1.25 (0.99–1.58)                              | 0.07             | 0.97 (0.74–1.27)   | 0.82             | <i>dropped</i>           |                  |
| Asthma                   | 1.12 (0.80–1.57)                              | 0.51             | 1.01 (0.69–1.48)   | 0.96             | <i>dropped</i>           |                  |
| Cardiovascular Disease   | <b>0.77 (0.60–0.98)</b>                       | <b>0.04</b>      | <b>0.59 (0.44–0.80)</b>  | <b>&lt;0.001</b> | <b>0.59 (0.44–0.79)</b>  | <b>&lt;0.001</b> |
| Digestive Disorders      | <b>2.07 (1.60–2.69)</b>                       | <b>&lt;0.001</b> | <b>1.88 (1.40–2.52)</b>  | <b>&lt;0.001</b> | <b>1.83 (1.37–2.44)</b>  | <b>&lt;0.001</b> |
| Diabetes Mellitus 1 or 2 | 0.88 (0.66–1.17)                              | 0.37             | 0.77 (0.55–1.07)   | 0.12             | <i>dropped</i>           |                  |
| Depression/Anxiety       | 1.24 (0.87–1.49)                              | 0.36             | 0.90 (0.65–1.23)   | 0.51             | <i>dropped</i>           |                  |
| Hypertension             | 1.18 (0.95–1.47)                              | 0.14             | 1.06 (0.81–1.38)   | 0.68             | <i>dropped</i>           |                  |
| Low Back Pain            | <b>1.29 (1.01–1.66)</b>                       | <b>0.04</b>      | 1.00 (0.75–1.32)   | 0.98             | <i>dropped</i>           |                  |
| <b>Females (N=1870)</b>  |   |                  |  |                  |                          |                  |
| <i>No disease</i>        | <i>1.0 (Referent)</i>                         |                  | <i>1.0 (Referent)</i>  |                  | <i>1.0 (Referent)</i>    |                  |
| Arthritis                | 1.18 (0.96–1.45)                              | 0.11             | 0.83 (0.65–1.06)   | 0.13             | <i>dropped</i>           |                  |
| Asthma                   | 1.24 (0.93–1.65)                              | 0.14             | 1.04 (0.76–1.43)   | 0.80             | <i>dropped</i>           |                  |
| Cardiovascular Disease   | 1.08 (0.85–1.38)                              | 0.54             | 0.94 (0.71–1.26)   | 0.69             | <i>dropped</i>           |                  |
| Digestive Disorders      | <b>2.21 (1.77–2.75)</b>                       | <b>&lt;0.001</b> | <b>1.72 (1.34–2.19)</b>  | <b>&lt;0.001</b> | <b>1.69 (1.33–2.15)</b>  | <b>&lt;0.001</b> |
| Diabetes Mellitus 1 or 2 | 0.89 (0.67–1.17)                              | 0.40             | 0.77 (0.56–1.06)   | 0.12             | 0.74 (0.54–1.01)         | 0.06             |
| Depression/Anxiety       | 1.02 (0.83–1.26)                              | 0.84             | <b>0.71 (0.56–0.91)</b>  | <b>0.006</b>     | <b>0.69 (0.54–0.87)</b>  | <b>0.002</b>     |
| Hypertension             | 1.04 (0.85–1.27)                              | 0.70             | 0.90 (0.71–1.15)   | 0.40             | <i>dropped</i>           |                  |
| Low Back Pain            | <b>1.70 (1.36–2.13)</b>                       | <b>&lt;0.001</b> | 1.29 (0.99–1.67)   | 0.06             | <i>dropped</i>           |                  |

<sup>1</sup> Each disease adjusted for age, marital status, ethnicity, BMI class, occupation, alcohol history, smoking history, insurance status, length of contact with clinic, total visit counts in last 5 years, and rest of the chronic diseases. All models included clinic as random effect.

<sup>2</sup> Males: Adjusted for age, ethnicity, occupation, alcohol history, insurance status, length of contact with clinic, total visit counts in last 5 years, cardiovascular disease and digestive disorders. Females: Adjusted for age, marital status, ethnicity, BMI class, alcohol history, insurance status, length of contact with clinic, total visit counts in last 5 years digestive disorders, depression, diabetes mellitus and low back pain.,