CANCER SCREENING AMONG OBESE AND NON-OBESE
INDIVIDUALS IN RURAL OREGON PRIMARY CARE CLINICS

by

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A THESIS

Presented to the Department of Public Health and Preventive Medicine

and the Oregon Health & Science University

School of Medicine

in partial fulfillment of

the requirements for the degree of

Master of Public Health

February 2008

School of Medicine

Oregon Health & Science University

CERTIFICATE OF APPROVAL

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LIST OF ABBREVIATIONS

ACS   American Cancer Society
BMI   Body Mass Index
BRFSS   Behavioral Risk Factor Surveillance System
CDC   Centers for Disease Control and Prevention
CRC   Colorectal Cancer
CI   Confidence Interval
DNA   Deoxyribonucleic Acid
DRE   Digital Rectal Examination
FOBT   Fecal Occult Blood Test
HPV   Human Papillomavirus
IBD   Inflammatory Bowel Disease
IRB   Institutional Review Board
MI   Multiple Imputation
OHSU   Oregon Health & Science University
OR   Odds Ratio
ORPRN   Oregon Rural Practice-based Research Network
PSA   Prostate Specific Antigen
RR   Relative Risk
SD   Standard Deviation
USPSTF   United States Preventive Services Task Force

ACKNOWLEDGEMENTS

Title: Cancer Screening Among Obese and Non-obese Individuals in Rural Oregon Primary Care Clinics

Background: Cancer screening among adults can reduce mortality, especially among obese adults, who are at an increased risk for developing cancer. Little is known about the adequacy of provision of cancer screening in rural primary care clinics or disparities that may exist between obese and non-obese individuals in rural areas.

Objective: To determine the relationship between body habitus and provision of recommended adult cancer screening services in clinics associated with a rural practice-based research network.

Design: Retrospective audit of 150 randomly selected patient charts per practice. Setting: Six rural primary care clinics in Oregon.

Outcome Measures: Documented screening for colorectal, breast, cervical and prostate cancers using USPSTF and ACS recommendations as standards.

Results: A total of 902 patient records were audited. Over 24% of patients were obese with an average BMI of 29.5 kg/m^2. Twenty-nine percent of patients age 50 or older received colon cancer screening. Forty-eight percent of men in this age group received prostate cancer screening. Forty-two percent of women age 40 or older received a clinical breast exam, and 41% received screening mammography. Thirty-two percent of eligible women had documented cervical cancer screening. Body habitus was not significantly associated with receipt of cancer screening for colorectal, breast and prostate cancers.

Conclusions: These rural clinics documented provision of recommended cancer screening at rates substantially below national averages and Healthy People 2010 targets. Body habitus does not appear to be related to receipt or non-receipt of cancer screening examinations. Interventions focused on improving cancer screening among all rural Oregon adults may be warranted rather than focusing solely on obese or overweight individuals.

INTRODUCTION

Obesity is a significant health problem in the United States. More than half of Americans are either overweight[i] or obese,[1] and the prevalence of obesity has increased by 70% over the past decade.[2] In 2006, Oregon had a 23.8% prevalence of obesity among adults, the third highest prevalence of any Western state.[3] Since 1990, the prevalence of obesity among adult Oregonians has increased by 118%.[4] The proportion of adult Oregonians who were obese or overweight in 2005 was 59.7%.[4]

Obese individuals are, on average, sicker than non-obese individuals. Obesity is a prominent risk factor for many chronic diseases, including, but not limited to, diabetes, asthma, heart disease, and osteoarthritis. Excess weight has been shown to negatively affect physical and functional capabilities.[5] These capabilities have, in turn, been demonstrated to correlate with lower levels of health status.[6] Obese individuals make more visits to physicians, receive more prescriptions and incur more health care costs than non-obese persons.[7]

Obese individuals are also at a higher risk for cancer, including cancers of the colon, prostate, breast, cervix and ovarian cancers. In 2003, Calle et al. found obesity in the U.S. may account for 14% of all deaths from cancer in men and 20% of cancer deaths in women.[8]

Nearly half (46%) of males and four of ten (38%) females will develop cancer at some point in their lifetime.[9] Contributors to cancer are lifestyle factors, inherited risk and tobacco. In 2005, one-third of all cancer deaths were estimated to be due to lifestyle-related factors such as poor nutrition, physical inactivity, obesity and overweight.[10]

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[i] The World Health Organization (WHO) defines overweight for adults as a body mass index (BMI) between 25 kg/m^2 and 29.9 kg/m^2. Obesity is defined by a BMI greater than or equal to 30 kg/m^2.

During each day of 2002 about 50 Oregonians were diagnosed with cancer, and another 20 Oregonians died of cancer.[11] In 2000, cancer surpassed heart disease as the leading cause of death in Oregon, causing one in four deaths in the state.[11]

Despite dramatic scientific gains, not all segments of the U.S. population have benefited to the fullest extent from advances in the understanding of cancer.[12] Oregonians disproportionately affected by cancer include rural communities, older Oregonians, racial and ethnic minorities, people with disabilities, and gay, lesbian, bisexual and transgender communities.[13]

Much of rural Oregon has unmet health care needs. The distance to cancer screening and treatment services can impact the use of recommended screening or treatment services. This is often called a geographic barrier to services. For example, in Eastern Oregon, a woman may need to travel 120 miles to receive a screening mammogram. There were geographic differences in the stages at which cancer was diagnosed in Oregon between 1998 and 2002. Figure 1 shows that the percentage of early-stage diagnoses of all cancer is generally lower in rural, eastern Oregon and higher in the more urban, western Oregon. These differences may be attributed to differences in cancer reporting, screening practices or lifestyle behaviors.

Figure 1. Regional variation in percentage of early stage diagnosis of all cancer between 1998 and 2002.[ii]
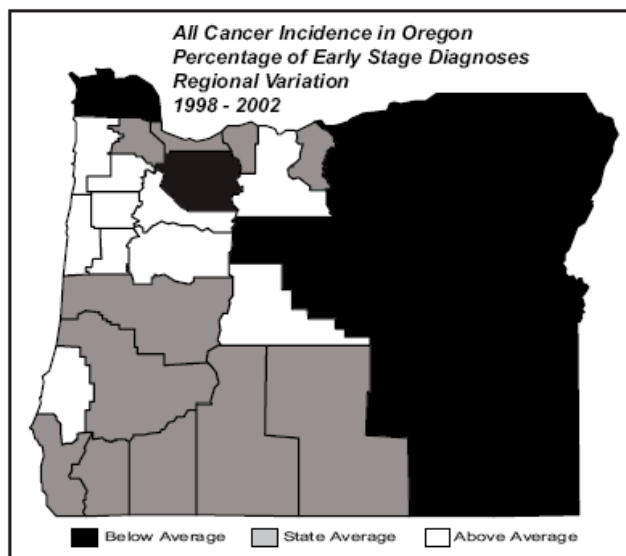
The geographic barrier to services is an acknowledged challenge facing cancer screening in Oregon. Other challenges include a lack of culturally and individually appropriate cancer resources for ethnic minorities and other underserved populations, a need for education for health professionals about cancer disparities and the resulting differences in health outcomes in underserved populations, and a need for more underserved minority and rural health care providers.[13]

Benefits of Early Detection of Cancers

Early detection means screening when there are no symptoms of a problem. Cancer screening examinations by a health professional can find cancer at its earliest stage, when treatment is most effective and the chance for survival is increased.

Cancers of interest in this study include breast, cervical, colorectal and prostate cancers. Screening can effectively detect breast, cervix and colon cancer. Early

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[ii] Figure from "Oregon Comprehensive Cancer Plan 2005-2010," published in June 2005 by the Oregon Partnership for Cancer Control.

detection of prostate cancer can improve clinical outcomes, however, screening tests for prostate cancer are not as successful in detection as for breast, cervical and colorectal cancers. Despite this, the American Cancer Society continues to recommend screening for prostate cancer with the available modalities because of the benefit of early detection.

Obesity as a Risk Factor for Cancer

Obesity is a recognized risk factor for colorectal, cervical, breast, and prostate cancers. Obese individuals have a 50% to 3-fold increased risk of colorectal cancer compared to normal weight people,[14-16] as well as an increased risk of mortality from colorectal cancer.[17] In 2000, Murphy and colleagues showed death rates from colon cancer increased across the entire range of BMI, especially among men. The rate ratio was highest for obese men, 1.75 (95% CI 1.49, 2.05) and for obese women 1.25 (95% CI 1.06, 1.46).[17]

Unfortunately, despite their increased risk for colorectal cancer, obese individuals are less likely receive CRC screening. In their 2006 study, Ferrante and colleagues found that obese patients had a 25% decreased odds of being screened for colorectal cancer compared to non-obese patients (OR 0.75, 95% CI, 0.62-0.91), after controlling for age, gender, total number of co-morbidities, number of visits to the physician in the past two years, and number of years in the practice.[18] Rosen found in 2004 that obese women were less likely to be screened for colorectal cancer than their non-obese peers.[19]

Obesity increases the risk of developing breast cancer. Breast cancer risk is markedly higher among obese postmenopausal women than among both obese and non-obese premenopausal women. Data from the European Prospective Investigation into

Cancer and Nutrition (EPIC) Study showed that obese postmenopausal women had a 31% excess risk of developing breast cancer compared with non-obese postmenopausal women.[20] Morimoto et al. in their 2002 study showed that obese postmenopausal women (defined as a BMI > 31.1 kg/m^2) had a relative risk of developing breast cancer of 2.52 (95% CI 1.62, 3.93) compared to their non-obese postmenopausal peers.[21] Obesity among premenopausal women has been shown to be inversely associated with risk of breast cancer. Some authors have argued that perhaps obesity is protective against development of breast cancer in premenopausal women. Obese (defined as a BMI > 31 kg/m^2) premenopausal women had a relative risk (RR) of 0.54 (95% CI 0.34, 0.85) compared with premenopausal women with a BMI of less than 21 kg/m^2 in a study by van den Brandt et al. in 2000.[22] Despite the inverse association between obesity and development of breast cancer in premenopausal women, the vast majority of breast cancer is diagnosed in post-menopausal women. Hence, the impact of obesity on risk for breast cancer in this particular group remains important.

Unfortunately, despite this increased risk of developing breast cancer, obese women are more likely to delay mammography and clinical breast exams than non-obese women.[23,24] In a 2007 study by Ferrante et al., obese women were less likely to be current with clinical breast exams (CBE) than their non-obese peers among all categories of obesity (BMI 30-34.9 kg/m^2: OR 0.75 (95% CI 0.59,0.96); BMI 35-39.9 kg/m^2: OR 0.55 (95% CI 0.38, 0.78); BMI ≥ 40 kg/m^2: OR 0.58 (95% CI 0.38, 0.88).[24] Among obese women, severely obese women (BMI ≥ 40 kg/m^2) were less likely to be up-to-date in their mammograms compared to non-obese women, however obese women in other obesity categories were not found to be significantly less likely to receive

mammograms.[24] In 2005, Ostbye et al. demonstrated that, compared to normal weight

women, obese women at all levels of obesity were less likely to receive screening

mammography [BMI 30-34.9 kg/m^2; OR 0.73 (95% CI 0.60, 0.88), BMI 35–39.9 kg/m^2;

OR 0.69 (95% CI 0.51, 0.93), BMI $\geq$ 40 kg/m^2; OR 0.59 (95% CI 0.40, 0.88)].[25]

Obesity is associated with a higher risk of death from cervical cancer. Calle et al.

in 2003 demonstrated a positive linear trend in death rates for cervical cancer across BMI

groups (p = 0.001).[8] Obese individuals are more likely to delay screening for cervical

cancer by Pap smears (OR 1.29, 95% CI 1.04, 1.58).[26] In 2005, Ostbye et al. found that

among middle-aged white women, as BMI increased, the odds of receiving a Pap test

decreased [BMI 30-34.9 kg/m^2; OR 0.68 (95% CI 0.57, 0.80), BMI 35–39.9 kg/m^2; OR

0.59 (95% CI 0.45, 0.78), BMI $\geq$ 40 kg/m^2; OR 0.50 (95% CI 0.35, 0.71)] .[25]

Recent studies have shown that while obesity is not associated with an increased

risk for low-grade prostate cancer, it does increase the risk of aggressive prostate cancer.

In 2007, Rodriguez et al. demonstrated that obese men had 1.54 times (95% CI 1.06,

2.23) the risk of advanced or fatal prostate cancer compared to their non-obese peers.

Additionally, they found that obesity was inversely associated with risk of non-metastatic

low-grade prostate cancer (RR 0.84, 95% CI 0.66, 1.06).[27]

Contrary to other cancers, Scales et al. found in 2007 that obese men are more

likely than normal weight men to be screened for prostate cancer using the prostate

specific antigen (PSA) test (OR 1.46, 95% CI 1.33, 1.61).[28] In 2004, Fontaine et al.

demonstrated similar findings. They found the odds of obese men receiving PSA serum

tests were 1.26 (95% CI 1.06, 1.36) times the odds of non-obese men.[29] Thus the

relationship between obesity and prostate cancer may not adhere to the inverse relationship seen with screening for colon, breast and cervical cancer.

Although the association between weight and certain forms of cancer is strong, other factors (e.g. family history, age, smoking status, and body fat distribution) play an important role in determining cancer risk. Nonetheless, the demonstrated increased cancer risk associated with obesity underscores the importance of preventive health care services, such as cancer screening, for obese individuals, in order to intervene in the development of cancers associated with excess body weight.

The reasons obese individuals are less likely to be screened are not clearly known. Obesity-related disparities may result from patient factors, physician factors, or their interactions. Patient-related factors may include poorer access to care (perhaps mediated by lower socioeconomic status or ability to pay) or increased reluctance among obese individuals to undergo screening. This reluctance is most likely related to many factors, including the impact of obesity on self-esteem and body image. Additionally, some screening tests may be more difficult, painful or time-consuming for obese individuals. For example, vaginal speculum examinations or mammograms are often reported to be more painful for obese women, which may lead to deferral of the exam.[25] Physician-related barriers to screening may include a perceived increase in the technical difficulty of the procedures or pain to the obese individual, the competing demands of managing other clinical comorbid conditions,[30] or physician bias against obese patients.[31] Obese patients may be stereotyped to have less willpower and be less concerned about their health than non-obese patients.[32] Physicians may feel that obese patients are less interested in preventive care, and thus be less likely to suggest cancer screening. Many

of these are speculations, as there has been no systematic effort to survey the barriers that obese individuals and healthcare providers perceive that may influence whether or not screening occurs.

Obesity and Cancer Screening Services in Rural America

Evidence suggests obesity is more common among people living in rural areas.[33,34] In addition, health services are less available in rural America for almost any disease or health issue, including obesity.[35] While the obesity epidemic is rooted in the interplay of very complex cultural and societal factors, the unique characteristics of rural public and private health care services also are likely contributors. Potential contributors are the lack of local public health capacities, changing lifestyles, dependence on Medicare for insurance coverage, lack of knowledge or information, lack of coordination of local providers, socio-economic disadvantage, geographic isolation, provider shortages and lack of transportation.[35]

Therefore, investigating the relative levels of cancer screening services delivered to obese rural individuals is critically important. It is not known whether rural obese individuals receive the same cancer screening services as their non-obese peers. It is important to document whether obese individuals are receiving fewer cancer screening services so that more appropriate clinical and educational interventions can be designed and implemented. By doing so, disparities in their care can be addressed by channeling resources into more appropriate interventions.

QUESTION AND SPECIFIC AIMS

The overall purpose of this study was to assess whether receipt of cancer screening varied according to obesity among patients seen at rural Oregon primary care clinics. The specific hypothesis was that obese individuals would be less likely to be screened for cancer than their non-obese peers, after controlling for other factors influencing screening. In this regard, there were several specific aims:

- Compare the cancer screening services received by non-obese and obese individuals, as appropriate for their age, gender, and recommended screening intervals for each screening exam.

- Compare cancer screening in rural Oregon to national cancer screening recommendations.

- Use these study findings to begin to identify unique needs of rural primary care clinic patient populations, especially among obese rural individuals.

The null hypothesis for this study was there is no difference in receipt of cancer screening between non-obese and obese individuals in these rural clinic populations.

The findings from this study will hopefully be used in the long term by health care providers and Oregon health policy-makers to reduce cancer disparities in rural Oregon.

METHODS

<u>Overview</u>

This is a cross-sectional study evaluating the association between BMI and receipt of colorectal, breast, cervical and prostate cancer screening using abstracted medical chart data. An abstraction form developed and tested for appropriate content by the designers of this study was used for data collection. This form is included as Appendix B.

<u>Study Population</u>

The patients were 902 randomly selected medical charts of individuals seen in primary care clinics in rural Oregon. Approximately 150 charts were abstracted from each of six different rural Oregon primary care clinics, all of which are members of the Oregon Rural Practice-based Research Network (ORPRN). Exclusion criteria include patients under the age of 18 or over the age of 80 on January 1, 2002. Each individual also had at least one visit to the physician during the two year period beginning January 1, 2002.

The ORPRN is comprised of rural Oregon clinicians and practices who joined the network because of their interest in clinical research within their patient populations. The majority of the clinicians are family physicians, however there are several general internists and pediatricians in the network. Many clinics are also staffed by nurse practitioners, physician's assistants and other non-physician clinicians.

Clinics were chosen to represent different rural geographical regions of the state of Oregon. They were located as follows; one coastal clinic, two northeastern Oregon

clinics, one eastern Oregon clinic, one central Oregon clinic, and one north-central

Oregon clinic. See Figure 3 below for the geographic locations of each site within

Oregon. Their corresponding counties are shaded yellow.

Figure 2. Geographic locations of rural clinic sites in Oregon.

Rural Cancer Screening Study Sites

✦ Study Site
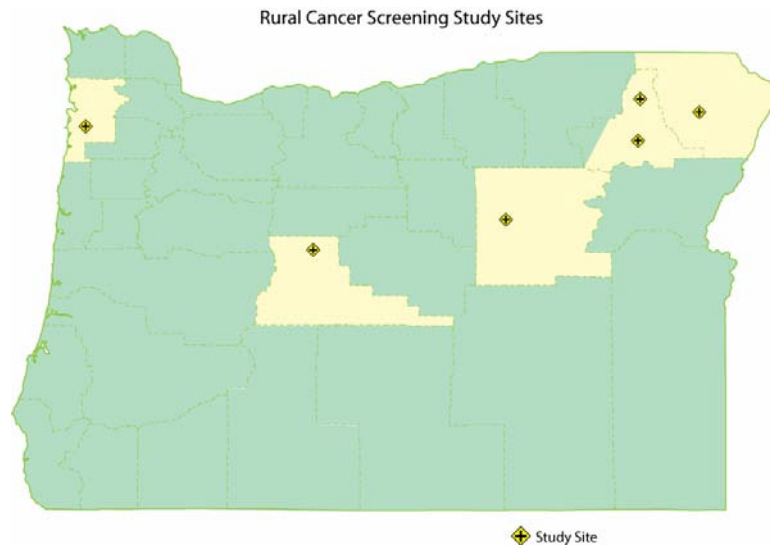
Much of Oregon is rural, with 89% of its total population living in its six

metropolitan areas.[36] Many counties are considered "frontier," defined as a population

density of less than six people per square mile. Communities within these frontier

counties are isolated from urban areas and individuals receive most of their medical care

within their small town.

The six clinics included in this study vary in their distance from larger towns. As

can be seen in Table 1, they range from 15 to 80 miles from larger towns. Their

populations in 2003 varied from 1097 to 32, 877 individuals. Each of the six counties

had a higher median family income than the Oregon state average for 2004 of $41,794.

Despite a higher median family income, four of the six counties had a higher proportion

of uninsured residents than the Oregon 2004 average of 14%. Other demographic

differences can be seen in Table 1.

Table 1. Community Characteristics. Obtained from Oregon Office of Rural Health Datasheets, November 2004.

Community	1	2	3	4a**	4b**	5	6
Population, 2003	7075	6858	4328	2402	4681	1097	32,877
Miles to Nearest Large Town	65	80	21	21	15	44	16
% of Pop. 65 + Yrs, 2003	20.5%	18.3%	21%	16.6%	16.5%	26.3%	14.4%
% Below FPL (Oregon Avg. = 11.6%)	14.0%	13.1%	7.7%	15.1%	13.7%	8.3%	7.6%
Median Family Income, 2004 (Oregon Median Family Income,2004 = $41,794)	$45,800	$43,000	$48,500	$47,800		$48,900	$57,800
Total OHP Eligibles Receiving Benefits, 2004 (Oregon Avg. = 10.5%)	8.4%	9.6%	10.1%	12.0%		6.8%	8.4%
Without Health Insurance, 2002 (Oregon Avg. = 14.0%)	16.5%	16.5%	12.9%	16.5%		18.8%	13.5%
Unemployment, 2003 (Oregon Avg. = 8.2%)	10.9%	11.3%	6.6%	6.5%		6.6%	7.7%
Number of Persons per Primary Care Provider in Service Area	1179	1372	1443	4681		0*	1265

*Denotes communities without physicians. These communities do have non-physician clinicians.
**Clinics 4a and 4b are two sites belonging to the same clinic. For the purpose of this data analysis data from these sites will be considered to be from one clinic.

Human Subjects Considerations

This study was reviewed and approved by the Oregon Health & Science

University (OHSU) Institutional Review Board (IRB).

Data Collection

Data for this study was collected by medical chart review. A medical chart abstraction form was developed by two experienced investigators and two data abstracters (Appendix B). The data abstracters were trained in chart review and data abstraction by an experienced ORPRN investigator at OHSU. The form was tested by the data abstracters and on paper medical charts at clinics associated with OHSU prior to field data collection. During initial abstraction form testing, the experienced investigator monitored data abstraction for quality control.

Data were gathered on site at each of the six rural Oregon primary care clinics. Each of two data abstracters visited three clinics. At each clinic, the abstracter randomly selected 150 medical charts. Charts were randomly selected by blindly pulling one chart from each shelf in the room sequentially until 150 charts were selected. During data collection, data were recorded on the paper abstraction form and later the same day entered by the abstracter into an Epidata 3.0 database designed specifically for this study. Data abstracters reconciled any questions regarding abstraction methodology by email or telephone conversation. Details from these conversations were documented for future reference.

Data were abstracted primarily from the two year period between January 1, 2002 and December 31, 2003. In general, abstracters restricted the review to chart notes during this period, with several exceptions. The entire patient chart was audited for a patient height, as it was assumed an adult height would remain essentially the same throughout their lifetime. Relevant time periods for each cancer screening exam were audited. Most cancer screening exams of interest to this study, including FOBT, Pap

smear, DRE, PSA, CBE, and mammogram, were recommended either yearly or biannually. For these exams, only data from the two-year period of interest were abstracted. Screening exams with a recommended frequency of greater than two years in this study were colonoscopy, flexible sigmoidoscopy, and barium study. For example, in an individual 50 years of age or older at the beginning of the study period, the ten year screening period for colonoscopy was considered to be January 1, 1994 – December 31, 2003. The chart was either reviewed from the year the individual turned 50 and were hence eligible for CRC screening, or from January 1, 1994 if they were eligible for screening during the entire ten-year period. For the same individual, the chart was reviewed from January 1, 1999 (the five year screening period for these exams was considered to be January 1, 1999 – December 31, 2003) for screening flexible sigmoidoscopy and barium study.

The length of time the patient had been a member of the practice was also abstracted. This was calculated by calculating the length of time from the patient's first visit to the clinic to the last day of the period of interest, December 31, 2003. This was recorded as less than 6 months, 6 to 12 months, 12 to 24 months, 2 to 5 years and greater than 5 years.

VARIABLE DEFINITIONS

<u>Overview</u>

The independent variable of primary interest in this study was obesity, defined as having a body mass index greater than or equal to 30 kg/m^2, calculated based on patient height from the chart, which could have been recorded at any time in the patient's chart,

and the first recorded weight value from within the two year window period. In the case of more than one height value, the lower measurement was used, as it was assumed the lower value was more accurate because it was likely measured without the patient wearing shoes. BMI was calculated by dividing the individual's weight in kilograms by his or her height in meters squared.

Two categories of the independent variable were defined based on BMI.

- Non-obese: Includes normal weight (BMI 18.5 – 24.9 kg/m^2) and overweight individuals (BMI 25 – 29.9 kg/m^2)

- Obese: Includes all individuals with a BMI $\geq$ 30 kg/m^2

Potential confounding variables included gender, age, ethnicity, length of time the patient had been a member of the clinical practice, total number of physician visits during the two year window period, and the presence of chronic disease.

The number of clinic visits during the window period was documented because it was considered a potential confounder of the relationship between obesity status and receipt of cancer screening. It is possible that obese individuals visit the physician less often and hence have fewer opportunities for receiving cancer screening. Similarly, the length of time the patient had been a patient of the clinic could potentially be a confounder, as obese individuals may have more recently established care and had less exposure to both counseling regarding their obesity and cancer screening. Alternatively, obese patients may have early onset of chronic diseases which necessitate more frequent or earlier attendance at the clinic. This could increase the number of encounters during which a screening service could be performed or ordered. Another potential confounder was the presence of chronic disease. It is possible that obese individuals are more likely

to have chronic medical conditions than their non-obese peers, and that these problems take priority over preventive services during their office visits. This possibility was investigated by comparison of the presence of a chronic disease and frequency of visits between obese and non-obese individuals.

The patients' reasons for visiting the clinician during the two year study period were recorded from the medical chart. These reasons were divided by investigators into acute care and chronic disease management. If a patient had any visits during the window period for any disease considered chronic, they were considered to have a chronic disease. For example, diabetes, hypertension, congestive heart failure, hyperlipidemia and gastroesophageal reflux disease were considered chronic diseases, while abdominal pain, acne, back strain and extremity pain were considered acute problems. Appendix A includes a comprehensive list of the conditions recorded.

Outcome Measures – Receipt of Cancer Screening

The outcomes of interest for this study were receipt of cancer screening examinations as appropriate for age and gender. These included screening for colorectal, breast, cervical and prostate cancers. Outcome variables were defined primarily using U.S. Preventive Services Task Force (USPSTF) or American Cancer Society (ACS) recommendations in effect during 2002-2003. Receipt of prostate cancer screening was defined according to ACS recommendations. Receipt of colorectal, breast, and cervical cancer screening was defined according to USPSTF recommendations. Cancer screening services received during the recommended time periods, in accordance with screening recommendations, were recorded as appropriate for age and gender. Outcomes were coded according to whether a patient received, did not receive, or declined screening

examination. There were only a few individuals who declined screening examinations of any type. The category of individuals who declined screening was collapsed with those who did not receive screening, since patients who declined screening remained unscreened for that particular cancer.

Colorectal Cancer Screening

USPSTF guidelines were used, which recommend all individuals 50 years old or older be screened for colorectal cancer according to any single modality or combination of the following modalities: a yearly fecal occult blood test (FOBT), flexible sigmoidoscopy every five years, colonoscopy every ten years, or a barium study of the colon every five years.[37] Individuals with a personal history of colon polyps, colorectal cancer, or inflammatory bowel disease (IBD) were excluded from this analysis, as exams among these individuals can no longer be considered screening. Screening was considered to have been completed if evidence could be found in the chart that patients had received any of the screening tests or combination of tests within the appropriate timeframe for that screening service.

Breast Cancer Screening

Recommendations by the U.S. Preventive Services Task Force (USPSTF) were used to determine receipt of screening for breast cancer. The USPSTF recommends all women 40 years or older receive a screening mammogram (with or without CBE) every 1-2 years.[38] Women with a personal history of breast cancer were excluded from this analysis, as CBE and mammography in these women were considered follow-up

examinations, rather than cancer screening. For the purpose of this study, patients were considered to have had a mammogram if there was a radiologic report of a mammogram or documentation of a discussion with the physician of mammography results within the two year window period. In this thesis, only the screening mammogram outcome was evaluated, as it is the most consistently recommended breast cancer screening modality.

Cervical Cancer Screening

USPSTF guidelines consider all women who are sexually active or greater than 21 years of age, whichever comes first, eligible for cervical cancer screening, which should occur at a frequency of at least every three years. After the age of 70, women no longer need to be routinely screened.[39] For the purposes of this study, all females between 18 and 70 years who had a cervix were considered eligible. A cervix was considered absent if the woman had a history of a hysterectomy recorded in their chart. Patients were considered screened if any of the following occurred during the two year study period: standard Pap smear, liquid-based cytology, or cervical HPV DNA typing.

Prostate Cancer Screening

Although the USPSTF does not recommend for or against routine screening for prostate cancer,[40] the American Cancer Society recommends offering both the prostate specific antigen (PSA) test and the digital rectal examination (DRE) annually to men starting at age 50.[41] For the purposes of this study, patients considered eligible for screening included all males 50 years or older without a personal history of prostate

cancer. Individuals were considered screened if they had a DRE or a PSA serum measurement within the two year window period.

Table 2 describes preventive services and standards included in this study.

Table 2. Preventive service variables measured and standards used for this study.

Preventive Services Measured		USPSTF Recommendations during 2002-2003
Colorectal Cancer Screening Screening in average risk individuals is effective, regardless of strategy chosen.[37] Screening was considered complete if one of these methods was used.	Fecal Occult Blood Test (FOBT)	$\geq$ 50 years, annually[37]
	Flexible Sigmoidoscopy	$\geq$ 50 years, every 5 years[37]
	Colonoscopy	$\geq$ 50 years, every 10 years[37]
	Barium Study	$\geq$ 50 years, every 5 years[37]
Breast Cancer Screening	Clinical Breast Exam (CBE)	Insufficient evidence to recommend for or against CBE alone for screening for breast cancer[38]
	Screening mammogram	Every 1-2 years for women aged $\geq$ 40 years[38]
Cervical Cancer Screening	Pap smear	At least every 3 years after onset of sexual activity or at age 21, whichever comes first[39]
Prostate Cancer Screening	Digital Rectal Exam (DRE)	Insufficient evidence to recommend for or against routine screening at this time[40]
	Prostate Specific Antigen (PSA)	Insufficient evidence to recommend for or against routine screening at this time[40]

Data Management

Body mass index was calculated from height and weight data as a continuous variable. The obesity status variable was created by dividing BMI into categories based on the following:

- Non-obese: BMI $\leq$ 29.9 kg/m^2

- Obese: $\geq$ 30 kg/m^2

To facilitate analysis of each cancer screening outcome, screening filter variables designating eligibility (including age, gender and personal history of each cancer according to screening guidelines) were created. Dichotomous variables were created

corresponding to receipt of each cancer screening examination, defining whether screening was complete or not. For example, in the case of screening for colorectal cancer, eligibility filters were created for age of 50 years or greater. Screening was classified as 0 = no colorectal cancer screening within the appropriate screening interval and 1 = colorectal cancer screening completed during the appropriate screening interval.

The number of visits for chronic diseases was transformed into a binary variable of presence or absence of chronic disease according to the reason for visiting the clinician. The presence or absence of chronic disease was thought to be the best estimation of an individual's overall health status.

The variable representing the length of time a patient had been a member of the clinic was initially represented by five different values (0 = ≤ 6 months, 1 = 6-12 months, 2 = 12-24 months, 3 = 2-5 years, 4 = ≥ 5 years). However, because a higher proportion of patients were members of their respective clinics for over five years, and less were members of their clinics for less than one year, the variable was re-categorized. It was transformed into three categories as follows: 0 = ≤ 2 years, 1 = 2 to 5 years and 2 = ≥ 5 years.

After review of descriptive statistics and histograms, one variable was removed from consideration on subsequent analyses. Race or ethnicity was often not available in the chart, and when available, was largely Caucasian. This corresponds to the demographics of rural Oregon. See Table 3 for breakdown of race/ethnicity in the 902 charts evaluated.

Table 3. Race/Ethnicity as recorded in medical charts.

Race/Ethnicity as Recorded in Chart	Frequency	Percent of Total Study Population
Caucasian	630	69.8
African-American	1	0.1
Asian	3	0.3
Native American	6	0.7
White, of Hispanic origin	5	0.6
Missing	257	28.5
Total	902	100.0

Power Analysis

The eligible sample sizes for colorectal cancer screening, screening mammogram, cervical cancer screening and prostate cancer screening were determined from the data. These were 279, 211, 211, and 130, respectively. Initial descriptive statistics demonstrated proportions of non-obese patients screened for each cancer. A power calculation tool was used to estimate the expected proportion of obese individuals of appropriate age and gender who received each cancer screening service.[42] As can be seen in Table 3, the current sample sizes will have adequate power to detect an effect size of 16-20% difference in proportion of individuals receiving CRC screening, a 19-24% difference in proportion of individuals receiving a screening mammogram, a 19-24% difference in proportion receiving cervical cancer screening, and a 23-29% difference in proportion receiving prostate cancer screening. Table 4 depicts the detectable odds ratios at varying powers using an alpha value of 0.05:

Table 4. Estimates of detectable effect. Bolded odds ratios are the odds ratios needed to detect a difference, if it exists, at 80% power and an alpha of 0.05.

	Total Eligible	Non-obese	Proportion of non-obese screened	% Power, Alpha = 0.05	Detectable Proportion	Detectable Difference	Detectable OR
Colorectal Cancer	279	118	0.33	70	0.49	0.16	1.95
				75	0.50	0.17	2.03
				80	**0.51**	**0.18**	**2.11**
				85	0.52	0.19	2.19
				90	0.53	0.20	2.29
Breast Cancer	211	131	0.48	70	0.67	0.19	2.20
				75	0.68	0.20	2.30
				80	**0.69**	**0.21**	**2.41**
				85	0.70	0.22	2.53
				90	0.72	0.24	2.78
Cervical Cancer	211	129	0.40	70	0.59	0.19	2.16
				75	0.60	0.20	2.25
				80	**0.61**	**0.21**	**2.35**
				85	0.62	0.22	2.45
				90	0.64	0.24	2.67
Prostate Cancer	130	71	0.48	70	0.71	0.23	2.65
				75	0.72	0.24	2.79
				80	**0.73**	**0.25**	**2.93**
				85	0.75	0.27	3.25
				90	0.77	0.29	3.63

Statistical Methods

Chart-abstracted data was exported from Epidata database to SPSS 14.0[43] statistical software. Descriptive statistics were calculated as appropriate for continuous and categorical variables. T-tests for continuous variables and chi-square tests for categorical variables were used to determine significant differences between obese and non-obese patients at a p=0.05 level of significance.

Table 5. Patient characteristics evaluated as variables in this study. Three variables were continuous and the remainder were categorical. Categorization is included.

Independent Variable of Primary Interest
Obesity Status
Non-obese (BMI ≤ 29.9 kg/m^2)
Obese (BMI ≥ 30 kg/m^2)
Other Independent Variables Evaluated
Patient BMI (continuous in kg/m^2)
Patient Age (continuous in years)
Number of total visits within two year window period (continuous)
Gender*
Male
Female
Presence of Chronic Disease
Chronic Disease Present
Chronic Disease Absent
Length of Time a Member of Practice
≤ 2 years
2-5 years
≥ 5 years
Independent Variables Included for Specific Cancers**
Family History of CRC
Family History Absent
Family History Present
Family History of Breast Cancer
Family History Absent
Family History Present
Family History of Prostate Cancer
Family History Absent
Family History Present

*Gender was only included as a variable for CRC screening, since it was the only cancer for which both men and women need to be screened.

**Family history of cervical cancer not included because it is not a known risk factor for development of cervical cancer.

The unadjusted relationship between obesity status and each cancer screening outcome was examined individually using univariate logistic regression models. The non-obese group (BMI ≤ 29.9 kg/m^2) was used as the reference category. Although it was not the primary interest in this study, BMI, measured as a continuous variable, was also regressed against cancer screening outcomes. This analysis was performed to insure that the relationship seen between obesity status as a categorical variable and cancer screening was not due to the categorization of BMI.

As a method for evaluation of confounding, the relationship between obesity status and cancer screening was adjusted for each of the other independent variables one at a time (Table 5). The variable was considered a confounder of the relationship between obesity status and cancer screening if the odds ratio changed by more than 10% with the addition of that variable to the model.

Then, the significant of the relationship between each confounding variable and the outcome of cancer screening was examined using univariate logistic regression modeling. The family history of colorectal, breast, and prostate cancer variables were examined for those respective cancers. Variables with a uni-variable p-value of 0.25 or less were included in building a multivariate model. A test statistic p-value of 0.25 was chosen as an initial selection criterion for variable selection because it is beneficial to include in a preliminary model any variables that could potentially be important in the final model.

All significant variables, plus patient age and obesity status, were included in preliminary main effects models for each cancer screening service. These models were developed for each cancer screening service using eligibility criteria described previously. Using backwards stepwise selection, variables non-significant at a 0.25 level were removed from the model until all remaining variables were statistically significant.[44] Age and obesity status, if removed during backwards selection, were added back to the main effects model after the other non-statistically significant variables were removed.

Interaction between variables was assessed by adding interaction terms individually to the preliminary main effects model, using a significance level of 0.25 for inclusion in the model. Then an automated SPSS procedure was used to check deliberate

variable selection methods. The fit of each multivariable logistic regression models was assessed by the method of Hosmer and Lemeshow for goodness-of-fit.[44]

Odds ratio estimates were used to compare the relationship between obesity status and receipt of screening for each cancer.

Sub-analyses were performed to further examine relationships thought to be important. For example, a sub-analysis of women over 60 years of age was performed to examine the relationship between obesity status and receipt of screening mammogram in post-menopausal women, as their risk for breast cancer is known to be higher than premenopausal women. Sixty years of age was chosen for sub-analysis because most women are post-menopausal at that time.

Multiple Imputation

Multiple imputation (MI) was performed for individuals that did not have height values in their medical chart using SAS 9.1 in order to estimate missing BMI values.[45] This increased the study's power and allowed for inferences to be made about the entire study population, as if BMI were calculable for every individual. In multiple imputation, each missing height value is replaced by a list of five simulated values, which are plausible alternative versions of the complete data. The heights of individuals with available heights in their medical chart are not changed by this procedure, but are incorporated into each of the five imputation models as the same value. The SAS procedure called PROC MI was used to create imputed datasets. Each of the five data sets were analyzed in the same fashion by a complete data method, which in this study was logistic regression (PROC LOGISTIC in SAS). The results, which vary slightly due

to differences in imputed data values, were then combined to obtain overall estimates of regression parameters and their standard errors. The results reflect missing-data uncertainty as well as finite-sample variation. The SAS procedure called PROC MIANALYZE was used to obtain combined results. In multiple imputation, the missing height values for each individual are created from his or her own observed characteristics (such as age, gender, weight, etc.), with random noise added to preserve a correct amount of variability in the imputed data.[46]

The missing height values in this study provided an ideal opportunity for multiple imputation. Imputing in this fashion assumes data were missing at random. There are several reasons for this. First, height is a biological continuous variable that follows a normal distribution. It is reasonable to assume heights would be distributed the same for individuals with and without height values recorded in their medical charts. In addition, the multiple imputation method created height values from other information available about these individuals, including their age, gender, and weight. Lastly, it can be reasonably assumed that having a height missing from a medical chart was not related to the individual's obesity status or cancer screening status, and was therefore missing at random.

Odds ratio estimates of primary interest in this study were calculated using only individuals with heights available in their chart. Then, odds ratio estimates of the relationship between obesity status and receipt of each cancer screening after multiple imputation of missing height values were compared to odds ratio estimates without individuals with missing heights.

RESULTS

The study sample was 42.6% (384/902) male and 57.4% (518/902) female. Their average age was 50.57 years (SD 15.96), 52.26 years (SD 15.35) for men and 49.32 years (SD 16.30) for women.

Ninety-two percent (830/902) of the study population had recorded weight values. The average weight at the first visit recorded within the study period was 186.63 lbs. (SD 15.96). The average weight for females was 171.32 lbs. (SD 38.35) and for males 206.92 lbs. (SD 39.47).

Sixty percent (541/902) of the study population had height values recorded in their chart. The average height was 66.57 inches (SD 4.03). The average male height was 69.66 inches (SD 3.20) and the average female height was 64.24 inches (SD 2.86). There was no significant difference between recording of height between genders (p-value = 0.817). Sixty percent (232/384) of men and 59.7% (309/518) of women had a height recorded at any time in their medical chart.

Body mass index values were available in 2% (18/902) of the study sample. These patients were all members of the only clinic with an electronic medical record that calculates BMI automatically when patient height and weight are entered.

Body mass index was calculable for 41.7% (526/902) of the study population. These individuals differed significantly in their age, number of total visits to the physician during the window period and in the presence of chronic disease (Table 6), compared to individuals for whom a BMI could be calculated. Those without a calculable BMI were, on average, four years younger (p-value < 0.001), and have one less visit to the physician during the two year window period (p-value = 0.003). Patients

without a calculable BMI, compared to patients with a calculable BMI, were less likely to have a chronic disease (p-value = 0.044). They did not differ significantly in their weight, gender or the length of time they had been a member of the practice.

Table 6. Demographic differences between patients for whom a BMI could be calculated and those without a calculable BMI. Variables with differences significant at a p=0.05 level are italicized.

Variable	Total	BMI available	No BMI available	p-value*
Total sample, N (%)	902 (100)	526 (58.31)	376 (41.69)	
Mean first weight recorded during the study period (SD)**	186.63 (42.63)	186.19 (42.14)	187.39 (43.52)	0.697
Mean age (SD)	50.57 (15.96)	52.18 (15.39)	48.32 (16.49)	<0.001
Mean number (SD) of total visits within two year window period	6.18 (5.53)	6.63 (5.31)	5.53 (5.76)	0.003
Gender Male, N (%) Female, N (%)	 384 (42.6) 518 (57.4)	 227 (43.2) 299 (56.8)	 157 (41.8) 219 (58.2)	0.675
Patients with chronic disease, N (%)	546 (60.5)	333 (63.3)	213 (56.6)	0.044
Length of time member of practice, N (%) ≤ 2 years 2-5 years ≥ 5 years.	 161 (17.8) 239 (26.5) 502 (55.7)	 82 (15.6) 144 (27.4) 300 (57.0)	 79 (21.0) 95 (25.3) 202 (53.7)	0.110

* p-value corresponds to chi-square value and t-test statistic, as appropriate for categorical and continuous variables, respectively.
** Weight recorded for 92% (830/902) of the study population.

Among the patients for whom a BMI could be calculated, the average BMI at first visit was 29.50 kg/m^2 (SD 6.08). The average BMI for men was 30.06 kg/m^2 (SD 5.25) and for women it was 29.07 kg/m^2 (SD 6.62).

Upon categorization of BMI into normal weight, overweight and obese categories, both men and women had a higher proportion of obese individuals than overweight individuals. Both genders had the fewest number within the normal weight category. Forty-five percent (101/224) of men were obese, 40.6% (91/224) were overweight, and 14.3% (32/224) were normal weight. Among women, 38.5% (112/291) were obese, 30.2% (88/291) were overweight, and 31.3% (91/291) were normal weight (Figure 4).

After collapsing into dichotomous form, 59.5% (313/526) of the study population were non-obese and 40.5% (213/526) were obese.

Figure 3. Distribution of study population into normal weight, overweight and obese categories.
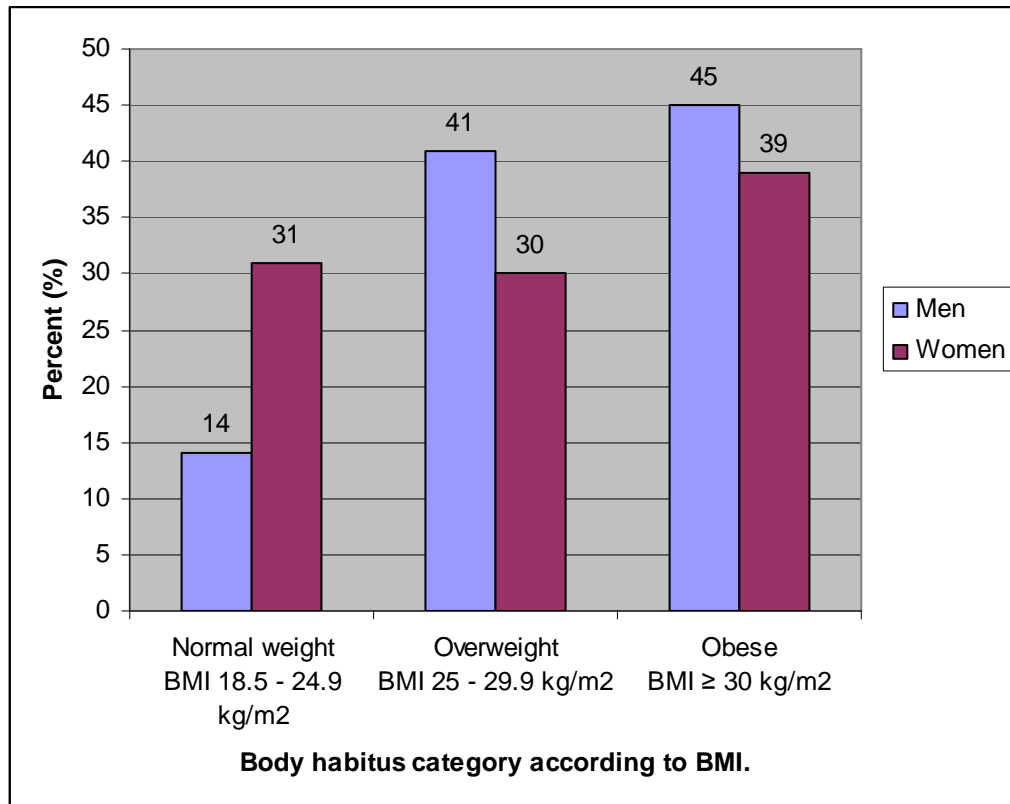
The average BMI of obese patients was 35.31 (SD 4.76) and of non-obese patients was 25.54 (SD 2.84). Obese patients differed significantly from their non-obese peers in their proportion with a chronic disease (71.8% vs. 54.1%, respectively, p = 0.001). A higher proportion of obese patients were a client of the clinic for two years or less and a higher proportion of non-obese patients had attended the clinic for five years or more. See Table 7 for other differences between obese and non-obese patients.

Table 7. Comparison of patient characteristics between obese and non-obese patients. Variables with differences significant at a p=0.05 level are italicized.

Variable	Total	Non-obese	Obese	p-value
Total sample, N (%)	526 (100)	313 (34.7)	213 (23.6)	
BMI	29.50 (6.08)	25.54 (2.84)	35.31 (4.76)	< 0.001
Mean first weight of study period (SD)	186.19 (42.14)	162.45 (26.62)	221.08 (36.07)	< 0.001
Mean age (SD)	52.18 (15.39)	52.32 (15.71)	51.98 (14.93)	0.803
Mean number (SD) of total visits within two year window period	6.63 (5.31)	6.31 (4.85)	7.11 (5.91)	0.089

Gender
   Male, N (%)
   Female, N (%)
	
	 227 (43.2)
	 299 (56.8)
		
		 126 (40.3)
		 187 (59.7)
			
			 101 (47.4)
			 112 (52.6)
				0.104

Patients with chronic disease, N (%)	333 (63.3)	180 (54.1)	153 (71.8)	0.001

Length of time member of practice, N (%)
   ≤ 2 years
   2-5 years
   ≥ 5 years.
	
	 82 (15.6)
	 144 (27.4)
	 300 (57.0)
		
		 39 (12.5)
		 85 (27.2)
		 189 (60.4)
			
			 43 (20.2)
			 59 (27.7)
			 111 (52.1)
				0.041

Table 8 lists the average imputed heights for the 830 patients after the multiple imputation procedure was implemented. The heights of individuals for whom a height could be found in the chart was not changed for the multiple imputation procedure. The average height of the 830 members of the study sample was 66.65 inches (SD 4.00). This is very similar to the mean height of the population prior to multiple imputation, which was 66.57 inches (SD 4.03). The mean BMI of the 830 patients was 29.50 kg/m^2 (SD 6.11). This was identical to the mean BMI of the population prior to multiple imputation, but with a slightly lower standard deviation of 6.08.

Table 8. Mean heights and BMIs after multiple imputation of height, listed by imputation number.

Imputation n=830	Mean Height of Total Sample in Inches (SD)	Mean BMI of Total Sample (kg/m^2)
1	66.76 (4.05)	29.40 (6.05)
2	66.58 (4.02)	29.56 (6.12)
3	66.58 (3.91)	29.56 (6.14)
4	66.66 (4.00)	29.49 (6.12)
5	66.69 (4.04)	29.47 (6.15)
Mean of 5 Imputations	66.65 (4.00)	29.50 (6.11)
Mean prior to multiple imputation	**66.57 in. (SD 4.03)** **n = 541**	**29.50 kg/m^2 (SD 6.08)** **n = 526**

Colorectal Cancer Screening

Overall 30% (131/441) of eligible individuals were screened for colorectal cancer (CRC) with any screening service. A BMI was calculable for 63.3% (279/441) of eligible individuals. Among those individuals with a calculable BMI, 34% (55/161) of eligible non-obese individuals and 33% (39/118) of eligible obese individuals were screened for CRC. Using chi-square analysis, no significant difference was found in receipt of CRC screening between obese and non-obese individuals (p-value = 0.85). Overall, 28% (35/124) of eligible males were screened for CRC. Twenty-nine percent (20/69) of eligible non-obese males and 27% (15/55) of eligible obese males were screened. There was no significant difference between receipt of CRC screening between obese and non-obese men (p-value = 0.83). Overall, 38% (59/155) of eligible females were screened for CRC. Thirty-eight percent (35/92) of eligible non-obese females and 38% (24/63) of eligible obese females were screened for CRC. Again, this difference was statistically non-significant (p-value = 0.995).

Overall there was no significant difference in receipt of colorectal cancer screening between obese and non-obese individuals (Table 9).

Table 9. Proportion of eligible patients who received colorectal cancer screening.

	Number eligible for colorectal cancer (CRC) screening	Number receiving screening (% eligible)	p-value
Total Study Population (Including Men and Women)			
Non-obese	161	55 (34%)	
Obese	118	39 (33%)	0.846
Total	279	94 (34%)	
Men			
Non-obese	69	20 (29%)	
Obese	55	15 (27%)	0.833
Total	124	35 (28%)	
Women			
Non-obese	92	35 (38%)	
Obese	63	24 (38%)	0.995
Total	155	59 (38%)	
Healthy People 2010 Goal = 50%			

Table 10 summarizes the characteristics of obese and non-obese individuals eligible for CRC screening (older than 50 years and without a personal history of CRC). The mean age was 62.71 (SD 9.05). Compared with non-obese patients, obese patients were more likely to be younger (p-value = 0.070) and to have a chronic disease (p-value = 0.031).

Table 10. Characteristics of individuals eligible for CRC screening and for whom a BMI could be calculated.

Variable	Total	Non-obese	Obese	p-value
Total sample, N (%)	279 (100)	161 (57.7)	118 (42.3)	
Mean age (SD)	62.71 (9.05)	63.55 (8.79)	61.57 (9.30)	0.070
Mean number (SD) of total visits within two year window period	7.36 (5.76)	7.03 (5.21)	7.81 (6.44)	0.269
Gender Male, N (%) Female, N (%)	124 (44.4) 155 (55.6)	69 (55.6) 92 (59.4)	55 (44.4) 63 (40.6)	0.533
Patients with chronic disease, N (%)	201 (72.0)	108 (67.1)	93 (78.8)	0.031
Length of time member of practice, N (%) ≤ 2 years 2-5 years ≥ 5 years.	42 (15.1) 72 (25.8) 165 (59.1)	19 (11.8) 44 (27.3) 98 (60.9)	23 (19.5) 28 (23.7) 67 (56.8)	0.201

Of individuals screened for CRC, the most common single screening modality

received was the fecal occult blood test (FOBT). Types of screening examinations

received by all patients eligible for CRC screening are listed in Table 11.

Table 11. Exams received as single screening modality.

CRC Screening Modality	Number of eligible individuals receiving screening (%) n = 441
FOBT	33 (7.5)
Flexible sigmoidoscopy	7 (1.6)
Colonoscopy	31 (7.0)
Barium study	2 (0.5)
Combination of any two or more screening modalities	30 (6.8)

Of the 279 patients eligible for colorectal cancer screening and for whom a BMI

could be calculated, 44% (124/279) were male and 56% (155/279) were female. The

only variable statistically significantly different between males and females was the

number of total visits to the physician within the chart abstraction period. On average,

eligible men visited the physician 6.5 times during this period and women visited the

physician 8.1 times (p-value = 0.024) (Table 12).

Table 12. Differences in variable distributions between men and women for whom a BMI could be calculated and who are eligible for colorectal cancer screening.

Variable	Total	Men	Women	p-value
Total sample, N (%)	279 (100)	124 (44.44)	155 (55.56)	
Mean age (SD)	62.71 (9.05)	62.81 (9.29)	62.63 (8.88)	0.868
Mean number (SD) of total visits within two year window period	7.36 (5.76)	6.50 (5.38)	8.05 (5.98)	0.024
Obesity status Non-obese, N (%) Obese, N (%)	161 (57.7) 118 (42.3)	69 (55.6) 55 (44.4)	92 (59.4) 63 (40.6)	0.533
Patients with chronic disease, N (%)	201 (72.0)	87 (70.2)	114 (73.5)	0.531
Length of time member of practice, N (%) ≤ 2 years 2-5 years ≥ 5 years.	42 (15.1) 72 (25.8) 165 (59.1)	14 (11.3) 32 (25.8) 78 (62.9)	28 (18.1) 40 (25.8) 87 (56.1)	0.268

Table 13 shows the unadjusted ORs of simple logistic regression models of CRC screening and covariates. Thirty-four percent of females were screened for CRC compared with 25% of males (p-value = 0.03). Patients who were screened for CRC had a higher mean number of visits to the physician during the two year primary abstraction period compared with those who were not screened (p-value = 0.07). Patients who were screened for CRC were more likely to have a chronic disease than patients who were not screened (p-value = 0.22). Family history of CRC was excluded from the model due to small cell sizes.

Table 13. Results of univariate logistic regression models of each variable and the outcome of receipt of colorectal cancer screening. Variables found to be significantly associated with receipt of CRC screening at a p≤0.25 level are italicized.

Independent Variable	Screened for CRC	Not screened for CRC	OR (95% CI)	p-value
Number of visits in the past 2 years Mean (SD)	8.12 (5.85)	6.92 (5.42)	1.029 (0.998, 1.0624)	0.069
Mean age (SD)	63.29 (8.85)	62.53 (9.00)	1.010 (0.987, 1.033)	0.412
Mean BMI (SD)	29.45 (5.99)	30.29 (6.30)	0.978 (0.938, 1.019)	0.286
Presence of chronic disease Chronic disease absent, N (%) Chronic disease present, N (%)	33 (25.6) 98 (31.4)	96 (74.4) 214 (68.6)	1.332 (0.839, 2.115)	0.224
Gender Female, N (%) Male, N (%)	82 (34.0) 49 (24.5)	159 (66.0) 151 (75.5)	1.589 (1.046, 2.414)	0.030
Family history of CRC* Family history absent, N (%) Family history present, N (%)	124 (28.8) 7 (70.0)	307 (71.2) 3 (30.0)	5.777 (1.470, 22.700)	0.012
Length of time member of practice, N (%) ≤ 2 years (referent category) 2-5 years ≥ 5 years	22 (28.9) 26 (24.3) 83 (32.2)	54 (71.1) 81 (75.7) 175 (67.8)	0.788 (0.406, 1.531) 1.164 (0.665, 2.039)	0.324
Obesity Status Non-obese, N (% within BMI category) Obese, N (% within BMI category)	55 (34.2) 39 (33.1)	106 (65.8) 79 (66.9)	0.951 (0.575, 1.574)	0.846

* Family history of CRC excluded due to small numbers of patients within categories.

The relationship between obesity status and CRC screening was adjusted for each of the individual possible confounding variables listed in Table 13. These included the

number of visits to the physician in the two-year period, age, presence of chronic disease, gender, family history of CRC, and length of time the patient had been a member of the practice. Based on comparison of unadjusted to adjusted odds ratios, none of the variables were confounders of the relationship between obesity status and receipt of CRC screening.

The relationship between CRC screening and gender and total number of visits during the window period were statistically significant at a p≤0.25 level of significance (Table 14).

Table 14. Unadjusted odds ratio estimates based on logistic regression models for colorectal cancer screening.

Variable	OR	95% CI	p-value
Gender	1.490	0.890, 2.494	0.129
Total Number of Visits During the Window Period	1.033	0.989, 1.079	0.141
Age	1.008	0.980, 1.037	0.587
Obesity Status	0.956	0.572, 1.597	0.862

The final main effects model for the relationship between obesity status and receipt of CRC screening, after backwards selection, included gender and total number of visits during the window period. Age and obesity status were re-entered into the model, as the risk of colon cancer increases with age so it is of clinical importance, and obesity status is the variable of interest for this study.

Interactions between included variables were assessed using a p=0.1 level of significance. Interactions thought a priori to be of interest were added one-by-one to the preliminary main effects model. The final model for CRC screening included age, gender, obesity status, total number of visits during the window period, and presence of chronic disease. The interaction between gender and presence of chronic disease was

found to be significant, with a Wald statistic of 3.786 (p-value = 0.043). The interaction

between age and obesity status was also found to be significant at a p=0.1 level of

significance, with a Wald statistic of 3.541 (p-value = 0.048). Therefore, these

interaction terms, as well as the variables presence of chronic disease and obesity status,

were left in the final logistic regression model. The final model is in Table 15.

Table 15. Adjusted odds ratios from multivariate final model of colorectal cancer screening.

Variable	OR	95% CI	p-value
Obese vs. Non-obese			
Age 55	0.64	0.33, 1.28	0.048
Age 65	1.15	0.67, 1.97	
Age 75	2.05	0.85, 4.92	
Total Number of Visits within the Window Period	1.04	0.99, 1.09	0.160
Female vs. Male			
Chronic disease present	2.12	1.13, 4.00	0.043
No chronic disease present	0.65	0.25, 1.70	

The Hosmer and Lemeshow goodness-of-fit test had a p-value of 0.331, which

means the observed data and expected values under the model are similar, implying the

model fits the data adequately.

After imputation of height values and calculation of BMI from these values, the

regression parameter estimates moved closer to zero, which is a blunting of the

associations in the logistic regression model. The model did not differ significantly

before and after imputation of height values. Odds ratio estimates for obesity status

before and after multiple imputation are in Table 16.

Table 16. CRC screening odds ratio estimates before and after multiple imputation.

Obesity Status (Obese vs. Non-obese)	Before Imputation OR (95% CI)* n = 279	After Imputation OR (95% CI)* n = 411
Age = 55	0.64 (0.33, 1.28)	0.76 (0.24, 2.35)
Age = 65	1.15 (0.67, 1.97)	1.17 (0.37, 3.68)
Age = 75	2.05 (0.85, 4.92)	1.81 (0.47, 7.03)

*These odds ratios represent the odds of obese versus non-obese individuals receiving cancer screening at varying ages, after controlling for, gender, total number of visits during the window period, presence of chronic disease and the interaction term gender*presence of chronic disease.

Based on the data gathered for this study, and after controlling for all other measured variables, variables associated with receipt of colorectal cancer screening included an individual's gender and number of visits to the physician within the time window period, age, obesity status and interactions between gender and presence of chronic disease and between age and obesity status.

The interaction between obesity status and age means that the odds of receipt of CRC screening varied by age. For example, as can be seen in Table 15, among obese 55-year-old individuals, the odds of receiving CRC screening were 0.64 (95% CI 0.33, 1.28) the odds of non-obese 55-year-old individuals. These odds increased with age, with obese 75-year-old individuals having twice the odds of receiving CRC screening as their non-obese 75-year-old peers (OR 2.05, 95% CI 0.85, 4.92). These differences are not statistically significant, likely due to small numbers of patients within these age categories.

The interaction between gender and presence of chronic disease means that the odds of women with a chronic disease receiving CRC screening were 2.12 times (95% CI 1.13, 4.00) higher than the odds of men with a chronic disease receiving CRC screening. Among females with a chronic disease, the odds of receiving CRC screening are 1.35 (95% CI 0.59, 3.08) the odds of females without a chronic disease. Among males with a

chronic disease, the odds of receiving CRC screening are 0.42 (95% CI 0.17, 1.00) the odds of males without a chronic disease. This is a statistically significant finding, that the odds are higher of males without a chronic disease receiving screening versus males with a chronic disease. The odds of men with a chronic disease being screened are lower than the odds of women with a chronic disease being screened for CRC.

In addition, after adjusting for all of these covariates, for each additional visit to the physician, the odds of receiving colorectal cancer screening increased 1.04 times (95% CI 0.99, 1.09). The odds of receipt of CRC screening for two visits to the physician are 1.07 (95% CI 0.97, 1.18). For eight visits to the physician, the odds are 1.32 (95% CI 0.90, 1.93).

Breast Cancer Screening

Overall 42% (145/344) of women eligible for breast cancer screening received a screening clinical breast exam, while 41% (141/344) of eligible women received screening mammogram. Thirty-two percent (109/344) of women received both, 11% (36/344) received only a CBE and 9% (32/344) received only a screening mammogram.

Forty-eight percent (63/131) of eligible non-obese women and 49% (39/80) of eligible obese women received screening mammograms (Table 17). The chi-square value was statistically non-significant (p-value = 0.483), which means the distribution of receipt of screening mammogram did not differ significantly by obesity status. Forty-five percent (59/131) of eligible non-obese women and 50% (40/80) of eligible obese women received screening clinical breast exams. The chi-square value was statistically non-

significant (p-value = 0.926), which means the proportion of women receiving a screening breast exam does not differ significantly by obesity status.

Table 17. Proportion of eligible women who received screening mammogram.

	Non-obese	Obese	Total
Number eligible	131	80	211
Number receiving screening (% of eligible)	63 (48%)	39 (49%)	102 (48%)
p-value = 0.483			
Healthy People 2010 Goal: 70%			

There was no significant difference between obese and non-obese women in their receipt of breast cancer screening. Obese women eligible for screening mammogram were, on average, one year older than non-obese women (p = 0.079), and had one more visit to the physician during the window period (p=0.029). Obese and non-obese women did not differ significantly in the presence of chronic disease, length of time they were a member of the practice and the presence of a family history of breast cancer (Table 18).

Table 18. Characteristics of women eligible for screening mammogram and for whom a BMI could be calculated.

Variable	Total	Non-obese	Obese	p-value
Total sample, N (%)	344 (100)	131 (62.1)	80 (37.9)	
Mean age (SD)	57.24 (11.60)*	56.95 (11.77)	57.78 (10.83)	0.079
Mean number (SD) of total visits within two year window period	7.23 (5.78)*	7.18 (4.60)	8.21 (6.68)	0.029
Patients with chronic disease, N (%)	145 (68.7)	131 (62.1)	80 (37.9)	0.124

Length of time member of practice, N (%)
  ≤ 2 years
  2-5 years
  ≥ 5 years.
	34 (16.1)
	52 (24.6)
	125 (59.2)
		18 (13.7)
		34 (26.0)
		79 (60.3)
			16 (20.0)
			18 (22.5)
			46 (57.5)
				0.469

Family history of breast cancer present	19 (9.0)	11 (8.4)	8 (10.0)	0.693

*Values in total column include all women eligible for screening mammogram, regardless of whether BMI could be calculated.

Upon univariate modeling of receipt of screening mammogram, significant variables included total number of visits within the window period, presence of chronic disease and family history of breast cancer. No categorical variables had cells with zero

events, so all were determined to be appropriate for inclusion in logistic regression

modeling. See Table 19 for results of univariate logistic regression modeling.

Table 19. Unadjusted odds ratio estimates from univariate logistic regression models of each variable and the outcomes of receipt of screening mammography. Variables found to be significantly associated with receipt of screening mammogram at a p=0.25 level are italicized.

	Screened for Breast Cancer	Not Screened for Breast Cancer	OR (95% CI)	p-value
Mean age (SD)	57.77 (10.65)	56.88 (12.22)	1.007 (0.988, 1.025)	0.486
Number of visits in the past 2 years			1.045 (1.006, 1.086)	0.022
Mean (SD)	8.10 (5.27)	6.63 (6.05)		
Mean BMI (SD)	29.39 (6.02)	29.17 (6.83)	1.005 (0.964, 1.049)	0.804
Presence of chronic disease				
Chronic disease absent, N (%)	39 (33.1)	79 (66.9)	1.666 (1.047, 2.651)	0.031
Chronic disease present, N (%)	102 (45.1)	124 (54.9)		
Length of time member of practice, N (%)				0.633
≤ 2 years (referent category)	22 (36.7)	38 (63.3)		
2-5 years	35 (39.3)	54 (60.7)	1 1.120 (0.570, 2.200)	
≥ 5 years	84 (43.1)	111 (56.9)	2 1.307 (0.720, 2.374)	
Family history of breast cancer				
Family history absent, N (%)	115 (37.2)	194 (62.8)	4.873 (2.207, 10.763)	<0.001
Family history present, N (%)	26 (74.3)	9 (25.7)		
Obesity Status				
Non-obese, N (% within BMI category)	63 (48.1)	68 (51.9)	1.027 (0.589, 1.791)	0.926
Obese, N (% within BMI category)	39 (48.8)	41 (51.2)		

No variables were found to be confounders of the relationship between obesity

status and receipt of screening mammogram. After logistic regression modeling using

backwards selection, the final main effects model included age, obesity status, total

number of visits during the window period, and family history of breast cancer. Upon

inclusion of potential interaction terms, none were found to be significant. Odds ratio

estimates from the final main effects model are in Table 20.

Table 20. Final main effects model for screening mammogram.

Variable	Adjusted OR	95% CI	p-value
Total Number of Visits within the Window Period	1.046	0.991, 1.103	0.102
Family History of Breast Cancer	6.706	1.881, 23.911	0.003
Age	1.006	0.981, 1.032	0.633
Obesity status	0.951	0.522, 1.697	0.864

The Hosmer and Lemeshow goodness-of-fit test had a p-value of 0.435, which

means the observed data and expected values under the model are similar, implying the

model fits the data adequately.

After imputation of height values and calculation of BMI from these values, the

logistic regression models did not differ for screening mammogram. For each variable,

the regression parameter estimates moved closer to zero, which demonstrates there is no

difference between screening likelihood in those with height data and those without.

Table 21 compares the odds ratio estimates for obesity status before and after multiple

imputation.

Table 21. Comparison of the odds of obese women receiving screening mammography compared to their non-obese peers, before and after multiple imputation.

	Before Imputation OR (95% CI) n = 88	After Imputation OR (95% CI) n = 133
Obesity Status (Obese vs. Non-obese)	0.95 (0.53, 1.70)	0.98 (0.60, 1.60)

*These odds ratios represent the odds of obese versus non-obese individuals receiving screening mammogram, after controlling for age, total number of visits during the window period, and family history of breast cancer.

Obesity status was not found to be significantly associated with receipt of

screening mammogram. Variables that were found to be significantly associated with

receipt of screening mammogram were the number of total visits to the physician during

the time period and a family history of breast cancer. After controlling for these variables

as well as obesity status and age, women with a family history of breast cancer had odds of receiving screening mammogram 6.71 higher (95% CI 1.88, 23.91) than their peers without a family history of breast cancer. The odds of obese women receiving screening mammogram were 0.95 (95% CI 0.53, 1.70) the odds of non-obese women. For each additional visit to the physician during the time period, the odds of receiving a screening mammogram were 1.05 (95% CI .99, 1.10) higher. Lastly, for each additional year of age, the odds of receiving screening mammogram were 1.01 (95% CI 0.98, 1.03) higher. For a 5-year increase in age, the odds of receiving screening mammogram were 1.03 (95% CI 0.91, 1.17). For a 10-year increase in age, the odds of receiving screening mammogram were 1.06 (95% CI 0.83, 1.36).

A sub-analysis logistic regression model was analyzed using only women over the age of sixty without a personal history of breast cancer, as these women were presumed to be post-menopausal. Upon univariate analysis, the only variable found to be significant was a family history of breast cancer. After adjusting for a family history of breast cancer and age, the odds of an obese woman over sixty receiving a screening mammogram were 1.64 (95% CI 0.66, 4.07) times higher than for her non-obese peers. After multiple imputation, the odds ratio estimate again moved closer to the null value of an odds ratio of one (Table 22).

Table 22. Odds ratios of obese versus non-obese women 60 years of age and older receiving screening mammography, before and after multiple imputation.

	Before Imputation OR (95% CI) n = 211	After Imputation OR (95% CI) n = 310
Obesity Status (Obese vs. Non-obese)	1.64 (0.66, 4.07)	1.37 (0.60, 4.20)

*These odds ratios represent the odds of obese versus non-obese individuals receiving screening mammogram, after controlling for age, total number of visits during the window period, and family history of breast cancer.

Cervical Cancer Screening

Overall 32% (120/381) of eligible women were screened for cervical cancer.
None of the screened patients received HPV DNA testing. Ninety-seven percent
(116/120) of screened women received a screening pelvic exam, 66% (79/120) received a
standard pap smear and 28% (33/120) received liquid cytology. Ninety-three percent
(112/120) received either a standard PAP or liquid cytology.

Forty percent (52/129) of eligible non-obese females and 38% (31/82) of eligible
obese females were screened for cervical cancer (Table 23). The chi-square value was
insignificant (p-value = 0.717), which suggests the distribution of receipt of cervical
cancer screening did not differ between categories of BMI.

Table 23. Cervical cancer screening according to obesity status.

Cervical Cancer Screening			
	Non-obese	Obese	Total
Number eligible	129	82	211
n receiving screening (% of eligible)	52 (40%)	31 (38%)	83 (39%)
p-value = 0.717			
Healthy People 2010 Goal = 90%			

There was no statistically significant difference between obese and non-obese
women in their receipt of cervical cancer screening. Obese and non-obese women
differed significantly in the length of time they were a member of the practice. A higher
proportion of obese women were members of the clinic for two years or less than non-
obese women, whereas a higher proportion of non-obese women were members of the
clinic for five or more years than obese women (p=0.011). Table 24 lists other
differences between obese and non-obese women eligible for cervical cancer screening,
none of which were statistically significant.

Table 24. Characteristics of women eligible for cervical cancer screening and for whom a BMI could be calculated.

Variable	Total	Non-Obese	Obese	p-value
Mean age (SD)	44.28 (14.11)*	46.15 (13.62)	45.96 (13.80)	0.476
Mean number of visits in the past 2 years (SD)	5.61 (5.06)*	5.97 (4.49)	5.83 (5.43)	0.675
Patients with chronic disease, N (%)	122 (57.8)	69 (53.5)	53 (64.6)	0.110
Length of time member of practice, N (%)				
≤ 2 years (referent category)	43 (20.4)	18 (14.0)	25 (30.5)	0.011
2-5 years	55 (26.1)	34 (26.4)	21 (25.6)	
≥ 5 years	113 (53.6)	77 (59.7)	36 (43.9)	

*Values in total column include all women eligible cervical cancer screening, regardless of whether BMI could be calculated.

Upon univariate modeling of the outcome of receipt of cervical cancer screening, none of the covariates were significant at a p=0.25 level of significance. Results of univariate logistic regression modeling are listed in Table 25.

Table 25. Results of univariate logistic regression models of each variable and the outcome of receipt of cervical cancer screening within the window period.

Variable	Screened for Cervical Cancer	Not Screened for Cervical Cancer	OR (95% CI)	p-value
Mean age (SD)	44.52 (13.33)	44.16 (14.47)	1.002 (0.987, 1.017)	0.821
Number of visits in the past 2 years			1.018 (0.976, 1.061)	0.406
Mean (SD)	5.92 (4.60)	5.46 (5.26)		
Mean BMI (SD)	28.71 (6.54)	29.46 (7.28)	0.985 (0.946, 1.025)	0.450
Presence of chronic disease				
Chronic disease absent, N (%)	54 (31.6)	117 (68.4)		
Chronic disease present, N (%)	66 (31.4)	144 (68.6)	0.993 (0.643, 1.534)	0.975
Length of time member of practice, N (%)				
≤ 2 years (referent category)	27 (31.8)	58 (68.2)		0.997
2-5 years	31 (31.6)	67 (68.4)	1 0.994 (0.532, 1.856)	
≥ 5 years	62 (31.3)	136 (68.7)	2 0.979 (0.567, 1.692)	
Obesity Status				
Non-obese, N (% within BMI category)	52 (40.3)	77 (59.7)		
Obese, N (% within BMI category)	31 (37.8)	51 (62.2)	0.900 (0.510, 1.589)	0.717

Based on unadjusted to adjusted odds ratios all with differences less than 10%, none of the variables in Table 25 were confounders of the relationship between obesity status and receipt of cervical cancer screening. Despite the absence of significant univariate findings, a multivariate model was made using all of the variables. Using backwards stepwise selection, the last remaining variable was total number of visits, which was not significant. As there were no significant variables to include in a multiple model, interactions between included variables were not assessed, nor was Hosmer-Lemeshow used to assess goodness of fit.

After multiple imputation of height values and calculation of BMI from these values, the univariate odds ratio estimate did not differ for cervical cancer screening (Table 26).

Neither obesity status nor any of the other variables were found to be significantly associated with receipt of cervical cancer screening.

Table 26. Comparison of odds of receipt of cervical cancer screening with univariate analysis before and after multiple imputation.

Odds of Receipt of Cervical Cancer Screening		
	Before Imputation OR (95% CI)* n = 211	**After Imputation OR (95% CI)* n = 346**
Obesity Status (Obese vs. Non-obese)	0.90 (0.51, 1.59)	0.917 (0.581, 1.447)

*These odds ratios represent the unadjusted odds of obese versus non-obese women receiving cervical cancer screening (without adjusting for other variables).

Prostate Cancer Screening

Overall 48% (99/207) of eligible individuals were screened. There are no applicable Healthy People 2010 goals for prostate cancer screening, as the USPSTF had not issued recommendations for prostate cancer screening. Forty-eight percent (34/71) of

eligible non-obese males and 51% (30/59) of eligible obese males received either a DRE or a PSA as screening for prostate cancer (Table 27). The chi-square value was statistically non-significant (p-value 0.74), which means the receipt of prostate cancer screening did not differ significantly between obese and non-obese individuals.

Table 27. Prostate cancer screening according to obesity status.

Prostate Cancer Screening			
	Non-obese	**Obese**	**Total**
Number of males eligible	71	59	130
n receiving screening (% of eligible)	34 (48%)	30 (51%)	64 (50%)
p-value = 0.737			
No Healthy People 2010 Goal			

Of the men receiving prostate cancer screening, 51% (50/99) received both PSA and a DRE. Thirty-five percent (35/99) received a PSA but no DRE and 14% (14/99) received DRE but no PSA.

Overall the percent of men receiving prostate cancer screening was relatively low and there was no significant difference in receipt of screening between obese and non-obese individuals. Sixty-seven percent (130/194) of eligible men had calculable BMIs. Table 28 lists differences between obese and non-obese men, none of which were statistically significant.

Table 28. Characteristics of men eligible for prostate cancer screening and for whom a BMI could be calculated.

Variable	Total	Non-obese	Obese	p-value
Mean age (SD)	62.55 (9.04)*	64.10 (8.78)	61.56 (9.80)	0.219
Mean number of visits in the past 2 years (SD)	6.60 (6.17)*	5.70 (4.74)	7.51 (5.55)	0.411
Presence of chronic disease, N (%)	92 (70.8)	44 (62.0)	48 (81.4)	0.333
Length of time member of practice, N (%)				
≤ 2 years (referent category)	14 (10.8)	20 (8.5)	8 (13.6)	0.521
2-5 years	35 (26.9)	29 (25.4)	17 (28.8)	
≥ 5 years	81 (62.3)	59 (66.2)	34 (57.6)	
Family history of prostate cancer present, N (%)	2 (1.5)	2 (1.8)	0	0.194

***Values in total column include all men eligible for prostate cancer screening, regardless of whether BMI could be calculated.**

Age, number of total visits within the window period and length of time a member of the practice were significant at a p=0.25 level in univariate models. Results of univariate logistic regression modeling are in Table 29.

Table 29. Results from logistic regression models of each variable and the outcome of receipt of prostate cancer screening. Italicized variables were considered significant at a p=0.25 level.

Variable	Screened for Prostate Cancer	Not Screened for Prostate Cancer	OR (95% CI)	p-value
Age mean (SD)	64.03 (8.76)	61.19 (9.12)	1.036 (1.005, 1.069)	0.025
Mean number of visits in the past 2 years (SD)	7.87 (7.02)	5.44 (5.03)	1.077 (1.020, 1.137)	0.008
Mean BMI (SD)	30.32 (4.79)	30.48 (5.48)	0.994 (0.929, 1.063)	0.856

Presence of chronic disease
  Chronic disease absent, N (%)
  Chronic disease present, N (%)
	
	26 (42.6)
	73 (50.0)
		
		35 (57.4)
		73 (50.0)
			
			1.346 (0.737, 2.458)
				
				0.333

Length of time member of practice, N (%)
  ≤ 2 years (referent category)
  2-5 years
  ≥ 5 years
	
	10 (33.3)
	23 (44.2)
	66 (52.8)
		
		20 (66.7)
		29 (55.8)
		59 (47.2)
			
			1 1.586 (0.622, 4.044)
			2 2.237 (0.969, 5.164)
				
				0.139

Family history of prostate cancer
  Family history absent, N (%)
  Family history present, N (%)
	
	96 (47.3)
	3 (75.0)
		
		107 (52.7)
		1 (25.0)
			
			3.344 (0.342, 32.687)
				
				0.299

Obesity Status
  Non-obese, N (% within BMI category)
  Obese, N (% within BMI category)
	
	34 (47.9)
	
	30 (50.8)
		
		37 (52.1)
		
		29 (49.2)
			
			1.126 (0.564, 2.246)
				
				0.737

Based on the unadjusted to adjusted odds ratios, age was found to be a confounder of the relationship between obesity status and receipt of prostate cancer screening. The unadjusted odds ratio was 1.126 (0.564, 2.246) and the adjusted odds ratio was 1.265 (0.620, 2.581), which is a difference of 11%. Therefore, age could be considered a moderate confounder, as it is very near the cutoff for consideration to be a confounder.

The final multivariate logistic regression model for prostate cancer screening can be seen in Table 30.

Table 30. Adjusted odds ratios for prostate cancer screening.

Variable	Adjusted OR	95% CI	p-value
Age	1.041	1.000, 1.084	0.049
Length of time a member of the practice ≤ 2 years (referent category) 2-5 years ≥ 5 years	 0.920 2.007	 0.243, 3.486 0.601, 6.698	0.144
Total number of visits within the window period	1.059	0.981, 1.143	0.144
Obesity status	1.216	0.578, 2.558	0.606

Interactions between included variables were assessed using a p=0.1 level of significance. Interaction terms were added one-by-one into the above model. None were found to be significant.

The Hosmer and Lemeshow goodness-of-fit statistic p-value of 0.416 does not allow rejection of the model, which means the observed data and expected values under the model are similar, implying the model fits the data adequately.

After imputation of height values and calculation of BMI from these values, the odds ratio estimates for the relationship between obesity status and receipt of prostate cancer screening differed only a small amount (Table 31). This small difference is unlikely to be clinically important.

Table 31. Comparison of odds of receipt of prostate cancer screening with univariate analysis before and after multiple imputation.

	Before Imputation OR (95% CI)* n = 130	After Imputation OR (95% CI)* n = 194
Obesity Status (Obese vs. Non-obese)	1.216 (0.578, 2.558)	1.297 (0.656, 2.565)

*These odds ratios represent the odds of obese versus non-obese men receiving prostate cancer screening, after controlling for age, length of time the patient had been a member of the clinic and the total number of visits within the window period.

Obesity status was not significantly associated with receipt of prostate cancer screening. Variables that were found to be significantly associated with prostate cancer

screening include age, number of total visits within the window period and length of time a member of the clinic. The odds of an obese man receiving prostate cancer screening were 1.22 (95% CI 0.58, 2.56) the odds of a non-obese man. A separate logistic regression using the outcome of receipt of screening PSA only was also performed. The odds of obese males receiving screening PSA were 1.01 (95% CI 0.47, 2.15) the odds of non-obese males receiving screening PSA.

As men age, the odds of receiving prostate cancer screening increase. For example, for each five year increase in age, the odds of prostate cancer screening increase 22% (OR 1.22, 95% CI 1.00, 1.50).

The odds of prostate cancer screening in men who had attended the clinic for 2-5 years were 0.92 (95% CI 0.24, 3.49) the odds of men who had been a member of the clinic for less than two years. However, men who had been attending the clinic for more than five years had 2.01 (95% CI 0.60, 6.70) times the odds of men who had been a member for less than two years. The odds of men who had been attending the clinic for more than five years had 2.18 (95% CI 0.93, 5.10) times the odds of men who had been attending the clinic for 2-5 years. These differences were not statistically significant, likely because of small numbers within each group.

DISCUSSION

This is the first study to look specifically at the relationship between obesity status and cancer screening in rural primary care clinics. While geographic health disparities are known to exist, this study clearly demonstrates an additional important disparity, which is that rural patient populations are being screened at rates well below national targets for colorectal, breast, and cervical cancer, regardless of their obesity status. Since obese individuals are at increased risk for these cancers, and the average BMI of individuals within this study is at the high end of overweight and almost obese, this patient population is at especially increased risk, which makes it even more important that they have complete cancer screening.

Unfortunately, the findings in this study likely overestimate the percent of individuals being screened in these rural communities in general. Each of the patients included in this study has regular access to a health care provider and visited the physician at least once during the two year data abstraction period. Most of these clinics are the only health clinics in their communities. Therefore, if an individual is not being seen at these clinics, it is possible they are not seeing a clinician regularly at all.

As can be seen in Table 32, the proportion of the study population current in their recommended screening is well below the national targets set by Healthy People 2010. In addition, they are also well below screening proportions reported from 2004 Oregon Behavioral Risk Factor Surveillance System (BRFSS).[iii] The difference between screened proportions found in this study and Oregon BRFSS data was a surprising

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[iii] The Behavioral Risk Factor Surveillance System (BRFSS) is the world's largest, on-going telephone health survey system, tracking health conditions and risk behaviors in the United States yearly since 1984. It was initiated by the Centers for Disease Control and Prevention (CDC), but is administered by each individual state.

finding. There are several possible reasons for this difference. Patients may have

multiple sources of medical care, besides the primary care clinics in this study, and

receive cancer screening services elsewhere. In this case, the receipt of cancer screening

in this study would underestimate the cancer screening examinations these patients are

truly receiving. For example, if a woman is going to the local public health department

for her annual pelvic and breast exams, these screening exams could be under-

documented in their primary physician's clinic records, if there is no system in place to

communicate between clinics. However, the underestimate would likely be the same for

both obese and non-obese individuals. Therefore, the relationship between obesity status

and receipt of each cancer screening would likely not change. Five of the six counties

included in this study have their own public health departments, but these vary in

distance from the primary care clinics and it is unknown how far patients may travel to

receive additional care. Some of the communities are located in close proximity to larger

towns with other potential sites of receipt of medical care. Confirmation with patient

interview would increase the accuracy of values for receipt of preventive services and

allow for reporting of services received from other sources.

Table 32. Comparison of study findings to 2004 Oregon BRFSS screening rates and Healthy People 2010 goals.

	Study Percent Screened	**Oregon BRFSS Percent Screened***	**Healthy People 2010 Goal**
Colorectal Cancer	30%	41%	50%
Breast Cancer	42%	74%	70%
Cervical Cancer	32%	84%	90%
Prostate Cancer	48%	--	--

Second, the BRFSS estimates are based on patient report by telephone interview,

whereas data for this study were pulled directly out of medical charts. It is possible the

BRFSS estimates are overestimates of screening examinations performed in these

communities, simply because telephone interviews differ in their accuracy from medical charts. Another possibility is that the screening rates in the six rural Oregon communities that participated in this study are low, lower than the overall state proportion reported in BRFSS. Differences in cancer screening behavior between rural and urban Oregon have not been documented, however it is possible they could play a role here. Future research would aid in understanding the differences seen in this study.

The results of this study demonstrate that obesity is not associated with a lower likelihood of screening for colorectal, breast, cervical and prostate cancers in these rural Oregon primary care clinics. This finding is contrary to other similar studies, which usually show obese individuals being screened at lower rates than non-obese individuals. It may be that clinicians in rural Oregon clinics do a better job managing the preventive and chronic care of their obese patients than clinicians in other similar studies. However, the overall screening proportions are low. In addition, the high average BMI of this patient population also makes it possible that these rural clinicians are really not treating overweight and obese patients any differently than non-obese patients. The average patient among this study population, with an average BMI of 29.5 kg/m^2 (SD 6.08), can be classified as very overweight and on the border of being classified as obese. Alternatively, because their patients are, on average, very overweight, factors that might deter a physician working with a less overweight population from providing adequate care to their obese patients do not play as much of a role.

The absence of a difference in screening between obese and non-obese populations may be due to the comparison being made – which is comparing obese patients to a small number of normal weight patients plus a larger number of overweight

patients. Since the average BMI of the entire study population is near the border of

overweight becoming obese, if most patients had BMIs near this value, the two

populations might be very similar. However, the average BMIs of the two groups were

statistically significantly different. The average BMI of the obese group was 35 kg/m^2

and the average BMI of the non-obese group was 25 kg/m^2. Therefore, if a difference in

the relationship between obesity status and screening for each cancer existed, the results

would likely have been significant. BMI, when evaluated as a continuous variable, was

not found to be significantly associated with receipt of screening for any of the four

cancers. This generates more confidence that if a relationship existed between body

habitus and cancer screening in these communities, we would have found it in this study.

Other studies have attributed the lower rate of screening among obese individuals

to their body habitus.[23,24,26] In this study, other factors must be acting on either the

clinicians, patients, or both, to lead to low screening rates in everyone. Cancer screening

does not appear to be a high priority for physicians, patients, or both. Possible clinician

barriers include other clinical or non-clinical demands, clinician beliefs, high volume of

daily patient visits and poor medical record documentation. Possible patient barriers

include low socioeconomic status and means to pay for health care, under- or un-

insurance, or fear of visiting the physician. A factor likely facing both patients and

clinicians is a shortage of clinicians in these rural areas of Oregon. A study further

investigating the reasons for these low screening rates is crucial to a better understanding

of how best to serve rural patient populations.

A possible source of selection bias, which occurs when a systematic error in the

ascertainment of study subjects results in a tendency towards distorting the measure

expressing the association between exposure and outcome, could be that the body habitus, and therefore obesity status, of clinic patients could be different from individuals not seeking medical care. If more obese or morbidly obese individuals do not see physicians in these communities, they would be screened at lower proportions than seen in this study. In this case the association between obesity status and cancer screening would be underestimated by this study. Similarly, if more normal weight individuals, such as young, healthy people without medical problems, do not regularly see the physician and are therefore less frequently screened, the association between obesity status and cancer screening found in this study would be an overestimate. It is likely a combination of these two scenarios is occurring, and the relationship seen in this study is close to the actual relationship between body habitus and cancer screening in rural Oregon primary care clinics.

An important finding in this study is that among patients with a chronic disease, the odds of being screened for colorectal cancer are different for men than for women. Eligible women with a chronic disease have twice the odds of receiving colorectal cancer screening as eligible men with a chronic disease. This is in direct contrast to findings published in 2006 by Ferrante et al., which showed that male gender was associated with increased odds of receiving colorectal cancer screening, after adjusting for age, total number of co-morbidities, years attending the practice and number of visits within the past two years.[18] Within the study population eligible for colorectal cancer screening, women were significantly more likely to visit the physician more often than men. Perhaps because women with chronic disease are visiting more often, the clinician can

add colorectal cancer screening to unrelated visits more often than with men with chronic disease who visit less often.

Unlike other studies, which have shown that obese women were less likely to be screened for breast cancer,[23-25] this study revealed no statistically significant difference in receipt of screening mammography between obese and non-obese women.

Similarly, this study did not show a statistically significant difference in receipt of cervical cancer screening between obese and non-obese individuals. This is contrary to other studies, which have shown that as BMI increases, the odds of receiving cervical cancer screening decrease.[25,26]

Lastly, this study was contrary to other studies, which have shown that obese men were more likely to receive a PSA test as screening for prostate cancer.[28,29] It is possible that combining PSA and DRE into one category of either did receive screening or did not receive screening led to an overestimate, as it is possible that some individuals who received a DRE received it for reasons other than prostate cancer screening.

Of note, is that among all of the screening examinations considered in this study, the PSA test is the only serum measurement. It is likely that the higher proportion of men receiving a PSA as screening for prostate cancer is because a serum measurement is a less invasive method of screening than the screening options for other screenable cancers (i.e. mammography, Pap smear, etc.).

STRENGTHS AND LIMITATIONS

This was a chart review study, which is limited by lack of documentation of certain information. Individual clinicians and clinics likely vary in their habits of recording information. For instance, there were many charts with missing heights and multiple imputation was used to generate BMIs for those individuals. Height is an optimal variable for imputation, as it is a biological variable that exists in a fairly narrow range. It can reasonably be assumed that the heights of individuals without a recorded height in their chart followed the same distribution as the heights of individuals who did have a height recorded, all other factors remaining equal. Lending support to the lack of significant difference in the distribution of height values between the two groups is that the average weight and standard deviations for those with and without height values in their chart were not statistically significantly different.

It is possible the eligible sample sizes available in this study were inadequate for detecting the actual difference in proportion of individuals receiving cancer screening between obese and non-obese individuals. Multiple imputation of the missing height values allowed for increasing the study sample substantially, which allowed for increased power to detect differences. After imputation, the odds ratio estimates of the relationship between obesity status and cancer screening moved closer to the null value. Therefore, this study's findings of statistically non-significant odds ratios close to the null are not a power issue, but rather are likely representations of the actual relationship between obesity status and cancer screening in this study population. Even if the sample size was increased immensely, the resulting odds ratios would not likely become statistically significant.

The analyses in this study are based on cross-sectional data, which imposes limitations on inferences of causal relationships. It therefore does not explain the reason for relationships seen between body mass index and receipt of cancer screening. For example, having a large body habitus does not cause a higher or lower probability of receiving cancer screening exams. However, much of our knowledge of clinical medicine comes from cross-sectional data. It is helpful for clinicians to know which of their patients' characteristics predispose them to higher risk for certain diseases, and it is especially useful to know which of their characteristics predispose them to receiving lesser quality care.

It is possible the absence of a significant relationship seen in this study between obesity status and cancer screening is related to a confounding variable that was not adjusted for by this study. For example, socioeconomic status could be related both to risk of obesity and to receipt of cancer screening. Data abstracted from medical charts for this study did not include information that would indicate socioeconomic status, such as insurance status, income, amount of education, or composition of household.

A potential source of misclassification bias in this study is that some examinations performed for diagnostic purposes could have been misclassified as a screening exam. The reason for performing an exam may not have been accurately or clearly recorded in the medical chart. Or, clinicians may be more likely to record an exam that was meant as a screening exam as a diagnostic exam for billing purposes, as payment is higher for a diagnostic test than a screening test. If exams that were meant as diagnostic examinations were improperly classified as screening exams in this study, the screening rates found in this study would be overestimates of the actual rates among this patient

population. The low rates seen in this study make it unlikely this occurred. In addition, there is no reason to think that improper recording or miscoding of diagnostic as screening exams would happen differently between obese and non-obese individuals.

This study evaluated cancer screening practices among rural Oregon primary care clinics. The sample populations consisted of predominantly white patients, and although information on insurance was not part of the data gathered, it could reasonably be assumed they were insured by private or public insurance. Therefore, these findings may not be generalized to patients without insurance.

The presence of chronic disease was used as an independent variable for this analysis. This method of measurement makes it impossible to distinguish between an individual with multiple chronic medical problems and an individual with a single uncomplicated chronic disease. It could be assumed that a patient with more than one chronic disease has a higher risk for developing complications such as cancer. However, if this categorization were to bias the results, it would do so towards an overestimate of the importance of the presence of chronic disease.

This study does not account for the unique characteristics of the six different rural Oregon communities in which the clinics were located. It is possible that each community may have different values that contribute to different rates of cancer screening among obese and non-obese individuals. These differences would be difficult to assess using this study design, which did not include surveys of individual clinicians and their cancer screening strategies. However, summarized information on cancer screening rates of rural primary care physicians in general is useful for demonstrating

disparities in care on a regional level, which is useful for Oregon policymaking and clinician education.

Data were abstracted by two different research assistants. Although the data abstraction technique was standardized between abstracters, it is still possible differences in collection were present. However, the collection differences are likely to be the same between the obese and non-obese individuals in this study, and thus likely did not significantly affect the data.

FUTURE RESEARCH

This study establishes that patients seen at six representative rural primary care clinics in Oregon are being screened for cancer at rates far below national targets. In order to create a solution to this problem, it is important to evaluate the reasons for the low screening rates. A clinician survey regarding perceived barriers to screening would provide information on clinician factors influencing the low rates. A survey of patients regarding other locations of care would reveal if these patients were receiving screening at other health clinics.

It is unknown what the BMI threshold of these clinicians is, especially in a setting where most of their patients are overweight or obese. A study documenting the BMI at which a clinician views a patient as overweight or obese would be useful in determining whether the clinician's perception of a patient's body habitus influences their screening decisions.

Future research on this topic would include similar comparisons of BMI and receipt of cancer screening including demographic information such as income, insurance

status, marriage status and level of education. In previous studies, these variables have been significantly associated with receipt of clinical preventive services, however this information is usually not available in medical charts, such as those that were used for this study. With the increase in use of electronic medical records, however, it will become simpler to include this information in analyses of clinic patient populations.

A prospective study following normal weight, overweight, obese and morbidly obese individuals over time, observing for receipt of cancer screening, would be especially useful. It would allow for structuring the study for sufficient sample sizes within each category. It would also allow for a more accurate depiction of where individuals receive their health care. In addition, it would be helpful to study the ways in which system, patient, and provider factors interact to result in delayed or missed opportunities for clinical preventive service delivery among this population.

Confirming study findings with patient interview in future studies would increase the accuracy of the results. It is known that patients often have multiple sources of care, and in this study, it was difficult to determine this from patient medical charts.

Rather than evaluating the presence of chronic disease as it affects the relationship between BMI and cancer screening, it might be more useful to determine the total number of chronic diseases. This might further explain the relationship between gender and chronic disease as it pertains to CRC screening.

CONCLUSION AND PUBLIC HEALTH IMPLICATIONS

Rural Oregonians are being screened for colorectal, breast, cervical and prostate cancer at abysmally low rates in rural primary care clinics, regardless of their obesity status. These rates are different than reported rates and importantly, are far below recommendations by Healthy People 2010. This is an important disparity to recognize, as this study also demonstrated that the individuals included in this study were, on average, very overweight, which puts them at an even higher risk for these cancers, which occur at increased rates with increased BMI.

Appendix A. Classification of reasons for visiting the physician into acute and chronic.

Conditions Considered Chronic Diseases	Conditions Considered Acute Diseases
Alcohol Abuse/Dependence	Abdominal Pain
Allergy Symptoms/Rhinitis	Acne
Atrial Fibrillation	Angina/Chest Pain
Arthritis	Anxiety
Asthma/Reactive Airways Disease (RAD)	Back Strain (acute)
Back pain (chronic)/Sciatica	Bronchitis
Cancer: Breast	Constipation
Cancer: Prostate	Contraception
Cancer: Colorectal	Dizziness/Syncope/Vertigo
Cancer: Other	Fatigue
Chronic pain	Fracture
Congestive Heart Failure (CHF)	Headache
Chronic Obstructive Pulmonary Disease (COPD)	Hemorrhoids
	Hyperthyroidism
Coronary Artery Disease (CAD)	Hypothyroidism
Depression	Incontinence
DM Type 1	Lab f/u/discussion NOS
DM Type 2	Laceration
Fibromyalgia	Libido/Sexual Dysfunction
Gastroesophageal Reflux Disease (GERD)	Myocardial Infarction
Hyperlipidemia	Neck Pain
Hypertension	Otitis Media (acute)
Overweight/Obesity	Pain of extremity or joint (arm, leg, knee, hip)
Peptic Ulcer Disease (PUD)/Gastritis/Stomach Pain	Pharyngitis (sore throat)
	Physical exam
Pregnancy	Pneumonia
Stroke/Transient Ischemic Attach (TIA)	Psych. Problem Other
Tobacco Abuse/Dependence	Rash/Fungal Infection
	Acute Renal Failure
	Sexually Transmitted Infection (STI)
	Sinusitis – Acute
	Skin problem (wart, keratoses, mole, skin tag eval/removal)
	Sleeping problems
	Sprain/Strain of extremity
	Surgery/procedure pre-op/f/u
	Tendonitis
	Trauma Minor Other
	Upper Respiratory Infection (URI)
	Urinary Tract Infection (UTI)
	Vaginal discharge/itching (yeast/bacterial – non-STI)
	Vomiting/nausea/diarrhea

Appendix B. Study chart data abstraction form.

General instruction — abstract visits between 1-1-02 and 12-31-03.

DEMOGRAPHIC & GENERAL

1.   Patient of practice for (since 12-31-03):
    1   ≤ 6 mo.
    2   6-12 mo.
    3   12-24 mo.
    4   2 yr.-5 yr.
    5   > 5 yr.

2.   Age as of 1-1-02 (yrs): _____

3.   Gender: M=0   F=1

4.   Race/Ethnicity (Circle one):
    1   Caucasian
    2   African-American
    3   Asian
    4   Native American
    5   Hispanic
    6   Other (Specify _____)
    7   Not available/cannot determine

OBESITY

5.   Height (in.):   _____
6a.   First Wt. (lbs.):   _____   6b. Mo: ___   6c. Yr:___
7a.   Last Wt. (lbs.):   _____   7b. Mo: ___   7c. Yr:___

8.   Is there a chart BMI recorded?   N=0   Y=1

9.   _____   # office visits for a "complete checkup"
10.   _____   # of visits for chronic disease management
11.   _____   # of visits for acute problems
12.   _____   # of prenatal/pregnancy care visits

13. Reasons for Visit	Total			Total
1	Abdominal Pain		37	Incontinence	
2	Acne		38	Lab f/u/discussion NOS	
3	**Alcohol Abuse/Dependence**		39	Laceration	
4	**Allergy Symptoms/Rhinitis**		40	Libido/Sexual Dysfunction	
5	Angina/Chest Pain		41	Myocardial Infarction	
6	Anxiety		42	Neck Pain	
7	**Atrial Fibrillation**		43	Otitis Media (acute)	
8	**Arthritis**		44	**Overweight/Obesity**	
9	**Asthma/Reactive Airway Disease**		45	Pain of extremity or joint (arm, leg, knee, hip)	
10	Back Strain (acute)		46	**Peptic Ulcer Disease (PUD)/Gastritis/Stomach Pain**	
11	**Back pain (chronic)/Sciatica**		47	Pharyngitis (sore throat)	
12	Bronchitis		48	Physical exam	
13	**Cancer: Breast**		49	Pneumonia	
14	**Cancer: Prostate**		50	**Pregnancy**	
15	**Cancer: Colorectal**		51	Psych. Problem Other	
16	**Cancer: Other (Specify: _____)**		52	Rash/Fungal Infection	
17	**Chronic pain**		53	Renal Failure	
18	**Congestive Heart Failure (CHF)**		54	Sexually Transmitted Infection (STI)	
19	Constipation		55	Sinusitis – Acute	
20	Contraception		56	Skin problem (wart, keratoses, mole, skin tag eval/removal)	
21	**Chronic Obstructive Pulmonary Disease (COPD)**		57	Sleeping problems	
22	**Coronary Artery Disease (CAD)**		58	Sprain/Strain of extremity	
23	**Depression**		59	**Stroke/Cerebrovascular Accident (CVA)/Transient Ischemic Attack (TIA)**	
24	Dizziness/Syncope/Vertigo		60	Surgery/procedure pre-op/f/u	
25	**Diabetes Type 1**		61	Tendonitis	
26	**Diabetes Type 2**		62	**Tobacco Abuse/Dependence**	
27	Fatigue		63	Trauma Minor Other	
28	**Fibromyalgia**		64	Upper Respiratory Infection (URI)	
29	Fracture		65	Urinary Tract Infection (UTI)	
30	**Gastroesophageal Reflux Disease (GERD)**		66	Vaginal discharge/itching (yeast/bacterial – non-STI)	
31	Headache		67	Vomiting/nausea/diarrhea	
32	Hemorrhoids		68	Other (specify _____)	
33	**Hyperlipidemia**		69	Other (specify _____)	
34	**Hypertension**		70	Other (specify _____)	
35	Hyperthyroidism		71	Other (specify _____)	
36	Hypothyroidism				

14.	Generally counseled to lose wt?	N=0	Y=1	
15.	Diet recommendations made?	N=0	Y=1	(If N, skip to 21)
16.	General "healthy" diet	N=0	Y=1	
17.	Low fat	N=0	Y=1	
18.	Low carb/high protein	N=0	Y=1	
19.	Other 1 (from list):	N=0	Y=1	If Y, 19a. _____
20.	Other 2 (from list):	N=0	Y=1	If Y, 20a. _____

       1   Portion Control
       2   Specific diet "foods" (e.g. Slimfast)
       3   Organized diet group (e.g. TOPS, Jenny Craig, Weight Watchers, etc.)
       4   Patient education material given
       5   Formal referral to Nutritionist
       6   Referral for bariatric surgery
       7   Other (_____)
       8   Medication

21.	Activity recommendations made?	N=0	Y=1	If N, skip to no. 27
22.	General "regular exercise"	N=0	Y=1	
23.	Increase activity level	N=0	Y=1	
24.	Walk	N=0	Y=1	
25.	Other 1 (from list):	N=0	Y=1	If Y, 25a. _____
26.	Other 2 (from list):	N=0	Y=1	If Y, 26a. _____

       1   Bike
       2   Swim
       3   Local Exercise class
       4   Exercise video/DVD at home
       5   Referral for exercise consultation (e.g. PT/Exercise Phys)
       6   Patient education material given
       7   Other (_____)

TOBACCO

27.	Tobacco use included as a vital sign in chart:	N=0	Y=1	
28.	Is pt. a former tobacco user?	N=0	Y=1	UNK=2
28a.	Does patient use tobacco?	N=0	Y=1	UNK=2

If N or UNK, skip to 40.

29.	Cigarettes	N=0	Y=1
30.	Cigars	N=0	Y=1
31.	Pipe	N=0	Y=1
32.	Snuff/Chew	N=0	Y=1
33.	Units used per day:		

   1      $\leq \frac{1}{2}$
   2      $\frac{1}{2}$ - 1
   3   ≥ 1
   4   UNK

34.	Advised to:	Quit by Clinician?	N=0	Y=1
35.		Cut Down?	N=0	Y=1
36.		Use Nicotine Replacement?	N=0	Y=1
37.		Use Zyban or Wellbutrin:	N=0	Y=1
38.	Other Advice:		N=0	Y=1 If Y, 38a. ___

   1   Use Acupuncture
   2   Call Quit Line
   3   Go to Cessation class
   4   Exercise
   5   Drink more water
   6   Seek mental health counseling
   7   Clinician counseling
   8   Patient given educational materials
   9   Use other modality (specify _____)

39.   Evidence patient quit tobacco use(In window)   N=0   Y=1

COLORECTAL CANCER SCREENING

40.	Is there a family history of CRC?	N=0	Y=1	UNK=2
41.	Personal history of polyps, IBD or CRC?	N=0	Y=1	UNK=2
42.	FOBT (2 yrs)	N=0	Y=1	Declined=2
43.	Office Rectal exam w/ FOBT (2 yrs)	N=0	Y=1	Declined=2
44.	Flexible Sigmoidoscopy (5 yrs)	N=0	Y=1	Declined=2
45.	Colonoscopy (10 yrs)	N=0	Y=1	Declined=2
46.	Barium Study (5 yrs)	N=0	Y=1	Declined=2

BREAST CANCER SCREENING

47.	Family hx of breast cancer?	N=0	Y=1	UNK=2
48.	Personal hx of breast cancer?	N=0	Y=1	UNK=2
49.	Clinical Breast Exam (2 yrs)	N=0	Y=1	Declined=2
50.	Screening Mammography (2 yrs)	N=0	Y=1	Declined=2

CERVICAL CANCER SCREENING

51.	Patient has a cervix?	N=0	Y=1	UNK=2
52.	History of abnormal pap smear?	N=0	Y=1	UNK=2
53.	Has pt. had colposcopy/biopsy?	N=0	Y=1	Declined=2
54.	Screening pelvic exam (2 yrs)	N=0	Y=1	Declined=2
55.	Std. Pap smear (2 yrs)	N=0	Y=1	Declined=2
56.	Liquid-based cytology (2 yrs)	N=0	Y=1	Declined=2
57.	HPV DNA typing (2 yrs)	N=0	Y=1	Declined=2

PROSTATE CANCER SCREENING

58.	Family history of prostate cancer?	N=0	Y=1	UNK=2
59.	Personal hx of prostate cancer?	N=0	Y=1	UNK=2
60.	Digital Rectal Exam	N=0	Y=1	Declined=2
61.	PSA	N=0	Y=1	Declined=2

IMMUNIZATIONS

62.	Pneumococcal polysaccharide vaccine	N=0	Y=1
63.	Influenza vaccine	N=0	Y=1
64.	Tetanus/diphtheria	N=0	Y=1

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