

Comparisons of Cancer Incidence and Mortality for Rural vs. Urban Pennsylvania Counties, Rural Appalachian Counties, and Rural U.S. Counties

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Executive Summary

This research set out to find if there were any significant differences in cancer incidence and mortality in rural Pennsylvania counties as compared to urban Pennsylvania counties, rural Appalachian counties, and rural U.S. counties. The cancers of focus for the study included: all cancer sites combined; breast (female only); colorectal; lung and bronchus; melanoma of the skin; oral cavity and pharynx (mouth); prostate; urinary bladder; and uterine cervix. These specific cancers were chosen as they account for 63 percent of all cancers diagnosed in Pennsylvania.

The research used cancer incidence data from the North American Association of Central Cancer Registries, Inc. for the most recent 5-year period available (2004-2008). It also used cancer registries from 28 other states that were willing to participate in the study.

To analyze cancer mortality rates, the researchers used cancer mortality data from the National Cancer Institute, and extracted age adjusted cancer mortality rates for all cancers combined, breast, colorectal, lung and bronchus, melanoma of the skin, oral cavity and pharynx, prostate, urinary bladder, and uterine cervix for the most recent 5-year period available (2003-2007), and for a 9-year period (1999-2007).

According to the research findings, for males of all races, Pennsylvania rural county cancer incidence rates were significantly higher than those for rural U.S. counties for all cancers combined, colon and rectum, urinary bladder, and prostate. When compared to rural Appalachian counties, both urinary bladder and prostate cancer incidence rates were significantly higher. When compared to urban Pennsylvania counties, only colon and rectum cancer rates were significantly higher.

For females of all races, Pennsylvania rural county cancer incidence rates were significantly higher than rates in rural U.S. counties for all cancers combined, colon and rectum, and urinary bladder. When compared to rural Appalachian counties, all cancers combined, urinary bladder, and breast were significantly higher. When compared to urban Pennsylvania counties, only melanoma of the skin was significantly higher.

In regard to mortality rates, the researchers made statistical comparisons for “all races combined” and “white, non-Hispanics” for the cancers of focus during a 5-year period (2004-2008) and a 10-year period (1997-2008) for both females and males. The rates in only a few rural Pennsylvania counties were found to be statistically significantly higher than the other

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Act, to promote and sustain the vitality of Pennsylvania's rural and small communities.

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groups for both males and females. The majority of findings indicated that cancer mortality rates in rural Pennsylvania are not significantly higher, but equal to, or significantly less than, rural U.S. counties, rural Appalachian counties, and urban Pennsylvania counties.

For males of all races, rural Pennsylvania county cancer mortality rates were significantly lower than rural U.S. counties for all cancers combined, lung and bronchus, and prostate. Rural Pennsylvania county cancer mortality rates were significantly lower than rural Appalachian counties for all cancers combined, oral cavity and pharynx, and lung and bronchus. Also, rural Pennsylvania county cancer mortality rates were significantly lower than urban Pennsylvania counties for prostate cancer.

For females of all races, rural Pennsylvania county cancer mortality rates were significantly lower than rural U.S. counties for lung and bronchus, and uterine cervix. Rural Pennsylvania county cancer mortality rates were significantly lower than rural Appalachian counties for all cancers combined, lung and bronchus, and uterine cervix. When compared to urban Pennsylvania counties, all cancer sites and lung and bronchus were significantly lower. The only rural Pennsylvania county cancer mortality rate that was significantly higher than rural Appalachia and rural U.S. counties was breast cancer.

In examining the staging data of cancer diagnoses in rural versus urban counties in Pennsylvania, and versus rural Appalachia and rural U.S. counties, the researchers found only a few significant differences. The percentage of distant stage diagnosis of lung and bronchus cancer was slightly higher in rural Pennsylvania counties as compared to rural Appalachia and rural U.S. counties. The percentage for later stage diagnoses of melanoma in rural Pennsylvania counties was slightly lower than the other groups. The percentage of distant stage diagnosis for breast cancer was slightly higher for women in rural Pennsylvania counties as compared to rural Appalachia and rural U.S. counties.

The researchers also analyzed data to determine whether educational attainment, median household income, unemployment rates for both 2000 and 2005, and primary care physician rates at the county level were predictive of county cancer incidence and mortality rates. They found a repetitive pattern in the analyses

where low educational attainment and high unemployment rates were most predictive of higher county level incidence and mortality rates in Pennsylvania.

A regression procedure conducted to determine if there was a significant increase across the 10-year period (1999-2008) in the incidence and mortality rates for all cancers, breast, colorectal, lung, and prostate cancers showed that trends in cancer incidence have been, for the most part, stable or decreasing in many rural Pennsylvania counties. This pattern mirrored what has been occurring nationally.

Trends in cancer mortality also have been stable or decreasing in many rural Pennsylvania counties. This pattern mirrored what has been occurring nationally as there have been significant decreases in the mortality rate trends for all cancers combined, colorectal cancer, breast cancer, lung cancer, and prostate cancer within Pennsylvania as a whole.

Finally, the researchers examined cancer incidence and mortality rates for rural Pennsylvania counties by health districts within the state.

In the northwest district, Forest County had the highest incidence rate of breast cancer in women, Jefferson County had the highest incidence rate of melanoma in women, and McKean County had the highest incidence rate of lung and bronchus cancer in women. Warren County had the highest cancer incidence rate for all cancer sites combined, the highest prostate cancer incidence rate and the highest urinary bladder cancer incidence rate in men.

In the north central district, Clinton County had the highest colorectal cancer mortality rate in men and Columbia County had one of the highest lung and bronchus mortality rates in men.

In the northeast district, Susquehanna County had the highest mortality rate for prostate cancer in men and Wayne County had the highest mortality rate for all cancers combined in women.

In the southwest district, Washington County had the 4th highest cancer incidence rate for all cancers combined in women.

In the southeast district, Schuylkill County, the only rural county in the district, had the 2nd highest incidence rate of urinary bladder cancer in women and the 2nd highest colorectal incidence rate in women.

Table of Contents

Introduction.....	3
Goals and Objectives	5
Methodology.....	5
Results.....	7
Conclusions.....	18
References	19

Introduction

Cancer is the second leading cause of mortality in the U.S., with more than 575,000 deaths due to cancer in 2011 (Hoyert and Xu, 2011). Cancer has been the leading cause of death worldwide, accounting for 7.6 million deaths, or about 13 percent of all deaths, in 2008 (World Health Organization, 2008). Nationwide, almost one in two males (44 percent) and more than one in three females (38 percent) will be diagnosed with cancer over the lifespan. According to the American Cancer Society, the estimated number of new cancer cases in 2012 nationwide was 1,638,910, with 78,340, or 5 percent, of these occurring in Pennsylvania. For the nation, the estimated number of deaths due to cancer in 2012 was 577,190, with 28,790 occurring in Pennsylvania (American Cancer Society, 2012). According to the State Cancer Registries (see <http://statecancerprofiles.cancer.gov/incidencrates>), the average annual incidence rate¹ during 2006-2010 in Pennsylvania for all cancers was about 495 for every 100,000 people, which ranks Pennsylvania as having the 8th highest cancer incidence rate in the U.S. The mortality rate² due to cancer (see <http://statecancerprofiles.cancer.gov/death-rates>) during the same time period was about 181 for every 100,000 people, ranking Pennsylvania as having the 17th highest cancer death rate out of all states.

The Costs Associated with Cancer

The National Institutes of Health estimated the annual cost of cancer in the U.S. was \$228 billion in 2008, which includes treatment costs and costs due to lost worker productivity (American Cancer Society, 2012).

Based on projected population increases, along with the aging U.S. population, medical treatment expenditures alone for cancer in 2020 are projected to reach at least \$158 billion (in 2010 dollars). This figure suggests a 27 percent increase over the 10-year period between 2010 and 2020 (Mariotto et al., 2011). According to the Milken Institute (2010), health care expenditures in 2010 reached about 19 percent of GDP, with cancer treatment accounting for 20 percent of the total expenditures.

Cancer Incidence and Mortality Rates³ in Urban vs. Rural Pennsylvania Counties

Of Pennsylvania's 67 counties, 48 are considered rural, according to the Center for Rural Pennsylvania definition⁴ of what constitutes a rural versus urban county. Of the 48 rural counties, 11 counties (23 percent) exceeded the average state incidence rate for all cancers during the 5-year period of 2002-2006. Warren and Carbon are the rural counties that had the highest incidence rates for all cancers. Of the state's 19 urban counties, nine (47 percent) exceeded the average state incidence rate for all cancers during the same 5-year period. Philadelphia and Delaware are the urban counties that had the highest incidence rates. In terms of mortality rates, 17 rural counties (35 percent) exceeded the average state mortality rate for all cancers, whereas only five urban counties (26 percent) exceeded the average mortality rate for Pennsylvania. Wayne, Carbon, and Potter are the rural counties that had the highest mortality rates. Philadelphia and Delaware are the two

1. Incidence rate is the number of new cases per a given population number (i.e., per 100,000) in a given time period. Incidence rates (cases per 100,000 population per year) are age-adjusted to the 2000 U.S. standard population.

2. Mortality rate is the number of deaths per a given population number (i.e., per 100,000) in a given time period. Mortality rates (cases per 100,000 population per year) are age-adjusted to the 2000 U.S. standard population.

3. Incidence and mortality rates are based on the 2002-2006 State Cancer Registry Data.

4. Rural county defined: Counties with a population density less than 284 (average statewide density) are considered rural.

urban counties that had the highest mortality rates. While rural counties may have lower cancer incidence rates when compared to the state average, they have disparately higher mortality rates.

The Most Common Cancers in Pennsylvania

According to the cancer registry data for years 2002-2006, the five cancers with the highest average number of new cancers diagnosed per year were lung and bronchus (10,438), prostate (10,211), female breast (9,667), colorectal (8,353), and urinary bladder (3,758). The five cancers with the highest mortality (death) rates are: lung and bronchus (8,027), colorectal (3,045), female breast (2,235), pancreas (1,703), and prostate (1,534).

Priority Cancers in Healthy People 2010 and 2020⁵

The primary goal of the Healthy People initiative is to coordinate a national effort to reduce the number of new cancer cases as well as the illness, disability, and death caused by cancer. Specifically, Healthy People 2010 and 2020 focus on specific cancers that can be prevented through education, behavior change, and screening. These cancers are lung and bronchus, prostate, female breast, colorectal, uterine cervix, urinary bladder, oral cavity and pharynx (mouth), and melanoma of the skin. The Healthy People 2010/2020 publications identified these cancers as having the highest priority in national cancer prevention efforts. Federal funding for cancer prevention parallels the recommendations set forth by the Healthy People 2010/2020 documents. According to the Pennsylvania cancer registry data for 2002 through 2007, 63 percent of all cancers diagnosed for Pennsylvania residents were priority cancers as described by Healthy People 2010/2020, and 52 percent of all cancer mortality in the commonwealth were due to these cancers.

Cancer Burden in the Appalachia Region vs. Rural Pennsylvania

The Appalachian region of the U.S. covers a 205,000 square mile region containing 420 counties within 13 states. In Pennsylvania, 46 of its 48 rural counties (96 percent) are in the Appalachian region. The entire region ranges along the spine of the Appalachian Mountains from upstate New York in the north to northeast Mississippi in the south. Of the close to 24 million people who reside in the Appalachian region, about 40

percent are considered economically distressed, with significantly higher unemployment and poverty rates, lower annual median income, and lower educational attainment (Milken Institute, 2010; Appalachian Regional Commission; Appalachian Community Cancer Network, 2010). In addition, residents of this region are less likely to have health insurance, and have lower access to health care due to greater geographic isolation with little, if any, public transportation (Milken Institute, 2010; Appalachian Regional Commission; Appalachian Community Cancer Network, 2010). Numerous studies have been conducted showing that rural Appalachia residents are less likely to engage in preventive behavior change, such as not using tobacco products, eating a balanced diet, avoiding over-exposure to the sun, obtaining Human Papillomavirus (HPV) vaccines, and losing weight, and/or less likely to access screening services, such as obtaining regular pap smears, mammograms, colonoscopies, and prostate exams, for the prevention or early detection of cancer (Milken Institute, 2010; Appalachian Regional Commission; Appalachian Community Cancer Network, 2010; Amey et al., 1997; Gosschalk and Carozza, 2003; Higginbotham et al., 2001; Monroe et al., 1992; Liff et al., 1991; Risser, 1996; Howe et al., 1992; Freeman and Wingrove, 2005; Wewers et al., 2006; Cates et al., 2009; and Monroe et al., 1992). Geographic isolation, and the corresponding lack of access to health care providers and cancer screening facilities have been shown to be related to cancers being diagnosed at a later stage of disease progression, resulting in significantly higher mortality rates and significantly higher cancer disparities in rural Appalachia (Rosenman et al., 1995; Mullan et al., 1996; Sankaranarayanan et al., 2009; Ananthakrishnan, 2011; Juang et al., 2009; Khan et al., 2010; Lengerich et al., 2005; Halverson et al., 2004). While disparities in cancer incidence and mortality in Appalachia versus the U.S. have been studied and documented, research has not been conducted to compare cancer incidence and mortality in rural Pennsylvania to the rest of rural Appalachia (Milken Institute, 2010; Appalachian Regional Commission).

Pennsylvania and Appalachian Efforts in Cancer Control and Prevention

The Pennsylvania Department of Health is one of 22 state departments that receives federal funding for cancer prevention programs. For example, the Pennsylvania Cancer Education Network is dedicated to public

5. Managed by the Office of Disease Prevention and Health Promotion, Healthy People 2010 and 2020 are sets of health objectives for the nation to achieve over a decade of time. This planning document is used nationally and provides benchmarks for states to improve the public's health.

education about cancer and has partnered with a number of organizations⁶ to provide education to improve cancer health literacy⁷, and the Healthy Woman Program seeks to increase screening for the underserved to prevent cervical and breast cancer deaths. The network also coordinates efforts to educate the public about colorectal cancer and skin cancer prevention (Freeman and Wingrove, 2005). In regard to cancer prevention efforts in the Appalachian region, numerous coalitions have formed that coordinate prevention efforts within 46 of Pennsylvania's 48 rural counties (Wewers et al., 2006).

Pennsylvania Department of Health Comprehensive Chronic Disease and Injury Prevention Strategic Plan (2012-2015)

Over the last few years, members of the statewide Public Health Council (the primary researcher serves on the council) have worked with staff from the Pennsylvania Department of Health's Bureau of Health Promotion and Risk Reduction to develop a 5-year strategic plan to reduce chronic disease, including cancer within Pennsylvania. The council recommended that chronic disease prevention and control programs access the best available epidemiologic data in identifying risk factors, and the impact and burden of chronic disease, with specific attention on addressing social inequities in chronic disease. The draft strategic plan⁸ was printed in August 2012 for final comment and input from members of the council. Future efforts for chronic disease prevention will emphasize coordinated community planning to improve the social-ecological factors (such as designing community environments conducive to healthy lifestyles) within work and school settings. Particular emphasis will be on creating systems-level changes within workplaces, schools, and communities to foster increased physical activity and access

to healthy foods, while identifying best practices in chronic disease management.

Goals and Objectives

The primary purpose of this research project was to identify if there were any significant differences in cancer incidence and mortality in rural Pennsylvania counties as compared to urban Pennsylvania counties, rural Appalachian counties, and rural U.S. counties.

The researchers calculated age adjusted⁹ incidence rates and mortality rates for rural Pennsylvania counties, urban Pennsylvania counties, rural Appalachian counties, and rural U.S. counties for the following cancers: all cancer sites combined; colorectal; female breast; lung and bronchus; melanoma of the skin; oral cavity and pharynx (mouth); prostate; urinary bladder; and uterine cervix.

The research also looked to determine whether key county level demographic characteristics, such as race/ethnicity, county level education level¹⁰, county level median household income, county level unemployment rates, and access to health care¹¹, were significantly related to cancer incidence and mortality. The study also looked to determine if the stages of cancer diagnosis for each of the cancers of focus listed above were significantly different for the four different regions.

Methodology

Extraction and Compilation of the Cancer Incidence Data

The researchers accessed and retrieved cancer incidence data from the member domain database of the North American Association of Central Cancer Registries, Inc. (NAACCR)¹². They also used data from the cancer registries of 28 states that indicated willingness to contribute data for the research. The remaining 22

6. Partners: Allegheny Health Department; Allentown Health Bureau, Chester County Health Department, Erie County Health Department, Montgomery County Health Department, Northeast Regional Cancer Institute, and Philadelphia Health Department.

7. Cancer health literacy is knowing how to change behavior to prevent onset of cancer, knowing early signs and symptoms of cancer, seeking cancer screening, and knowing how to access the health care system to obtain preventive care.

8. *Pennsylvania Department of Health Bureau of Health Promotion and Risk Reduction Comprehensive Chronic Disease and Injury Prevention Strategic Plan (Draft II)*, August 3, 2012.

9. Age adjusted rates are a way to make fairer comparisons between counties that have different age distributions. For example, a county having a higher percentage of elderly may have a higher rate of cancer death as compared to a county with a younger population, merely because the elderly are more likely to get cancer or die of cancer. Age adjustment can make these different counties more comparable. A "standard" population distribution (i.e., the U.S. 2000 standard population) is used to adjust age rates. The age-adjusted rates are rates that would have existed if the population under study had the same age distribution as the "standard" population.

10. Education level: proportion of residents 25+ years of age who are high school graduates.

11. Access to health care: proportion of county residents reported to have no personal doctor or health care provider.

12. NAACCR is a professional organization that develops and promotes uniform data standards for cancer registration; provides education and training; certifies population-based registries; aggregates and publishes data from central cancer registries; and promotes the use of cancer surveillance data and systems for cancer control and epidemiologic research, public health programs, and patient care to reduce the burden of cancer in North America.

states were either considered to have inadequate cancer registries, or refused participation in the research.

The investigators extracted age adjusted cancer incidence rates for the most recent 5-year period available (2004-2008) for the following cancers of focus: all cancer sites combined; breast (female only); colorectal; lung and bronchus; melanoma of the skin; oral cavity and pharynx (mouth); prostate; urinary bladder; and uterine cervix. In addition, they accessed staging data (such as in situ, local, regional, distant) at the county level for Pennsylvania to determine if any patterns existed on whether certain cancers were diagnosed in the later stages of disease progression. These cancers were selected since they are the priority cancers identified within the Healthy People 2020 and account for nearly two-thirds (63 percent) of all incident cancers in Pennsylvania. The researchers constructed separate data tables for rural Pennsylvania counties (n=48), urban Pennsylvania counties (n=19), rural Appalachian counties (n=233) and rural U.S. counties (n=1,379) within the 28 states that participated for a total of 1,679 counties. For rural and urban Pennsylvania counties, the researchers extracted additional county level data from the U.S. Census¹³ for: educational attainment (the percentage of county residents completing high school) in 2000; median household income in 2000; and unemployment rates for 2000 and 2005. Using the University of Wisconsin's County Health Rankings, they also compiled the primary care physician rate¹⁴ (number of primary care physicians for every 100,000 residents in 2005). Finally, the researchers separated the data tables by gender and race (all races and white, non-Hispanic). This was done to control for confounding by race and ethnicity. Additional racial breakdowns to examine specific ethnicities were not possible due to low counts. Extraction of the data for the 10-year period allowed the investigators to compare those cancers that were less common and suppressed¹⁵ using 5-year data due to low counts.

Extraction and Compilation of the Cancer Mortality Data

The researchers retrieved cancer mortality data from a public domain software (SEER*Stat), developed by the National Cancer Institute (NCI), to analyze cancer mortality rates. The investigators extracted age-adjusted cancer mortality rates for the most recent 5-year period available (2003-2007), and for a 9-year period (1999-2007) for the cancers of focus: breast (female only); colorectal; lung and bronchus; melanoma of the skin; oral cavity and pharynx (mouth); prostate; urinary bladder; and uterine cervix. The researchers constructed separate data tables for rural and urban Pennsylvania counties, rural Appalachian counties and rural U.S. counties.

Similar to the process conducted to create the incidence database, the researchers extracted the county level data from the U.S. Census for rural and urban Pennsylvania counties and paired them with the incidence data. The county level data were: educational attainment (percentage of county residents completing high school) in 2000; median household income in 2000; and unemployment rates for 2000 and 2005. They also compiled the primary care physician rate (number of primary care physicians for every 100,000 residents in 2005) from the University of Wisconsin's County Health Rankings, and finally, separated the data tables by gender and by race (all races vs. white, non-Hispanic). Additional racial breakdowns to examine specific ethnicities were not possible due to low counts. Extraction of the data for the 10-year period allowed the investigators to compare those cancers that were less common and suppressed using 5-year data due to low counts.

Data Analyses

To determine if there were significant differences in the county cancer age adjusted incidence and mortality rates, the researchers conducted Z-score calculations¹⁶ to determine if specific county rates were significantly higher or lower for rural vs. urban Pennsylvania counties, rural Appalachian counties, and rural U.S. coun-

13. Data tables, using the American Fact Finder Search feature were compiled using the 2000 US Census, and the 2005 Community Survey of the U.S. Census.

14. See <http://www.countyhealthrankings.org/> to access primary care physician rate for Pennsylvania counties. This measure was used to estimate resident's access to health care, and may be a predictor in the prevention of cancer, or early detection of cancer. County health rankings first became available in 2004; data from 2005 were used.

15. Data suppression is done to preserve both residents' confidentiality and statistical precision. For population-based cancer rates, county level cancer incidence and mortality rates are suppressed when there is a count of fewer than 4 residents to protect confidentiality.

16. A Z-score provides statistical information regarding how much above or below the specific rate is as compared to the overall group mean of the given rate of cancer. If the Z-score for a given county has a value of 0, the county rate is equal to the overall mean rate for all counties combined. If the Z-score is equal to +/-1, its value is equal to one standard deviation above or below the mean. A Z-score value of +/- 1.96 is needed to indicate the given individual rate score is statistically significantly higher or lower (at the $p < .05$ level), and a value of +/- 2.58 is needed to indicate the given score is statistically significantly higher or lower than the group mean (at the $p < .01$ level).

ties. Due to the large number of statistical tests used, the alpha level¹⁷ used to determine statistical significance was set at a more conservative level of $p < .01$.

The researchers also conducted linear regression analyses¹⁸ to determine whether the county demographic variables (educational attainment; median household income; unemployment rates; and the primary care physician rate) were related to the cancer incidence and mortality rates for all cancers combined and the specific cancers of focus.

Results

Incidence Rates

As shown in Table 1, for males of all races, Pennsylvania rural county cancer incidence rates were significantly higher as compared to rural U.S. counties for: all cancers combined (572.4); colon and rectum (63.3); urinary bladder (45.8); and prostate (154.4). When compared to rural Appalachian counties, both urinary bladder and prostate cancer incidence were significantly higher. When compared to urban Pennsylvania counties, only colon and rectum cancer was significantly higher.

Pennsylvania rural county cancer incidence rates were significantly lower as compared to rural U.S.

counties for lung and bronchus (89.7) and melanoma of the skin (21.4). In addition, the Pennsylvania rural county incidence rate for oral cavity and pharynx (16.3) was significantly lower as compared to rural Appalachian counties.

For females of all races, Pennsylvania rural county cancer incidence rates were significantly higher as compared to rural U.S. counties for all cancers combined (434.3), colon and rectum (46.7), and urinary bladder (11.3). When compared to rural Appalachian counties, all cancers combined, urinary bladder, and breast (118.3) were significantly higher. When compared to urban Pennsylvania counties, only melanoma of the skin (16.6) was significantly higher.

The only Pennsylvania rural county cancer incidence rate that was significantly lower as compared to rural U.S. counties, rural Appalachia, and urban Pennsylvania counties was lung and bronchus (53.5). All cancers combined, and breast cancer incidence rates were significantly lower as compared to Pennsylvania urban counties.

As shown in Table 2 (see Page 8), for white, non-Hispanic males, Pennsylvania rural county cancer incidence rates were significantly higher as compared to rural U.S. counties for: all cancers combined (569.7); colon and rectum (63.4); urinary bladder (46.3); and

Table 1. Age Adjusted Incidence Rates for Selected Cancer Sites by Sex and Place of Residence, All Races, 2004-2008

Sex	Place of Residence	Cancer Site						
		All Sites Rate (99% CI)†	Oral Cavity and Pharynx Rate (99% CI)†	Colon and Rectum Rate (99% CI)†	Lung and Bronchus Rate (99% CI)†	Melanoma Rate (99% CI)†	Urinary Bladder Rate (99% CI)†	Prostate Rate (99% CI)†
SEX								
MALES								
	Rural PA	572.4 ² (566.1-578.8)	16.3 ⁶ (15.2-17.4)	63.3 ^{1,2} (61.2-65.5)	89.7 ^{5,6} (87.3-92.3)	21.4 ^{5,6} (20.2-22.7)	45.8 ^{2,3} (44.0-47.7)	154.4 ^{2,3} (151.1-157.6)
	Urban PA	578.5 (574.4-582.6)	15.9 (15.2-16.6)	60.6 (59.2-61.9)	88.2 (86.5-89.8)	21.8 (21.0-22.6)	44.7 (43.6-45.9)	156.3 (154.2-158.5)
	Rural U.S.*	560.0 (558.2-561.8)	16.9 (16.6-17.2)	60.1 (59.5-60.7)	96.9 (95.8-97.3)	23.6 (23.2-24.0)	39.8 (39.3-40.3)	149.9 (148.1-150.0)
	Appalachia*	570.9 (567.2-574.6)	17.7 (17.0-18.3)	61.6 (60.4-62.9)	105.5 (104.0-107.1)	23.4 (22.6-24.2)	41.9 (40.9-42.9)	145.2 (143.4-147.1)
WOMEN								
	Rural PA	434.3 ^{2,3,4} (429.2-439.5)	6.2 (5.6-6.9)	46.7 ² (45.1-48.3)	53.5 ^{1,2,3} (51.8-55.3)	16.6 ¹ (15.5-17.8)	11.3 ^{2,3} (10.5-12.1)	118.3 ^{3,4} (115.6-121.1)
	Urban PA	447.2 (444.0-450.5)	6.0 (5.6-6.4)	45.7 (44.7-46.7)	59.3 (58.2-60.5)	14.8 (14.1-15.4)	10.9 (10.5-11.4)	127.2 (125.5-129.0)
	Rural U.S.*	414.5 (413.1-415.9)	6.1 (6.0-6.3)	43.8 (43.3-44.2)	58.8 (58.3-59.3)	16.3 (16.0-16.6)	9.9 (9.7-10.1)	117.3 (116.5-118.0)
	Appalachia*	423.4 (420.4-426.3)	6.2 (5.9-6.6)	45.3 (44.4-46.3)	61.5 (60.4-62.6)	17.3 (16.6-17.9)	10.2 (9.8-10.7)	114.4 (112.9-116.0)

† Mortality rate (deaths per 100,000) adjusted for age using the 2000 standard US population; 99% Confidence Interval. * Rural counties only. ¹ Significantly higher than the rate in Urban PA counties. ² Significantly higher than the rate in Rural U.S. counties. ³ Significantly higher than the rate in Rural Appalachia counties. ⁴ Significantly lower than the rate in Urban PA counties. ⁵ Significantly lower than the rate in Rural U.S. counties. ⁶ Significantly lower than the rate in Rural Appalachia counties.

17. The alpha level is defined as the probability of obtaining a significant finding that is really a “false positive.” That is, the probability of making the false claim that the finding is significant (when it is not). An alpha level set at a probability of 1 percent ($p < .01$) indicates that your finding achieved has a 1 percent chance that it is a false positive or erroneous. A more rigorous alpha level was set for this study due to the numerous analyses conducted. Thus, the chances of obtaining a “false positive” finding in this study was 1 percent.

18. Linear regression analysis is widely used for prediction and forecasting future values; in this case, forecasting future cancer rates. Regression analysis is also used to understand which independent variables (in this case, the demographic characteristics) are related to the dependent variables (cancer rates), and to explore the forms of these relationships. While regression analysis can be used to infer causal relationships between the independent and dependent variables, one should not assume this correlation implies that the independent variables cause changes in the values of the dependent variables (that is, causation).

Table 2. Age Adjusted Incidence Rates for Selected Cancer Sites by Sex and Place of Residence, White Non-Hispanic, 2004-2008

Sex	Place of Residence	Cancer Site							
		All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Prostate Rate (99% CI) [†]	
MEN									
	Rural PA	569.7 ^{1,2} (563.3-576.2)	16.3 ⁶ (15.2-17.4)	63.4 ^{1,2} (61.3-65.6)	89.7 ^{1,5,6} (87.2-92.3)	21.5 ^{4,5,6} (20.3-22.8)	46.3 ^{2,3} (44.4-48.1)	150.9 ^{1,2,3} (147.7-154.2)	
	Urban PA	562.0 (557.6-566.4)	15.6 (14.9-16.4)	59.5 (58.1-60.9)	86.2 (84.5-88.0)	23.7 (22.8-24.7)	47.0 (45.8-48.3)	142.1 (139.9-144.3)	
	Rural US*	560.2 (558.3-562.1)	17.2 (16.8-17.5)	60.0 (59.3-60.6)	97.6 (96.8-98.4)	25.9 (25.5-26.3)	42.0 (41.5-42.5)	142.6 (141.7-143.6)	
	Appalachia*	570.4 (566.6-574.1)	17.7 (17.1-18.4)	62.0 (60.8-63.3)	106.0 (104.4-107.6)	23.9 (23.1-24.7)	42.6 (41.6-43.7)	141.8 (140.0-143.7)	
		Cancer Site							
		All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Breast Rate (99% CI) [†]	Uterine Cervix Rate (99% CI) [†]
WOMEN									
	Rural PA	433.5 ^{2,3,4} (428.3-438.8)	6.2 (5.5-6.8)	46.5 ^{1,2} (44.9-48.2)	53.5 ^{4,5,6} (51.8-55.3)	16.6 ⁵ (15.5-17.8)	11.4 (10.6-12.2)	118.1 ^{3,4} (115.4-120.9)	8.3 ¹ (7.5-9.2)
	Urban PA	448.1 (444.6-451.7)	5.9 (5.5-6.4)	44.8 (43.7-45.9)	58.5 (57.3-59.8)	16.6 (15.9-17.3)	11.4 (10.9-12.0)	127.9 (126.0-129.9)	6.9 (6.4-7.4)
	Rural US*	422.1 (420.5-423.6)	6.3 (6.1-6.5)	43.5 (43.0-44.0)	61.4 (60.9-62.0)	18.1 (17.8-18.5)	10.4 (10.1-10.6)	119.1 (118.3-119.9)	8.4 (8.1-8.6)
	Appalachia*	425.4 (422.4-428.4)	6.3 (5.9-6.6)	45.2 (44.3-46.2)	62.2 (61.1-63.3)	17.5 (16.9-18.2)	10.4 (9.9-10.8)	114.9 (113.3-116.5)	8.9 (8.4-9.4)

[†] Mortality rate (deaths per 100,000) adjusted for age using the 2000 standard US population; 99% Confidence Interval. * Rural counties only. ¹ Significantly higher than the rate in Urban PA counties. ² Significantly higher than the rate in Rural U.S. counties. ³ Significantly higher than the rate in Rural Appalachia counties. ⁴ Significantly lower than the rate in Urban PA counties. ⁵ Significantly lower than the rate in Rural U.S. counties. ⁶ Significantly lower than the rate in Rural Appalachia counties.

prostate (150.9). When compared to rural Appalachian counties, both urinary bladder and prostate cancer incidence were significantly higher. When compared to urban Pennsylvania counties, all cancers combined, colon and rectum, lung and bronchus, and prostate incidence rates were significantly higher.

The only Pennsylvania rural county cancer incidence rate that was significantly lower than rural U.S. counties, rural Appalachia, and urban Pennsylvania counties was melanoma (21.5). In addition, the Pennsylvania rural county incidence rate for oral cavity and pharynx (16.3) was significantly lower than rural Appalachian counties and for lung and bronchus was significantly lower than the rural U.S. and rural Appalachia county rates.

For white, non-Hispanic females, Pennsylvania rural county cancer incidence rates were significantly higher as compared to rural U.S. counties for all cancers combined (433.5) and colon and rectum (46.5). When compared to rural Appalachian counties, all cancers combined and breast (118.1) were significantly higher. When compared to urban Pennsylvania counties, colon and rectum and uterine cervix (8.3) were significantly higher. The only Pennsylvania rural county cancer incidence rate that was significantly lower than rural U.S. counties, rural Appalachia, and urban Pennsylvania counties was lung and bronchus (53.5).

All cancers combined and breast cancer incidence rates were significantly lower as compared to Pennsylvania urban counties.

Tables 3 and 4 provide a summary of the Z-score analyses, which determined whether incidence rates by gender were significantly higher for specific rural counties as compared to all rural Pennsylvania counties,

urban Pennsylvania counties, rural Appalachian counties and rural U.S. counties.

As shown in Table 3, for women, only Washington County had a significantly higher rate for all cancers combined when compared to other rural Pennsylvania counties. No rural Pennsylvania county had a significantly higher rate for oral cavity and pharynx cancer. In regard to colon and rectum cancer, Clearfield and Schuylkill counties had significantly higher rates when compared to other rural and urban Pennsylvania counties. Crawford, Fayette, Monroe and Washington counties had significantly higher rates for lung and bronchus when compared to other rural Pennsylvania counties. Melanoma rates were significantly higher in Franklin County when compared to other rural and urban Pennsylvania counties. The melanoma rate was significantly higher in Jefferson County when compared to urban Pennsylvania counties. Only Schuylkill County had significantly higher urinary bladder rates when compared to other rural Pennsylvania counties and urban Pennsylvania counties. Forest County had a significantly higher breast cancer rate when compared to other rural Pennsylvania counties and urban Pennsylvania counties while Washington County had a significantly higher breast cancer rate when compared to other rural Pennsylvania counties. No rural Pennsylvania county had significantly higher rates for uterine cervix cancer.

As seen in Table 4 (Page 10), for men, Lawrence, Mercer, and Warren counties had significantly higher rates for all cancers combined as compared to other rural Pennsylvania counties and urban Pennsylvania counties. Cambria County had a significantly higher rate for all cancers combined when compared to other rural Pennsylvania counties. No rural Pennsylvania

Table 3: Age-adjusted Cancer Incidence Rates among Women in Rural Pennsylvania by Cancer Site and County, 2004-2008

Rural PA	All Cancers	Oral Cavity and Pharynx	Colon and Rectum	Lung and Bronchus	Melanoma of the Skin	Urinary Bladder	Breast	Uterine Cervix
County	Rate	Rate	Rate	Rate	Rate	Rate	Rate	Rate
Adams	460.4	7.8	52.8	50.7	19.6	12.4	130.5	5.7
Armstrong	393.6 ^{4,7}	4.4	44.3	48.5	12.6	12.7	102.7 ⁴	7.4
Bedford	413.7	5.8	50.3	40.6 ⁴	25.6 ¹	8.8	112.6	10.4
Blair	411.0 ⁴	6.6	46.2	47.8 ⁴	15.7	10.3	108.7 ⁴	7.0
Bradford	452.2	8.9	44.9	64.4	16.1	11.9	127.9	4.6
Butler	443.2	4.4	44.9	54.9	16.6	9.5	129.5	7.2
Cambria	427.1	6.3	48.4	45.2 ^{4,7}	15.1	13.9	110.5 ⁴	7.4
Cameron	416.8	9.5	34.0	75.4	22.0	9.9	104.9	20.2
Carbon	437.2	7.9	45.1	45.4 ⁴	18.5	12.6	110.2	6.3
Centre	414.8 ⁴	8.4	40.7	44.2 ⁴	17.4	7.5	118.0	5.6
Clarion	459.2	4.7	55.4	48.9	18.5	7.3	138.1	7.1
Clearfield	456.2	6.8	57.9 ^{0,1}	56.3	19.3	14.6	126.2	7.9
Clinton	445.1	4.9	49.1	70.9	18.7	6.1	127.0	7.9
Columbia	418.4	7.0	41.3	41.7 ⁴	18.7	11.1	115.5	10.4
Crawford	446.5	5.7	50.3	67.0 ⁰	21.3	6.0 ^{4,7}	117.4	11.5
Elk	407.6	5.4	55.7	60.0	11.7	12.6	99.0	8.2
Fayette	437.9	5.8	42.6	62.4 ⁰	7.9 ^{4,7}	9.8	111.6 ⁴	10.8
Forest	455.8	3.8	33.2	63.5	27.4	4.7	207.7 ^{0,1}	0.0
Franklin	422.2	6.6	41.0	46.2 ⁴	25.2 ^{0,1}	9.2	124.3	10.0
Fulton	407.1	5.3	35.7	50.7	24.5	13.9	107.8	8.8
Greene	457.5	9.6	55.9	69.1	13.4	9.0	107.2	5.6
Huntingdon	387.6 ^{4,7}	8.5	44.3	47.2	20.2	8.3	92.6 ^{4,7}	4.8
Indiana	405.2 ⁴	4.5	42.9	41.7 ^{4,7}	11.2	14.3	125.6	6.7
Jefferson	428.2	4.9	42.6	45.6	26.7 ¹	12.4	107.8	7.8
Juniata	402.8	7.4	45.3	37.2	17.5	8.2	116.7	6.1
Lawrence	465.0	4.1	49.9	50.6	18.3	13.5	122.0	9.6
Lycoming	442.3	5.9	48.0	58.6	17.4	10.7	113.5	10.7
McKean	481.7	5.4	49.7	81.7 ^{0,1}	18.2	13.1	126.6	10.6
Mercer	439.7	5.6	47.8	48.6 ⁴	17.5	11.9	116.5	10.5
Mifflin	451.3	6.9	44.5	60.6	19.1	14.8	124.4	6.3
Monroe	442.0	7.3	42.6	66.5 ⁰	12.9	11.1	125.9	8.9
Montour	471.0	6.0	50.2	46.9	31.8	15.1	122.2	6.8
Northumberland	427.6	6.2	40.1	51.1	15.5	8.7	116.7	11.6
Perry	460.0	5.9	43.7	59.2	21.0	5.0	141.2	2.4
Pike	425.3	6.4	47.3	55.2	16.4	12.7	113.3	10.3
Potter	446.3	5.1	47.2	49.0	6.3	11.8	138.8	20.8
Schuylkill	433.4	7.2	57.6 ^{0,1}	51.0	18.5	16.3 ^{0,1}	104.0 ^{4,7}	9.8
Snyder	361.8 ^{4,7}	5.7	52.0	34.4 ^{4,7}	19.0	5.9	97.6 ⁴	6.4
Somerset	426.9	3.3	44.2	35.2 ^{4,7}	16.2	13.4	103.9 ⁴	13.2
Sullivan	377.4	7.1	15.1	38.0	14.0	11.4	111.0	24.6
Susquehanna	417.0	7.1	49.0	54.8	8.9	10.6	115.1	9.8
Tioga	437.5	6.3	44.9	63.7	10.6	11.5	135.6	1.4
Union	432.9	8.1	50.9	40.5 ⁴	24.6	10.6	124.3	8.2
Venango	429.4	2.9	45.8	65.3	22.9	11.2	122.0	6.9
Warren	438.1	2.4	43.1	63.6	21.2	17.4	125.0	9.1
Washington	466.7 ⁰	8.2	45.6	64.5 ⁰	11.5 ⁷	12.5	132.5 ⁰	7.9
Wayne	418.1	7.3	45.4	59.2	13.3	11.7	104.4	9.4
Wyoming	474.3	3.5	49.9	59.1	17.5	8.1	130.0	7.2

Underlying mortality data provided by NCHS (www.cdc.gov/nchs). Rates are per 100,000 and age-adjusted to the 2000 U.S. Std Population (19 age groups - Census P25-1130) standard; Confidence intervals (Tiware mod) are 99% for rates. * Rate obtained from PA Cancer Incidence and Mortality, 99% Confidence Interval based on estimated S.E. (S.E.= rate/ sqrt(n)). † Rates based on 1999-2007 data, 99% Confidence Interval by Tiware method. ^ Statistic not displayed due to small number of deaths during the period 1999-2007. n = Number of cases on which is based the 5-yr or 10-year rates (or count of cases in most recent 5-year period, if too few for rate calculation). 0 = Significantly higher than the rate in Rural PA. 1 = Significantly higher than the rate in Urban PA. 2 = Significantly higher than the rate in Rural U.S. 3 = Significantly higher than the rate in Rural Appalachia. 4 = Significantly lower than the rate in Urban PA. 5 = Significantly lower than the rate in Rural U.S. 6 = Significantly lower than the rate in Rural Appalachia. 7 = Significantly lower than the rate in Rural PA.

county had a significantly higher rate for cancer of the oral cavity and pharynx. Only Cambria County had a significantly higher rate for colon and rectum cancer when compared to urban Pennsylvania counties. For lung and bronchus, Fayette and Lawrence counties had significantly higher rates when compared to other rural Pennsylvania counties and urban Pennsylvania counties. No rural Pennsylvania county had a significantly higher rate for melanoma. Cambria County had significantly higher urinary bladder rates as compared to urban Pennsylvania counties, while Warren County had significantly higher urinary bladder rates as compared to other rural Pennsylvania counties and urban Pennsylvania counties. Finally, there were a large number of rural Pennsylvania counties (Bedford, Butler, Cambria, Clarion, Mercer, Somerset, Union, and Warren) that had significantly higher rates for prostate cancer as compared to other rural Pennsylvania counties and urban Pennsylvania counties.

Mortality Rates

According to the findings, only a few rural Pennsylvania counties had statistically significantly higher mortality rates as compared to the other groups for both males and females. The majority of findings indicated that cancer mortality rates in rural Pennsylvania counties are not significantly higher, but are equal to, or significantly less than, rural U.S. counties,

Table 4. Age-adjusted Cancer Incidence Rates among Men in Rural Pennsylvania by Cancer Site and County, 2004-2008

Rural PA County	All cancers		Oral Cavity and Pharynx		Colon and Rectum		Lung and Bronchus		Melanoma of the Skin		Urinary Bladder		Prostate	
	Rate		Rate		Rate		Rate		Rate		Rate		Rate	
Adams	530.3	^{4,7}	13.7		61.1		79.0		24.8		41.0		127.1	^{4,7}
Armstrong	526.6	^{4,7}	11.2		55.3		84.8		15.2		45.2		155.5	
Bedford	575.4		17.2		57.4		72.7		23.8		55.4		203.9	^{0,1}
Blair	539.8	⁴	19.0		68.0		95.6		17.4		44.3		112.6	^{4,7}
Bradford	591.2		21.7		64.0		90.3		31.3		40.7		160.6	
Butler	580.1		14.3		58.4		84.7		23.4		40.3		173.2	^{0,1}
Cambria	603.0	⁰	15.5		72.9	¹	77.8	⁷	20.0		54.1	¹	179.5	^{0,1}
Cameron	556.8		29.2		74.1		54.3		18.7		55.6		171.4	
Carbon	581.5		12.7		63.9		96.8		27.3		52.6		131.1	⁴
Centre	541.8		11.9		52.3		79.1		27.7		38.6		158.6	
Clarion	632.5		12.6		64.2		89.8		31.1		53.8		188.1	^{0,1}
Clearfield	583.3		17.7		65.3		97.8		24.7		45.9		149.3	
Clinton	603.9		21.7		74.4		93.9		25.5		50.9		165.1	
Columbia	598.6		12.9		67.1		94.5		26.2		53.2		166.9	
Crawford	555.0		17.7		56.5		91.7		19.9		51.2		153.8	
Elk	578.1		17.7		73.0		77.8		12.1		46.4		170.7	
Fayette	596.5		15.9		65.1		108.0	^{0,1}	12.3	^{4,7}	53.4		139.8	⁴
Forest	632.1		18.8		80.3		101.2		25.5		88.6		155.1	
Franklin	574.8		14.8		67.7		87.7		27.8		40.3		154.0	
Fulton	532.0		8.4		67.7		80.9		29.4		28.7		138.7	
Greene	582.4		20.5		66.0		107.5		10.8		52.5		128.8	
Huntingdon	525.9		14.4		60.7		87.6		22.4		31.0		120.6	^{4,7}
Indiana	560.8		15.7		65.2		73.3	⁷	20.4		47.6		164.7	
Jefferson	544.9		20.7		65.0		70.4		19.4		41.9		166.7	
Juniata	463.7	^{4,7}	18.6		64.8		66.5		26.3		34.5		106.9	^{4,7}
Lawrence	641.0	^{0,1}	17.0		68.2		109.3	^{0,1}	17.7		43.3		164.7	
Lycoming	557.0		16.8		68.7		85.2		22.5		46.5		140.4	
McKean	553.9		20.4		68.7		93.5		21.3		45.0		120.2	^{4,7}
Mercer	631.7	^{0,1}	17.4		59.2		93.5		20.8		50.7		205.0	^{0,1}
Mifflin	529.0		24.5		49.3		82.3		28.4		49.2		116.7	^{4,7}
Monroe	544.5	⁴	16.8		55.1		97.6		19.5		38.1		136.6	^{4,7}
Montour	630.9		13.5		54.5		101.5		30.6		36.4		167.8	
Northumberland	587.0		13.2		65.8		90.1		25.7		41.5		170.0	
Perry	542.8		19.3		69.5		102.8		25.2		36.7		95.0	^{4,7}
Pike	514.6	^{4,7}	16.8		57.6		97.0		15.8		35.2		121.0	^{4,7}
Potter	588.7		13.3		64.0		92.8		20.9		54.9		160.3	
Schuylkill	590.1		18.8		68.9		99.9		23.1		44.4		144.6	
Snyder	502.0	^{4,7}	16.4		56.7		76.9		17.7		40.1		146.8	
Somerset	583.2		13.8		64.6		81.2		18.7		44.5		186.0	^{0,1}
Sullivan	626.5		11.2		53.1		105.5		42.7		55.1		161.6	
Susquehanna	541.0		17		60.5		92.7		14.0		43.0		147.5	
Tioga	584.5		14.2		60.4		82.0		26.1		48.2		172.5	
Union	590.2		17.5		61.8		75.3		31.5		28.0	^{4,7}	195.3	^{0,1}
Venango	582.5		12.6		57.9		105.1		19.5		51.0		155.3	
Warren	661.0	^{0,1}	17.4		66.5		70.2		21.6		73.0	^{0,1}	235.5	^{0,1}
Washington	568.8		18.2		66.1		93.8		13.8	^{4,7}	48.4		143.9	
Wayne	494.9	^{4,7}	12.6		56.7		82.7		16.9		41.7		123.6	
Wyoming	621.7		18.7		68.3		95.9		29.3		50.8		160.0	

See notes under Table 3.

rural Appalachia, and urban Pennsylvania counties.

As shown in Table 5, for males of all races, Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural U.S. counties for all cancers combined (236.7), lung and bronchus (72.3), and prostate (23.6). Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural Appalachian counties for all cancers combined (236.7), oral cavity and pharynx (3.8), and lung and bronchus (72.3). Pennsylvania rural county cancer mortality rates were significantly lower as compared to urban Pennsylvania counties for prostate cancer.

For females of all races, Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural U.S. counties for lung and bronchus (36.5) and uterine cervix (2.3). Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural Appalachian counties for all cancers combined (159.0), lung and bronchus, and uterine cervix. When compared to urban Pennsylvania counties, all cancer sites and lung and bronchus were significantly lower. The only Pennsylvania rural county cancer mortality rate that was significantly higher as compared to rural U.S. counties and rural Appalachia counties was breast cancer (25.5).

Table 5: Age-adjusted Mortality Rates for Selected Cancer Sites by Sex and Place of Residence, All Races, 2003-2007

		Cancer Site							
Gender	Place of Residence	All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Prostate Rate (99% CI) [†]	
MEN									
	Rural PA	236.7 ^{5,6} (232.6-240.9)	3.8 ⁶ (3.3-4.4)	23.2 (21.9-24.5)	72.3 ^{5,6} (70.1-74.6)	4.1 (3.6-4.7)	8.5 (7.7-9.3)	23.6 ^{4,6} (22.3-25.0)	
	Urban PA	240.8 (238.1-243.6)	3.5 (3.2-3.9)	23.7 (22.9-24.6)	71.1 (69.6-72.5)	4.3 (4.0-4.7)	8.3 (7.8-8.8)	25.6 (24.7-26.5)	
	Rural U.S.*	243.5 (242.3-244.8)	4.3 (4.1-4.5)	22.9 (22.5-23.2)	79.9 (79.2-80.6)	4.3 (4.1-4.5)	7.7 (7.4-7.9)	25.7 (25.3-26.2)	
	Appalachia*	260.5 (258.3-262.7)	4.5 (4.1-4.9)	23.5 (22.6-24.5)	93.3 (91.4-95.1)	4.6 (4.2-5.1)	7.7 (7.2-8.3)	24.5 (23.5-25.6)	
	PA	239.6 (237.4-241.9)	3.6 (3.4-3.9)	23.6 (22.9-24.6)	71.4 (70.2-72.7)	4.3 (4.0-4.6)	8.4 (7.9-8.8)	25.0 (24.3-25.8)	
	U.S.	225.5 (225.0-225.9)	3.9 (3.8-4.0)	21.2 (21.0-21.3)	68.8 (68.6-69.1)	4.0 (3.9-4.0)	7.5 (7.4-7.6)	24.7 (24.6-24.9)	
WOMEN									
		All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Breast Rate (99% CI) [†]	Uterine Cervix Rate (99% CI) [†]
	Rural PA	159.0 ^{4,6} (156.0-162.0)	1.3 (1.0-1.6)	15.8 (14.9-16.7)	36.5 ^{4,6} (35.1-37.9)	1.9 (1.6-2.3)	2.3 (2.0-2.7)	25.5 ^{2,3} (24.3-26.7)	2.2 ^{5,6} (1.8-2.6)
	Urban PA	166.1 (164.2-168.0)	1.3 (1.1-1.4)	16.3 (15.7-16.9)	42.0 (41.1-43.0)	1.9 (1.7-2.1)	2.5 (2.3-2.7)	25.6 (24.9-26.4)	2.3 (2.0-2.5)
	Rural U.S.*	161.1 (160.2-162.0)	1.5 (1.4-1.6)	15.9 (15.7-16.2)	43.4 (43.0-43.9)	1.9 (1.8-2.0)	2.2 (2.1-2.3)	24.0 (23.6-24.3)	2.7 (2.6-2.9)
	Appalachia*	168.8 (166.6-171.1)	1.6 (1.4-1.9)	16.4 (15.7-17.1)	47.7 (46.6-48.9)	2.3 (2.1-2.6)	2.4 (2.2-2.7)	24.2 (23.4-25.1)	2.9 (2.6-3.2)
	PA	164.0 (162.4-165.6)	1.3 (1.1-1.4)	16.1 (15.7-16.6)	40.4 (39.6-41.2)	1.9 (1.7-2.1)	2.4 (2.3-2.6)	25.6 (25.0-26.3)	2.2 (2.0-2.4)
	U.S.	155.4 (155.1-155.8)	1.4 (1.4-1.5)	14.9 (14.8-15.0)	40.6 (40.4-40.7)	1.7 (1.7-1.8)	2.2 (2.1-2.3)	24.0 (23.8-24.1)	2.4 (2.4-2.5)

[†] Mortality rate (deaths per 100,000) adjusted for age using the 2000 standard US population; 99% Confidence Interval. * Rural counties only. ¹ Significantly higher than the rate in Urban PA counties. ² Significantly higher than the rate in Rural U.S. counties. ³ Significantly higher than the rate in Rural Appalachia counties. ⁴ Significantly lower than the rate in Urban PA counties. ⁵ Significantly lower than the rate in Rural U.S. counties. ⁶ Significantly lower than the rate in Rural Appalachia counties.

Table 6: Age-adjusted Mortality Rates for Selected Cancer Sites by Sex and Place of Residence, White Non-Hispanic, 2003-2007

		Cancer Site							
Gender	Place of Residence	All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Prostate Rate (99% CI) [†]	
MEN									
	Rural PA	238.8 ^{4,5} (234.6-243.1)	3.9 ¹ (3.4-4.5)	23.4 (22.1-24.8)	73.0 ^{1,5,6} (70.7-75.3)	4.2 ^{4,5,6} (3.7-4.8)	8.6 (7.8-9.5)	23.5 (22.2-24.9)	
	Urban PA	235.8 (233.0-238.7)	3.3 (2.9-3.6)	23.1 (22.2-24.0)	69.7 (68.1-71.2)	4.9 (4.5-5.3)	8.6 (8.1-9.2)	23.1 (22.2-24.1)	
	Rural U.S.*	243.2 (241.9-244.5)	4.1 (3.9-4.3)	22.6 (22.2-23.0)	81.0 (80.3-81.8)	4.9 (4.7-5.0)	8.1 (7.8-8.3)	23.9 (23.5-24.4)	
	Appalachia*	262.0 (258.8-265.3)	4.4 (4.0-4.8)	23.6 (22.6-24.6)	94.1 (92.2-96.0)	4.9 (4.4-5.3)	7.8 (7.2-8.4)	23.8 (22.8-24.9)	
	PA	236.8 (234.5-239.2)	3.5 (3.2-3.8)	23.2 (22.5-24.0)	70.7 (69.5-72.0)	4.7 (4.4-5.0)	8.6 (8.2-9.1)	23.3 (22.5-24.0)	
	U.S.	227.4 (226.8-227.9)	3.8 (3.7-3.8)	20.9 (20.8-21.1)	71.0 (70.7-71.3)	4.8 (4.7-4.9)	8.2 (8.1-8.3)	23.0 (22.8-23.1)	
WOMEN									
		All Sites Rate (99% CI) [†]	Oral Cavity and Pharynx Rate (99% CI) [†]	Colon and Rectum Rate (99% CI) [†]	Lung and Bronchus Rate (99% CI) [†]	Melanoma Rate (99% CI) [†]	Urinary Bladder Rate (99% CI) [†]	Breast Rate (99% CI) [†]	Uterine Cervix Rate (99% CI) [†]
	Rural PA	160.1 ^{4,5} (157.1-163.2)	1.3 (1.0-1.6)	15.8 (14.9-16.8)	36.7 ^{4,5,6} (35.3-38.2)	1.9 ⁶ (1.6-2.3)	2.4 (2.0-2.7)	25.7 ^{2,3} (24.5-27.0)	2.2 ⁶ (1.9-2.7)
	Urban PA	163.5 (161.5-165.6)	1.2 (1.0-1.4)	15.9 (15.3-16.6)	41.4 (40.4-42.5)	2.1 (1.9-2.4)	2.4 (2.2-2.6)	25.1 (24.3-25.9)	1.9 (1.7-2.2)
	Rural U.S.*	162.6 (161.6-163.6)	1.5 (1.4-1.6)	15.8 (15.5-16.1)	45.6 (45.1-46.2)	2.2 (2.1-2.3)	2.2 (2.1-2.4)	23.6 (23.2-24.0)	2.5 (2.4-2.6)
	Appalachia*	169.6 (167.4-171.9)	1.6 (1.4-1.9)	16.3 (15.7-17.0)	48.5 (47.3-49.7)	2.4 (2.1-2.7)	2.4 (2.2-2.7)	24.2 (20.5-25.1)	2.8 (2.5-3.2)
	PA	162.4 (160.7-164.1)	1.2 (1.1-1.4)	15.9 (15.4-16.4)	39.9 (39.1-40.8)	2.1 (1.9-2.3)	2.4 (2.2-2.6)	25.3 (24.6-26.0)	2.0 (1.8-2.2)
	U.S.	158.7 (158.3-159.1)	1.5 (1.4-1.5)	14.6 (14.5-14.8)	43.8 (43.6-44.0)	2.1 (2.1-2.2)	2.3 (2.2-2.4)	23.9 (23.8-24.1)	2.1 (2.0-2.1)

[†] Mortality rate (deaths per 100,000) adjusted for age using the 2000 standard US population; 99% Confidence Interval. * Rural counties only. ¹ Significantly higher than the rate in Urban PA counties. ² Significantly higher than the rate in Rural U.S. counties. ³ Significantly higher than the rate in Rural Appalachia counties. ⁴ Significantly lower than the rate in Urban PA counties. ⁵ Significantly lower than the rate in Rural U.S. counties. ⁶ Significantly lower than the rate in Rural Appalachia counties.

Table 7: Age-adjusted Cancer Mortality Rates among Women in Rural Pennsylvania by Cancer Site and County, 2003-2007

County	All Cancers		Oral Cavity and Pharynx	Colon and Rectum	Lung and Bronchus	Melanoma of the Skin	Urinary Bladder	Breast	Uterine Cervix	
	Rate		Rate	Rate	Rate	Rate	Rate	Rate	Rate	
Adams	155.5		^	14.6	37.0 ⁵	^	^	24.2	^	
Armstrong	158.1		^	17.3	35.5 ⁵	^	^	25.0	^	
Bedford	150.1		^	20.7	29.5 ^{4,5,6}	^	^	28.8	^	
Blair	160.9		^	16.3	33.4 ^{4,5,6}	^	3.2 [†]	27.3	^	
Bradford	148.7		^	10.9 [*]	42.2	^	^	21.4	^	
Butler	155.8		^	17.1	35.2 ^{5,6}	^	2.8 [†]	29.3	2.7	†
Cambria	155.1		^	17.5	31.5 ^{4,5,6}	2.7 [†]	2.5 [†]	24.1	3.0	†
Cameron	146.5	[*]	^	^	^	^	^	^	^	
Carbon	178.8		^	18.0	37.4	^	^	29.3	^	
Centre	141.2	^{4,5,6,7}	^	13.4	33.5 ^{5,6}	^	^	19.2	^	
Clarion	162.8		^	18.9	28.3 ^{5,6}	^	^	31.0	^	
Clearfield	145.9	^{4,6}	^	18.2	36.1 ⁵	^	^	17.5 ^{4,7}	^	
Clinton	157.1		^	18.6	32.9	^	^	24.7	^	
Columbia	148.0		^	14.1	22.8 ^{4,5,6,7}	^	^	28.3	^	
Crawford	166.8		^	18.1	37.9	^	^	25.8	^	
Elk	178.0		^	17.8	42.7	^	^	27.1	^	
Fayette	164.9		^	15.0	41.4	^	2.3 [†]	25.5	3.5	†
Forest	135.5	[*]	^	^	^	^	^	^	^	
Franklin	142.6	^{4,5,6,7}	^	11.7 ^{4,6}	31.4 ^{4,5,6}	^	^	23.3	^	
Fulton	137.7	[*]	^	^	^	^	^	^	^	
Greene	176.3		0	14.0 [*]	40.9	^	^	28.9	^	
Huntingdon	135.2	^{4,6}	^	16.4 [†]	31.9 ⁵	0	^	15.9	^	
Indiana	141.0	^{4,5,6}	^	13.9	31.6 ^{4,5,6}	^	^	23.0	^	
Jefferson	149.8		^	15.0	36.7	^	^	18.8	^	
Juniata	134.0		^	19.0 [†]	^	^	^	25.0 [†]	^	
Lawrence	157.5		^	18.1	30.1 ^{4,5,6}	^	^	22.3	^	
Lycoming	159.1		^	15.6	42.1	^	2.8 [†]	23.8	^	
McKean	178.2		^	12.9 [*]	54.3 ⁰	^	^	24.3	^	
Mercer	162.0		^	13.9	35.6 ⁵	^	^	28.3	^	
Mifflin	162.8		^	14.4	36.8	^	^	24.7	^	
Monroe	167.5		^	17.3	42.4	^	^	27.8	^	
Montour	174.4	[*]	^	21.0 [†]	34.9 [*]	^	^	24.5 [†]	^	
Northumberland	158.4		^	12.9	36.2 ⁵	^	^	27.4	^	
Perry	189.8		^	20.5	41.2	^	^	33.8	^	
Pike	133.2	^{4,5,6,7}	^	13.4 [†]	34.6	^	^	22.7	^	
Potter	197.4	[*]	^	20.1 [†]	51.7 [*]	^	^	32.5 [†]	^	
Schuylkill	178.8	^{0,2}	^	19.0	38.1 ⁵	^	3.1 [*]	31.2 ^{2,3}	4.0	†
Snyder	150.1		^	22.2	32.9	^	^	21.6	^	
Somerset	151.5		^	16.8	26.3 ^{4,5,6,7}	^	^	22.7	^	
Sullivan	141.8	[*]	^	^	^	^	^	^	^	
Susquehanna	166.9		^	18.1	36.7	^	^	19.7	^	
Tioga	157.2		0	21.5	35.4	^	^	30.4	^	
Union	145.6		^	13.1 [†]	25.9 ^{4,5,6}	^	^	20.9	^	
Venango	150.2		0	11.4	43.9	^	^	28.0	^	
Warren	150.2		0	13.0 [*]	38.5	^	^	22.1	^	
Washington	172.6	⁰	^	14.1	45.6	2.2 [†]	2.3 [†]	27.4	^	
Wayne	192.5	^{0,1,2}	^	20.3	43.9	^	^	32.0	^	
Wyoming	160.9		^	^	42.2	^	^	25.6 [*]	^	

See notes under Table 3.

As shown in Table 6, for white, non-Hispanic males, Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural U.S. counties and Pennsylvania urban counties for all cancers combined (238.8), lung and bronchus (73.0), and melanoma (4.2). Pennsylvania rural county cancer mortality rates were also significantly lower as compared to rural Appalachian counties for lung and bronchus and for

melanoma. The Pennsylvania rural counties mortality rate for lung and bronchus and oral cavity and pharynx cancers (3.9) were significantly higher as compared to urban Pennsylvania counties.

For white, non-Hispanic females, Pennsylvania rural county cancer mortality rates were significantly lower as compared to rural Appalachian counties for all cancers combined (160.1), colon and rectum (15.8),

Table 8: Age-adjusted Cancer Mortality Rates among Men in Rural Pennsylvania by Cancer Site and County, 2003-2007

County	All cancers		Oral Cavity and Pharynx		Colon and Rectum		Lung and Bronchus		Melanoma of the Skin		Urinary Bladder		Prostate	
	Rate		Rate		Rate		Rate		Rate		Rate		Rate	
Adams	227.6	⁶	^		18.9		64.5	^{5,6}	^		7.2	†	23.6	
Armstrong	247.7		^		31.3		81.7		^		8.2	†	22.0	
Bedford	236.1		^		20.1		70.5	⁶	^		^		30.7	
Blair	260.8	⁰	4.4	†	22.8		84.8	^{0,1}	^		13.8	^{0,1,2,3}	24.8	
Bradford	229.0		^		15.1		65.1	⁶	^		^		31.7	
Butler	228.6	⁶	^		22.6		66.8	^{5,6}	3.3	†	7.3		23.5	
Cambria	237.5	⁶	5.3	*	25.9		71.0	⁶	^		6.7		22.1	
Cameron	277.1	[*]	^		^		^		^		^		^	
Carbon	270.1	⁰	^		27.8		74.7		^		15.9	^{0,1,2,3}	22.3	
Centre	201.4	^{4,5,6,7}	^		17.4		61.8	^{5,6}	5.3	†	^		22.2	
Clarion	232.0		^		32.3		72.9		^		^		23.9	*
Clearfield	239.7		^		22.4		73.5	⁶	^		10.0	*	23.6	
Clinton	265.4		^		39.6	^{0,1,2,3}	71.6		^		^		26.3	*
Columbia	250.4		^		30.1		88.7	¹	^		10.6	†	23.5	
Crawford	247.4		^		21.0		81.6		^		10.0	*	26.8	
Elk	229.4		^		23.7	*	63.1	⁶	^		^		28.5	*
Fayette	245.7		4.7	*	22.7		82.2		^		6.5		17.3	^{4,5,6,7}
Forest	227.2	[*]	^		^		^		^		^		^	
Franklin	215.7	^{4,5,6,7}	^		22.7		69.2	⁶	4.3	†	5.6	†	19.0	
Fulton	229.5	[*]	^		^		70.2	[*]	^		^		^	
Greene	241.6		^		21.5	†	77.7		^		^		^	
Huntingdon	245.0		^		22.0	*	74.5		^		^		27.6	
Indiana	204.9	^{4,5,6,7}	^		21.3		57.4	^{5,6,7}	^		6.7	†	20.1	
Jefferson	213.6	⁶	^		32.9		58.6	^{5,6}	^		^		16.1	^{*,4,5}
Juniata	204.5	⁶	^		35.2	*	59.4	⁶	^		^		^	
Lawrence	272.0	^{0,1,2}	^		24.5		80.4		5.0	*	9.3		30.3	
Lycoming	230.7	⁶	^		19.2		66.6	^{5,6}	^		9.3		29.0	
McKean	270.2		^		29.6		78.0		^		12.2	†	26.2	
Mercer	236.5	⁶	4.2	†	19.2		72.1	⁶	5.0	†	6.6	*	20.9	
Mifflin	230.1		^		26.3		69.5	⁶	^		11.0	†	20.9	*
Monroe	240.6		^		18.3		76.8	⁶	5.9	*	7.3		25.9	
Montour	284.3	[*]	^		^		95.4	[*]	^		^		^	
Northumberland	241.1		^		29.3		69.3	⁶	^		9.3		20.0	
Perry	240.5		^		33.0		70.0		^		^		18.6	†
Pike	223.0	⁶	^		15.7	*	66.7	⁶	^		^		28.6	
Potter	246.7	[*]	^		29.1	†	92.0	[*]	^		^		^	
Schuylkill	249.6		5.8		26.5		80.0	⁶	4.6	*	6.3		26.9	
Snyder	209.1	⁶	^		24.8	*	58.0	⁶	^		^		25.9	*
Somerset	227.7	⁶	^		20.7		69.6	⁶	^		6.6	†	23.4	
Sullivan	245.7	[*]	^		^		^		^		^		^	
Susquehanna	247.4		^		24.3		63.0	⁶	^		^		38.7	^{0,3}
Tioga	235.0		^		19.1	*	75.0		^		^		25.0	
Union	185.7	^{4,5,6,7}	^		15.0	† ^{4,5,6,7}	48.0	^{4,5,6,7}	^		^		24.7	*
Venango	251.5		^		18.7		88.8		^		10.4	†	17.6	*
Warren	211.3	⁶	^		17.2	*	60.1	⁶	^		^		24.8	
Washington	235.9	⁶	5.5		23.2		74.5	⁶	4.3		9.7		22.4	
Wayne	249.6		^		32.0	*	72.0	⁶	^		11.9	†	30.8	
Wyoming	237.7		^		32.8	*	60.7	⁶	^		^		30.7	†

See notes under Table 3.

lung and bronchus (36.7), melanoma (1.9), and uterine cervix (2.2). Pennsylvania rural counties had a significantly lower all cancer sites mortality rate and lung and bronchus mortality rate as compared to urban Pennsylvania counties. Lastly, Pennsylvania rural counties breast cancer mortality rate (25.7) was significantly higher as compared to rural U.S. counties and rural Appalachian counties.

In examining whether mortality rates were significantly higher for specific rural Pennsylvania counties, Z-score calculations were conducted for each gender

across each commonwealth county, and compared to all rural Pennsylvania and urban Pennsylvania counties, all rural Appalachian counties, and rural U.S. counties that participated in the study. Tables 7 and 8 provide a summary of these analyses. It should be noted that a number of these calculations could not be conducted due to cancer registry data suppression because of small counts in mortality, even when data for a 10-year period were examined. For women, rural Pennsylvania county level rates were not available for oral cavity and pharynx, melanoma, urinary bladder, and uterine cervix.

Table 9: Distribution of Cancer Cases by Stage at Diagnosis and Place of Residence, Women of All Races, 2004-2008

Site and Stage	Rural PA		Urban PA			Rural US		Rural Appalachia			
	No.	%	No.	%	p*	No.	%	p	No.	%	p
All Cancers Combined											
Total	47119		123105			492236			118103		
In-situ	684	1.5%	1630	1.3%		6210	1.3%		1563	1.3%	
Local	21451	45.5%	56545	45.9%		223981	45.5%		53669	45.4%	
Regional	9288	19.7%	24377	19.8%		96403	19.6%		22580	19.1%	
Distant	11076	23.5%	29060	23.6%		114622	23.3%		27608	23.4%	
Unknown	4620	9.8%	11493	9.3%	0.009	51020	10.4%	0.0001	12153	10.3%	0.0011
Oral Cavity and Pharynx											
Total	644		1538			6969			1709		
In-situ	0		0			0			0		
Local	317	49.2%	664	43.2%		3137	45.0%		793	46.4%	
Regional	191	29.7%	465	30.2%		2040	29.3%		510	29.8%	
Distant	95	14.8%	283	18.4%		1042	15.0%		257	15.0%	
Unknown	41	6.4%	126	8.2%	0.027	750	10.8%	0.004	149	8.7%	0.2587
Colon and Rectum											
Total	5276		12894			51315			12629		
In-situ	0		0			0			0		
Local	2409	45.7%	5836	45.3%		23015	44.9%		5743	45.5%	
Regional	1392	26.4%	3431	26.6%		13435	26.2%		3340	26.4%	
Distant	1038	19.7%	2576	20.0%		10331	20.1%		2472	19.6%	
Unknown	437	8.3%	1051	8.2%	0.928	4534	8.8%	0.4014	1074	8.5%	0.9658
Lung and Bronchus											
Total	5936		16477			71543			17557		
In-situ	0		0			0			0		
Local	1179	19.9%	3240	19.7%		15200	21.2%		3705	21.1%	
Regional	1040	17.5%	2818	17.1%		12476	17.4%		3090	17.6%	
Distant	3118	52.5%	8832	53.6%		35980	50.3%		8879	50.6%	
Unknown	599	10.1%	1587	9.6%	0.49	7887	11.0%	0.002	1883	10.7%	0.0401
Melanoma											
Total	1620		3884			18286			4430		
In-situ	0		0			0			0		
Local	1325	81.8%	3038	78.2%		14717	80.5%		3572	80.6%	
Regional	143	8.8%	333	8.6%		1316	7.2%		360	8.1%	
Distant	44	2.7%	138	3.6%		609	3.3%		146	3.3%	
Unknown	108	6.7%	375	9.7%	0.001	1644	9.0%	0.0009	352	7.9%	0.1936
Breast											
Total	12613		34275			137469			31569		
In-situ	0		0			0			0		
Local	7958	63.1%	21990	64.2%		86653	63.0%		19704	62.4%	
Regional	3352	26.6%	8907	26.0%		37137	27.0%		8576	27.2%	
Distant	840	6.7%	2253	6.6%		8059	5.9%		1939	6.1%	
Unknown	463	3.7%	1125	3.3%	0.07	5620	4.1%	0.0004	1350	4.3%	0.0033
Uterine Cervix											
Total	693		1803			8531			1983		
In-situ	0		0			0			0		
Local	333	48.1%	830	46.0%		4070	47.7%		970	48.9%	
Regional	229	33.0%	591	32.8%		2571	30.1%		608	30.7%	
Distant	100	14.4%	263	14.6%		1235	14.5%		300	15.1%	
Unknown	31	4.5%	119	6.6%	0.238	655	7.7%	0.0138	105	5.3%	0.6016
Urinary Bladder											
Total	1391		3386			13123			3205		
In-situ	684	49.2%	1630	48.1%		6210	47.3%		1563	48.8%	
Local	489	35.2%	1190	35.1%		4829	36.8%		1108	34.6%	
Regional	70	5.0%	200	5.9%		751	5.7%		192	6.0%	
Distant	73	5.2%	181	5.3%		574	4.4%		149	4.6%	
Unknown	75	5.4%	185	5.5%	0.813	759	5.8%	0.2499	193	6.0%	0.546

* p-value for the Chi-square test compared to rural Pennsylvania.

For men, rural Pennsylvania county level data were not available for oral cavity and pharynx, melanoma, and for many counties, urinary bladder cancer.

When looking at cancer mortality rates in women, Schuylkill and Wayne counties had significantly higher rates for all cancers combined as compared to other rural Pennsylvania counties and urban Pennsylvania counties. For Wayne County, the rate for all cancers combined was also significantly higher as compared to other rural U.S. counties. There were no significant

differences in the colon rectum cancers in relation to the comparison groups. Only McKean County had a higher lung and bronchus mortality rate, which was significantly higher than other rural Pennsylvania counties. Only Schuylkill County had a breast cancer mortality rate that was significantly higher than rural U.S. counties, and rural Appalachia.

When looking at cancer mortality rates in men, Blair, Carbon, and Lawrence counties had significantly higher rates for all cancers combined when compared to other rural Pennsylvania counties. In addition, Lawrence County also had a significantly higher rate for all cancers combined when compared to urban Pennsylvania counties, and rural U.S. counties. Clinton County had a significantly higher colon rectum cancer mortality rate as compared to rural and urban Pennsylvania counties, rural U.S. counties, and rural Appalachia. Blair and Columbia counties had significantly higher lung bronchus mortality rates. Blair County's rate was significantly higher than those in rural and urban Pennsylvania counties. Columbia County's rate was significantly higher than

those in urban Pennsylvania counties. While there was a lot of missing data, both Blair and Carbon counties had significantly higher urinary bladder mortality rates when compared to rural and urban Pennsylvania counties, rural U.S. counties, and rural Appalachia. Only Susquehanna County had a significantly higher prostate cancer mortality rate, which was higher than those in other rural Pennsylvania counties and rural Appalachia.

The researchers used a number of independent variables to determine their influence on the incidence and

Table 10: Distribution of Cancer Cases by Stage at Diagnosis and Place of Residence, White Non-Hispanic Women, 2004-2008

Site and Stage	Rural PA		Urban PA			Rural US			Rural Appalachia		
	No.	%	No.	%	p*	No.	%	p	No.	%	p
All Cancers Combined											
Total	45781		104833			439420			113776		
In-situ	671	1.5%	1499	1.4%		5859	1.3%		1533	1.3%	
Local	20838	45.5%	48954	46.7%		201817	45.9%		51819	45.5%	
Regional	9023	19.7%	20501	19.6%		85145	19.4%		22202	19.5%	
Distant	10775	23.5%	24275	23.2%		101953	23.2%		26596	23.4%	
Unknown	4474	9.8%	9604	9.2%	0.000	44646	10.2%	0.002	11626	10.2%	0.030
Oral Cavity and Pharynx											
Total	623		1311			6279			1645		
In-situ	0		0			0			0		
Local	304	48.8%	579	44.2%		2853	45.4%		763	46.4%	
Regional	185	29.7%	405	30.9%		1863	29.7%		493	30.0%	
Distant	93	14.9%	226	17.2%		910	14.5%		244	14.8%	
Unknown	41	6.6%	101	7.7%	0.233	653	10.4%	0.021	145	8.8%	0.345
Colon and Rectum											
Total	5146		10985			45355			12144		
In-situ	0		0			0			0		
Local	2363	45.9%	4995	45.5%		20559	45.3%		5554	45.7%	
Regional	1353	26.3%	2960	26.9%		11891	26.2%		3210	26.4%	
Distant	1005	19.5%	2147	19.5%		8954	19.7%		2364	19.5%	
Unknown	425	8.3%	883	8.0%	0.819	3951	8.7%	0.668	1016	8.4%	0.990
Lung and Bronchus											
Total	5796		14041			66134			17069		
In-situ	0		0			0			0		
Local	1146	19.8%	2825	20.1%		14154	21.4%		3607	21.1%	
Regional	1012	17.5%	2412	17.2%		11539	17.4%		2996	17.6%	
Distant	3047	52.6%	7415	52.8%		33185	50.2%		8638	50.6%	
Unknown	591	10.2%	1389	9.9%	0.83	7256	11.0%	0.001	1828	10.7%	0.042
Melanoma											
Total	1556		3575			17343			4285		
In-situ	0		0			0			0		
Local	1269	81.6%	2828	79.1%		13983	80.6%		3454	80.6%	
Regional	142	9.1%	311	8.7%		1266	7.3%		352	8.2%	
Distant	44	2.8%	130	3.6%		580	3.3%		144	3.4%	
Unknown	101	6.5%	306	8.6%	0.030	1514	8.7%	0.001	335	7.8%	0.176
Breast											
Total	12253		29162			122478			30407		
In-situ	0		0			0			0		
Local	7754	63.3%	19074	65.4%		78438	64.0%		19063	62.7%	
Regional	3242	26.5%	7373	25.3%		32380	26.4%		8212	27.0%	
Distant	817	6.7%	1790	6.1%		6838	5.6%		1871	6.2%	
Unknown	440	3.6%	925	3.2%	0.000	4822	3.9%	0.000	1261	4.1%	0.008
Uterine Cervix											
Total	661		1280			6746			1850		
In-situ	0		0			0			0		
Local	311	47.0%	614	48.0%		3272	48.5%		906	49.0%	
Regional	222	33.6%	403	31.5%		2022	30.0%		565	30.5%	
Distant	98	14.8%	190	14.8%		966	14.3%		279	15.1%	
Unknown	30	4.5%	73	5.7%	0.617	486	7.2%	0.028	100	5.4%	0.468
Urinary Bladder											
Total	1369		3047			12191			3127		
In-situ	671	49.0%	1499	49.2%		5859	48.1%		1533	49.0%	
Local	483	35.3%	1067	35.0%		4459	36.6%		1077	34.4%	
Regional	69	5.0%	168	5.5%		671	5.5%		181	5.8%	
Distant	72	5.3%	153	5.0%		517	4.2%		146	4.7%	
Unknown	74	5.4%	160	5.3%	0.967	685	5.6%	0.364	190	6.1%	0.633

* p-value for the Chi-square test compared to rural Pennsylvania.

mortality rates for the cancers of focus. Due to the large number of analyses, the likelihood of obtaining a statistically significant finding by chance was a concern. To correct for this, a Bonferroni correction formula was applied to determine which *p*-values of the regression models were to be deemed significant. With this correction, only regression models with *p*-values at .0017 or lower were considered to be statistically significant.

The independent variables (measured at the county level) used in the regression analyses included: region (rural Pennsylvania, urban Pennsylvania, rural U.S., and rural Appalachia); primary care physician (PCP)

rate (analysis was done for Pennsylvania counties only); educational attainment in 2000; unemployment rate in 2000; unemployment rate in 2005; and median household income in 2000. The dependent variables were incidence (2004-2008) and mortality (2003-2007) rates for all cancer combined, colorectal cancer, lung and bronchus cancer, melanoma, oral cavity and pharynx, prostate cancer, and urinary bladder cancer. In addition, these analyses were also conducted by gender, and by race (all races combined vs. white, non-Hispanic). Analyses looking at further racial breakdowns were not possible due to low counts and data suppression of cancer rates by the cancer registries.

According to the findings, two independent variables were repeatedly predictive of numerous cancer incidence and mortality rates; county level median household income in 2000 and educational attainment in 2000. While a separate

T-test revealed a significant difference in the mean primary care physician rate of urban (mean= 120.2) versus rural (mean= 82.4) counties ($T= 2.0$; $p = .048$), the primary care physician rate was not a significant factor in neither cancer incidence nor mortality for Pennsylvania. On a few occasions, county level unemployment rates (in 2000 and/or 2005) were also found to be a significant factor.

Overall, of the 1,679 counties included in this study, those with the highest cancer incidence and/or mortality rates tended to have a pattern of having the lowest median household incomes, and lowest educational attainment levels.

Table 11: Distribution of Cancer Cases by Stage at Diagnosis and Place of Residence, Men of All Races, 2004-2008

Site and Stage	Rural PA		Urban PA			Rural U.S.		Rural Appalachia			
	No.	%	No.	%	p*	No.	%	p	No.	%	p
All Cancers Combined											
Total	52174		125630			562549			135461		
In-situ	2107	4.0%	5077	4.0%		19716	3.5%		4935	3.6%	
Local	24617	47.2%	59615	47.5%		266767	47.4%		63676	47.0%	
Regional	7169	13.7%	18070	14.4%		78156	13.9%		18805	13.9%	
Distant	12984	24.9%	30467	24.3%		137265	24.4%		33673	24.9%	
Unknown	5297	10.2%	12401	9.9%	0.0004	60645	10.8%	0.0000	14372	10.6%	0.0001
Oral Cavity and Pharynx											
Total	1311		3049			15447			3804		
In-situ	0		0			0			0		
Local	454	34.6%	971	31.8%		5490	35.5%		1384	36.4%	
Regional	466	35.5%	1180	38.7%		5389	34.9%		1316	34.6%	
Distant	291	22.2%	676	22.2%		3157	20.4%		809	21.3%	
Unknown	100	7.6%	222	7.3%	0.1917	1411	9.1%	0.1516	295	7.8%	0.6826
Colon and Rectum											
Total	5387		12191			55338			13407		
In-situ	0		0			0			0		
Local	2554	47.4%	5672	46.5%		25500	46.1%		6217	46.4%	
Regional	1356	25.2%	3153	25.9%		14136	25.5%		3483	26.0%	
Distant	1065	19.8%	2525	20.7%		11294	20.4%		2688	20.0%	
Unknown	412	7.6%	841	6.9%	0.1171	4408	8.0%	0.2889	1019	7.6%	0.5676
Lung and Bronchus											
Total	7920		18303			93387			24312		
In-situ	0		0			0			0		
Local	1199	15.1%	3021	16.5%		16791	18.0%		4361	17.9%	
Regional	1334	16.8%	3081	16.8%		15813	16.9%		4149	17.1%	
Distant	4542	57.3%	10494	57.3%		50679	54.3%		13138	54.0%	
Unknown	845	10.7%	1707	9.3%	0.0008	10104	10.8%	0.0000	2664	11.0%	0.0000
Melanoma											
Total	1986		4873			24276			5704		
In-situ	0		0			0			0		
Local	1492	75.1%	3585	73.6%		18578	76.5%		4405	77.2%	
Regional	221	11.1%	518	10.6%		2112	8.7%		530	9.3%	
Distant	119	6.0%	274	5.6%		1371	5.6%		321	5.6%	
Unknown	154	7.8%	496	10.2%	0.0197	2215	9.1%	0.0008	448	7.9%	0.0982
Prostate											
Total	15074		36130			160201			37238		
In-situ	0		0			4			0		
Local	12252	81.3%	28893	80.0%		127983	79.9%		30105	80.8%	
Regional	1183	7.8%	3087	8.5%		13767	8.6%		2843	7.6%	
Distant	609	4.0%	1418	3.9%		6150	3.8%		1450	3.9%	
Unknown	1030	6.8%	2732	7.6%	0.0009	12297	7.7%	0.0000	2840	7.6%	0.0141
Urinary Bladder											
Total	4269		9808			40038			10013		
In-situ	2107		5077			19712			4935		
Local	1592	37.3%	3498	35.7%		15049	37.6%		3750	37.5%	
Regional	229	5.4%	510	5.2%		2104	5.3%		552	5.5%	
Distant	136	3.2%	316	3.2%		1299	3.2%		317	3.2%	
Unknown	205	4.8%	407	4.1%	0.0709	1874	4.7%	0.9863	459	4.6%	0.9778

* p-value for the Chi-square test compared to rural Pennsylvania.

Cancer Staging Comparisons

Generally speaking, 5-year cancer survival rates were much higher for those who had been diagnosed in the earlier stages of cancer. For those diagnosed with Stage 3 (regional) or Stage 4 (distant) cancer, 5-year survival rates were lower. Chi-Square analyses were conducted across both genders for all races, and for white, non-Hispanics to see if the staging data for rural Pennsylvania counties were significantly different as compared to the comparison counties.

For women, numerous statistically significant Chi-Squares were found; however, most of these significant

findings were due to differences in the percentage of “unknown” stage, and not due to differences in actual staging diagnosis. Across all cancers, the percentages for early stage (in-situ and local) and later stage (regional and distant) diagnoses for women of all races, and for women who were white, non-Hispanic were relatively similar across the four groups. The percentage of distant stage diagnosis of lung and bronchus cancer was slightly higher in rural Pennsylvania counties as compared to rural U.S. counties and rural Appalachia. The percentage for later stage diagnosis of melanoma in rural Pennsylvania counties was slightly lower when compared to the other groups. The percentage of distant stage diagnosis for breast cancer was slightly higher for women in rural Pennsylvania counties as compared to rural U.S. counties and rural Appalachia (See Tables 9 and 10).

For men, a similar pattern of numerous statistically significant Chi-Squares were found. Most of these significant findings were due to differences in the percentage of

“unknown” stage, and not due to differences in actual staging diagnosis. Across all cancers, the percentages for early stage (in-situ and local) and later stage (regional and distant) diagnoses for men of all races, and for men who were white, non-Hispanic were relatively similar across the four groups. Similar to women, for men who were white, non-Hispanic, the percentage of distant stage diagnosis of lung and bronchus cancer was slightly higher in rural Pennsylvania counties as compared to urban Pennsylvania counties, rural U.S. counties, and rural Appalachia. The percentage for later stage diagnoses of melanoma in rural Pennsylvania counties was slightly higher when compared to

rural U.S. counties and rural Appalachia counties. The percentage of distant stage diagnosis for prostate cancer was slightly higher for men in rural Pennsylvania counties as compared to urban Pennsylvania counties, rural U.S. counties, and rural Appalachia (See Tables 11 and 12).

Trend Analyses

Trend analyses were conducted to determine if there were significant increases across the 10-year period (1999-2008) in the incidence rates for all cancers combined, breast, colorectal, lung, and prostate cancers. Trend analyses for the other cancers of focus could not be completed because of data suppression. Please note that the analyses determined whether there was a significant increase or decrease in the rate over time, and not whether the specific rate was higher or lower than the state average.

The findings indicated that trends in cancer incidence have been, for the most part, stable or decreasing in many rural Pennsylvania counties. This pattern mirrored what was occurring nationally.

Colorectal cancer has significantly decreased within Pennsylvania as a whole.

Lawrence, Lycoming, Tioga and Warren counties witnessed a significant percentage increase in incidence rates for all cancers combined. Warren County witnessed a significant increase in prostate cancer during the 10-year time frame.

Trend analyses were also conducted to determine if there were significant increases across the 10-year period (1998-2007) in the mortality incidence rates for all cancers combined, breast, colorectal, lung, and prostate cancers. Trend analyses for the other cancers of focus could not be done due to data suppression. Please note the analyses determined whether there was a signifi-

Table 12: Distribution of Cancer Cases by Stage at Diagnosis and Place of Residence, White Non-Hispanic Men, 2004-2008

Site and Stage	Rural PA		Urban PA			Rural US			Rural Appalachia		
	No.	%	No.	%	p*	No.	%	p	No.	%	p
All Cancers Combined											
Total	50409		105564			498692			129702		
In-situ	2073	4.1%	4737	4.5%		18730	3.8%		4848	3.7%	
Local	23706	47.0%	50217	47.6%		236235	47.4%		60738	46.8%	
Regional	6951	13.8%	15474	14.7%		69944	14.0%		18079	13.9%	
Distant	12628	25.1%	25455	24.1%		121316	24.3%		32362	25.0%	
Unknown	5051	10.0%	9681	9.2%	0.0000	52467	10.5%	0.0000	13675	10.5%	0.0001
Oral Cavity and Pharynx											
Total	1271		2596			13886			3648		
In-situ	0		0			0			0		
Local	444	34.9%	858	33.1%		5072	36.5%		1337	36.7%	
Regional	455	35.8%	1030	39.7%		4877	35.1%		1266	34.7%	
Distant	276	21.7%	522	20.1%		2698	19.4%		761	20.9%	
Unknown	96	7.6%	186	7.2%	0.1396	1239	8.9%	0.0880	284	7.8%	0.6863
Colon and Rectum											
Total	5248		10403			48970			12940		
In-situ	0		0			0			0		
Local	2494	47.5%	4892	47.0%		22787	46.5%		6001	46.4%	
Regional	1317	25.1%	2728	26.2%		12598	25.7%		3362	26.0%	
Distant	1045	19.9%	2096	20.1%		9823	20.1%		2597	20.1%	
Unknown	392	7.5%	687	6.6%	0.1224	3762	7.7%	0.5595	980	7.6%	0.5141
Lung and Bronchus											
Total	7720		15679			84405			23485		
In-situ	0		0			0			0		
Local	1171	15.2%	2671	17.0%		15359	18.2%		4198	17.9%	
Regional	1297	16.8%	2687	17.1%		14420	17.1%		4015	17.1%	
Distant	4423	57.3%	8853	56.5%		45529	53.9%		12694	54.1%	
Unknown	829	10.7%	1468	9.4%	0.0001	9097	10.8%	0.0000	2578	11.0%	0.0000
Melanoma											
Total	1922		4543			23297			5555		
In-situ	0		0			0			0		
Local	1440	74.9%	3368	74.1%		17832	76.5%		4279	77.0%	
Regional	217	11.3%	507	11.2%		2061	8.8%		523	9.4%	
Distant	119	6.2%	264	5.8%		1329	5.7%		318	5.7%	
Unknown	146	7.6%	404	8.9%	0.3718	2075	8.9%	0.0009	435	7.8%	0.0882
Prostate											
Total	14360		28579			137527			35047		
In-situ	0		0			4			0		
Local	11690	81.4%	23364	81.8%		110283	80.2%		28356	80.9%	
Regional	1140	7.9%	2532	8.9%		12121	8.8%		2699	7.7%	
Distant	588	4.1%	1046	3.7%		5115	3.7%		1360	3.9%	
Unknown	942	6.6%	1637	5.7%	0.0000	10004	7.3%	0.0000	2632	7.5%	0.0019
Urinary Bladder											
Total	4203		9067			37850			9828		
In-situ	2073	49.3%	4737	52.2%		18726	49.5%		4848	49.3%	
Local	1572	37.4%	3236	35.7%		14233	37.6%		3687	37.5%	
Regional	227	5.4%	469	5.2%		1967	5.2%		541	5.5%	
Distant	134	3.2%	274	3.0%		1210	3.2%		312	3.2%	
Unknown	197	4.7%	351	3.9%	0.0154	1714	4.5%	0.9662	440	4.5%	0.9859

* p-value for the Chi-square test compared to rural Pennsylvania.

cant increase or decrease in the rate over time, and not whether the specific rate was higher or lower than the state average.

According to the analyses, trends in cancer mortality have been stable or decreasing in many rural Pennsylvania counties. This pattern mirrored what was occurring nationally. There have been significant decreases in the mortality rate trends for all cancers combined, colorectal cancer, breast cancer, lung cancer, and prostate cancer within Pennsylvania as a whole. Franklin and Monroe counties witnessed a significant percentage decrease in the 10-year trends for mortality rates in all cancers combined.

Conclusions

Pennsylvania ranks 8th out of all states in cancer incidence rates. Overall cancer incidence in men and women in rural Pennsylvania was significantly higher when compared to other rural counties throughout the U.S. Specific cancers on which to focus prevention efforts include colorectal cancer and urinary bladder cancer for both genders. Gender specific cancers that need attention include prostate cancer for men, and breast cancer for women.

In terms of mortality rates, Pennsylvania ranks 17th out of all states in cancer mortality rates. Overall cancer mortality within rural Pennsylvania counties is either on par, or significantly better, when compared to urban Pennsylvania counties, rural U.S. counties, or rural Appalachia. However, this is not true for breast cancer mortality. More efforts are needed to improve breast cancer mortality within rural Pennsylvania counties as the rate is significantly higher when compared to rural U.S. counties, and rural Appalachia.

In the cancer staging comparisons, the researchers found a number of statistically significant findings. One common pattern across gender and race was found in the lung and bronchus staging data. When compared to rural Appalachia and rural U.S. counties, rural Pennsylvania county lung and bronchus cancer rates were more likely to be late stage (about 53 percent distant stage among women and 57 percent distant stage among men) diagnosis. This finding was statistically significant for both males and females of all races, and for males and females who were white, non-Hispanic.

Gender specific significant findings included women of all races, and those who are white, non-Hispanic within rural Pennsylvania counties being diagnosed with late stage (7 percent distant) breast cancer as compared to rural Appalachia and rural U.S. counties. Another gender specific finding was men of all races, and men who are white, non-Hispanic within rural Pennsylvania counties being diagnosed with late stage melanoma (6.0 to 6.2 percent distant) as compared to rural Appalachia and rural U.S. counties. Lastly, men who are white, non-Hispanic within rural Pennsylvania counties were significantly more likely to be diagnosed with late stage prostate cancer (4 percent distant) as compared to urban Pennsylvania counties and rural U.S. counties.

Across all cancers of focus in this study, no significant percentage increases were noted in cancer incidence and/or mortality within the 10-year study period. In many cases, there was a significant decrease

in cancer incidence, which paralleled the national trend. Overall, Pennsylvania saw no notable change in cancer incidence and a 1 percent decrease in cancer mortality during 1999-2008. Colorectal cancer had the greatest decrease in incidence rates at -2.4 percent in the 10-year period. Regarding mortality rates, colorectal (-3.0 percent), prostate (-2.1 percent), and breast (-2.1 percent) all had significant decreases in the 10-year period.

Cancer Incidence and Mortality for Rural Pennsylvania Counties by Health District

The following presents the rural Pennsylvania county specific cancer incidence and mortality findings based on existing health districts in Pennsylvania.

Northwest District

There were no significant differences in cancer incidence or mortality rates for Cameron, Clearfield, Elk, and Venango counties. Forest County had the highest incidence rate for breast cancer in women. Jefferson County had the highest incidence rate for melanoma in women. Lawrence County had the 2nd highest incidence rate and the highest mortality rate for all cancers combined in men. McKean County had the highest incidence rate for lung and bronchus cancer in women. Mercer County had the 3rd highest incidence rate for all cancers combined in men and the 2nd highest prostate cancer incidence rate in men. Warren County had the highest cancer incidence rate for all cancer sites combined and the highest prostate cancer incidence rate in men.

North Central District

There were no significant differences in cancer incidence or mortality rates for Bradford, Centre, Lycoming, Montour, Northumberland, Potter, Snyder, Sullivan, and Tioga counties. Clinton County had the highest colorectal cancer mortality rate in men. Columbia County had the 2nd highest lung and bronchus mortality rate in men, and Union County had the 4th highest prostate cancer incidence rate in men.

Northeast District

There were no significant differences in cancer incidence or mortality rates for Pike and Wyoming counties. Carbon County had the 2nd highest mortality rate in men for all cancers combined, along with the highest urinary bladder cancer mortality rate in men. Susquehanna County had the highest mortality rate for prostate cancer in men, and Wayne County had the highest mortality rate for all cancers combined in women.

Southwest District

There were no significant differences in cancer incidence or mortality rates for Armstrong, Green, and Indiana counties. Fayette County had the 3rd highest lung and bronchus cancer incidence rate for women, and the 2nd highest lung and bronchus cancer incidence rate for men. Washington County had the 4th highest cancer incidence rate for all cancers combined in women.

South Central District

There were no significant differences in cancer incidence or mortality rates for Adams, Fulton, Huntingdon, Juniata, Mifflin, and Perry counties. Bedford

County had the 3rd highest incidence rate in melanoma in women. Blair County had the 3rd highest mortality rate for all cancers combined in men. Franklin County had the 4th highest incidence rate in melanoma in women. This region has a few counties with high melanoma incidence rates in women.

Southeast District

The southeast district consists of highly populated urban counties with the exception of Schuylkill County. Schuylkill County had the 2nd highest colorectal cancer incidence rate and the 2nd highest incidence rate for urinary bladder cancer in women.

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