Urban/Rural Disparities in Cancer Incidence in New York State, 2008-2012

Timothy J. Conwell,[a,b] Francis P. Boscoe[b]

a: Grinnell College, 1115 8th Ave, Grinnell, IA 50112, USA
conwellt@grinnell.edu

b: New York State Cancer Registry, 150 Broadway, Suite 361, Albany, NY 12204, USA
francis.boscoe@health.ny.gov

Corresponding Author: Francis P. Boscoe[b]

Keywords: urban/rural, cancer disparities, liver, prostate, thyroid, poisson regression

PeerJ PrePrints | https://dx.doi.org/10.7287/peerj.preprints.1224v1 | CC-BY 4.0 Open Access | rec: 9 Jul 2015, publ: 9 Jul 2015

Urban/Rural Disparities in Cancer Incidence in New York State, 2008-2012

Abstract

We measured urban/rural disparities in cancer incidence in New York State using a data set with more than 500,000 tumors diagnosed among New York State residents between 2008-2012 geocoded to the census tract level. Using poisson regression, we computed the site and stage-specific relative risks of cancer by level of urbanicity after adjustment for age, sex, socioeconomic status and race/ethnicity. 18 of the 23 cancer sites analyzed showed some form of significant association between cancer incidence and urbanicity, although the risk differences were generally small. Differences in risk of 50% or more were seen for stomach, liver, distant-stage uterine, and thyroid cancers (each higher in New York City than in rural areas); esophagus, distant-stage kidney, and distant-stage lung (each lower in New York City than in rural areas); and distant-stage prostate cancer (higher in rural areas).

1. Introduction

The identification and measurement of cancer disparities between urban and rural residents is a fundamental aspect of cancer surveillance. Such disparities defy easy summary as they tend to be spatially and temporally dynamic and can vary greatly between anatomic cancer sites. Studies within the United States have had quite mixed results, though a presumption of rural disadvantage persists [1]. This is based on the idea that rural residents have less access to medical care, because there is less supply and travel barriers are greater [2]. However, a 2009 Illinois-based study suggested the possibility of a “rural reversal”, finding that risks were greatest in urban Chicago for late-stage breast, colorectal, lung, and prostate cancers [3]. The authors hypothesized that this may reflect poorer adherence to screening protocols among urban residents, although studies have generally found lower screening rates among rural residents [4].

Studies since 2009 have continued to yield mixed findings. Those that have found elevated risks among rural residents included Jemal et al., who reported an increased risk of late stage prostate cancer and prostate cancer mortality in nonmetropolitan areas of the U.S. [5], and Hines and Markossian, who found an increased risk of death for colon cancer among rural residents in Georgia [6]. A meta-analysis by Nguyen-Pham et al. found that rural breast cancer patients had higher odds of late stage breast cancer than urban patients [7], and Singh et al. found a higher risk of cancer mortality in both urban non-metropolitan and rural counties for five cancer sites and all cancers combined [8].

In contrast, other studies have reported neutral findings with no advantage to either urban or rural residents.Parikh-Patel et al. reported no significant difference in stage of diagnosis for colorectal cancer by urban/rural residence [9], and Blair et al. repeated this finding, also extending it to breast cancer and melanoma [10]. A meta-analysis by Obertova et al. identified multiple studies where prostate cancer incidence was better, worse, and about the same in urban versus rural locations [11].

These studies are not necessarily contradictory insofar as they considered different outcomes, sites of cancer, stages at diagnosis, time points, and geographical areas. They also used, in some

cases, differing definitions of the urban-rural continuum and adjusted for different confounding variables in different ways. More crucially, they have most often been conducted at the county scale, even though many counties contain a mixture of urban, suburban and rural portions, making the assignment of a single county-level urban/rural descriptor problematic. They also have tended to focus on only the most common cancer sites of prostate, breast, lung, and colorectal. Notably, the differences in risk that have been identified in these studies have most often been in the 10 percent to 20 percent range. While this constitutes a statistically significant difference in a typical state or national study, it is not an amount that lends itself to clear public health responses.

The present study aims to further the investigation of urban/rural disparities in cancer incidence by making use of data from a large state with a distinct urban/rural gradient (New York) at a fine geographic resolution (census tract) and for a wider range of cancer sites than has previously been studied (23 in total), while also taking stage at diagnosis into consideration.

2. Materials/Methods

We identified all reportable malignant tumors among New York State residents diagnosed between 2008 and 2012 from the New York State Cancer Registry. The New York State Cancer Registry has been a North American Association of Central Cancer Registries (NAACCR) gold-certified registry since the year 2000 and was named as one of 19 Registries of Excellence by the Centers for Disease Control and Prevention (CDC) in 2015. For the site-specific analysis, the tumors were restricted to the 23 most common anatomic cancer sites that together account for 92% of all cancer incidences in New York. We categorized each tumor by anatomic site, sex, and the census tract of residence at diagnosis. Census tracts are relatively permanent subdivisions of about 4,000 people designed to be relatively homogeneous with respect to population characteristics at the time of their creation; there were 4,870 populated tracts in New York State in the 2010 census. Census tracts were available for over 99.5% of the tumors; the remainder were imputed based on the zip code of residence, where available.

Each census tract was characterized by urban/rural status using the Urban Rural Indicator Codes (URIC) from the 2010 United States Census. The URIC codes comprise 4 categories: all urban (the entire population lives in an urban area), mostly urban (more than half, but not all, of the population lives in an urban area), mostly rural (more than half, but not all, of the population lives in a rural area), and all rural (the entire population lives in a rural area). We created an additional category, New York City all urban, to distinguish the unique characteristics of the New York City population from the smaller cities of New York State. Each census tract was further characterized by its household poverty rate as measured by the 2008-2012 American Community Survey into one of four categories: <5%, 5% to <10%, 10% to <20%, and ≥20%. Census tracts were also characterized by their majority race/ethnicity composition according to the 2010 Census into the exclusive categories of white, black, Hispanic, other, and mixed (that is, where no group was in the majority). While individual race/ethnicity was available in the cancer data, there was no corresponding age and sex-specific population data at the census tract level to allow individual adjustment for race/ethnicity. The distributions of the URIC, poverty, and race/ethnic codes are given in Table 1. After excluding about 0.1% of the tumors because one or

more of the essential data items were missing (age/sex/tract/zip), the final number included in the study was 539,658.

Using Poisson regression, we calculated the overall and site-specific expected number of cancer cases for each census tract based on its total population, its age and sex distribution, and its urban/rural, race/ethnicity, and poverty categories. From these results we derived the risk of site specific cancer incidence and all sites combined for each of the urban/rural categories relative to the reference category of all rural.

We further obtained the stage at diagnosis for each tumor using the SEER Summary Stage 2000 classification system, which classifies tumors as local, regional, distant, or unknown stage. We then computed the site and stage-specific relative risks for each of the urban/rural categories. For simplicity, we report only the ratios of distant to local stage (that is, where the stage distribution varies by urban/rural status). Leukemia, myeloma, and brain cancer were excluded from the stage analysis because they are unstaged or infrequently staged. All sites combined was also excluded from the stage analysis.

3. Results

Figure 1 displays the modeled relationship between urban/rural residence and cancer incidence for each of the anatomic sites. For sites with distinct differences in stage the local and distant stage results are shown; otherwise, we show all stages combined. A majority of cancer sites demonstrated a significant relationship with urban/rural measures. Of the twenty-three sites analyzed, eighteen had a 95% confidence interval that excluded unity. Sites associated with rural residence included esophagus, larynx, lung (distant), melanoma, prostate, testis, bladder, kidney (distant), and brain. Sites associated with urban residence included oral (distant), stomach, liver, pancreas, breast, uterus (distant), ovary, thyroid, and non-Hodgkin's lymphoma (local). Among the stageable sites, seven displayed a significant difference by urban/rural classification. Sites with a rural disadvantage consisted of lung (distant), prostate (local and distant), and kidney (distant). Sites with an urban advantage consisted of oral (distant), breast (local and distant), uterus (distant), and non-Hodgkin's lymphoma (local). For all sites combined, risk of cancer incidence in New York City was slightly lower and risk of cancer incidence was slightly higher in the all urban non-NYC category.

4. Discussion

We found a significant relationship between urban/rural residence and cancer incidence for a majority of the most common cancer sites. Our discussion will focus on three of these sites (liver, prostate, and thyroid), as these were among the strongest and most compelling findings and are sites that have been receiving increasing attention within the cancer surveillance community in recent years.

Liver cancer demonstrated a nearly 60% increased risk in New York City relative to entirely rural locations. Chronic hepatitis is the single largest risk factor for liver cancer [12] and hepatitis rates are substantially higher among foreign-born persons than among US-born persons [13]. Liver cancer itself has also been found to be higher among foreign-born than native-born people

[14]. In New York City, 36% of the population is foreign born while only 11% of the remainder of New York State is foreign born, so this is likely contributing to the elevated risk in New York City [15][16]. An additional possible explanation for the higher risk of liver cancer in urban areas could be higher levels of alcohol consumption in urban areas than rural areas [17], as alcohol consumption is a known risk factor for liver cancer [18]. Alcohol related deaths have been reported to be much higher in New York City than the rest of the state [19].

Distant prostate cancer displays approximately a 50% higher risk in rural areas relative to all other locations. Previous research on the relationship between prostate cancer and urban/rural residence has not been consistent, with some studies reporting a positive association with urban, some with rural, and some reporting no relationship [11]. However, several potential contributing factors to a higher risk of distant stage prostate cancer in rural locations have been identified. One contributing factor to increased rural late stage prostate cancer risk may be a relative lack of access to health care or screening in rural areas [5]. Distant stage prostate cancer might also be exacerbated by a lack of education and opposition to prostate screening in rural areas [20][21]. Educational efforts discussing prostate cancer screening have demonstrated long term effects on screening likelihood [22]. Knowledge of prostate cancer screening risks and benefits was also shown to correspond with a more active patient role in screening decision making [23]. This suggests a potential lack of rural prostate screening education may contribute to the higher risk of late stage incidence. Smoking is also a known risk factor for prostate cancer [24]. As smoking rates are generally higher in rural areas than urban [25], smoking combined with less access to medical facilities and uninformed opposition to screening may contribute to the increased risk of distant stage prostate cancer in rural areas.

Thyroid cancer incidence demonstrates a nearly 50% higher risk in urban areas than rural. The most universally agreed upon contributing factor to thyroid cancer is radiation exposure, especially during childhood [26]. Medical exposure to radiation has drastically increased in recent years, corresponding with more frequent use of CT scans and nuclear medicine [27][28]. Therefore, a possible explanation for higher thyroid cancer risk in urban areas worth investigating is increased exposure to medical radiation at a young age due to easier access to medical facilities using CT scans or other radioactive medical techniques. Another possible explanation may be higher rates of incidental diagnosis in urban areas. Highly sensitive imaging techniques allow for the incidental detection of many non-palpable nodules, the majority of which may be benign, during imaging of the neck area [29]. These benign nodules may be over-reported as cases of cancer incidence. Incidental diagnoses might also be more common in urban areas where access to advanced imaging technology may be more common than in rural areas where there are several barriers to medical access such as higher travel time, especially for cancer treatment [2]. Increased rates of thyroid cancer may also be caused by unique genetic or cultural factors in New York City, as higher rates of thyroid cancer were found in highly observant Jewish neighborhoods in New York City [30].

Our study contained a number of strengths relative to similar studies. First, it used a clearly defined urban/rural variable measured at a fine geographic resolution. Second, it used a large, high-quality data
set covering a wide range of cancer sites far exceeding the number typically included in such studies. Third, it adjusted for socioeconomic status and race/ethnicity, allowing the independent

effect of urban/rural residence to be identified. This is useful given that so much of how urban and rural disparities are conceived is driven by these other factors. The race/ethnicity adjustment was unorthodox in that it was performed at the neighborhood level rather than the more usual individual level, a necessity in order to be able to conduct the analysis at the census tract level. While this could be viewed as a limitation, there is precedent for studying neighborhood racial composition rather than individual race [31]. Just as researchers have argued that the socioeconomic characteristics of one's neighborhood can be more influential in health outcomes than one's individual socioeconomic characteristics [32], the same could hold for race/ethnicity. Regardless, for the majority of people, the neighborhood and individual race/ethnicity assignments in our study would be identical, a logical consequence of our majority-based rule, and so the results would be expected to be similar.

Cancer disparities are most often understood to refer to racial/ethnic disparities, but, as this paper has attempted to demonstrate, other forms of disparities such as those between urban and rural areas are also deserving of measurement and analysis. The current ability to geocode cancer cases with high accuracy and precision, and the availability of fine-grained definitions of urban and rural locations, have made this a much easier prospect. Going forward, central cancer registries and public health agencies can track such things as the persistence of the rural disadvantage in late-stage prostate cancer and the urban disadvantage in liver cancer and begin to envision ways of ameliorating these disparities.

References

[1] Weaver KE, Geiger AM, Lu L, Case LD. Rural-urban disparities in health status among US cancer survivors. *Cancer*. 2013; 119(5): 1050-1057.

[2] Chan L, Hart LG, Goodman DC. Geographic access to health care for rural Medicare beneficiaries. *J Rural Health*. 2006; 22(2): 140-146.

[3] McLafferty S, Wang F. Rural reversal? Rural-urban disparities in late stage cancer risk in Illinois. *Cancer*. 2009; 115(12): 2755-2764.

[4] Cole AM, Jackson JE, Doescher M. Urban-rural disparities in colorectal cancer screening: cross-sectional analysis of 1998–2005 data from the Centers for Disease Control's Behavioral Risk Factor Surveillance Study. *Cancer Med.* 2012; 1(3): 350-356.

[5] Jemal A, Ward E, Wu X, Martin HJ, McLaughlin CC, Thun MJ. Geographic patterns of prostate cancer mortality and variations in access to medical care in the United States. *Cancer Epidemiol Biomarkers Prev*. 2005; 14(3): 590-595.

[6] Hines RB, Markossian TW. Differences in late-stage diagnosis, treatment, and colorectal cancer-related death between rural and urban African Americans and Whites in Georgia. *J Rural Health*. 2012; 28(3): 296–305.

[7] Nguyen-Pham S, Leung J, McLaughlin D. Disparities in breast cancer stage at diagnosis in urban and rural adult women: a systematic review and meta-analysis. *Ann Epidemiol*. 2014; 24(3): 228-235.

[8] Singh GK, Williams SD, Siahpush M, Mulhollen A. Socioeconomic, rural-urban, and racial inequalities in US cancer mortality: part I—all cancers and lung cancer and part II—colorectal, prostate, breast, and cervical cancers. *J Cancer Epidemiol.* 2011; 107497.

[9] Parikh-Patel A, Bates JH, Campleman, S. Colorectal cancer stage at diagnosis by socioeconomic and urban/rural status in California, 1988–2000. *Cancer*. 2006; 107 (S5): 1189–1195.

[10] Blair SL, Sadler GR, Bristol R, Summers C, Tahir Z, Saltzstein SL. Early cancer detection among rural and urban Californians. *BMC Public Health*. 2006; 6(1): 194.

[11] Obertova Z, Brown C, Holmes M, Lawrenson R. Prostate cancer incidence and mortality in rural men—a systematic review of the literature. *Rural Remote Health*. 2012; 12(2): 2039.

[12] El-Serag HB. Epidemiology of viral hepatitis and hepatocellular carcinoma. *Gastroenterology*. 2012; 142(6): 1264–1273.

[13] Ward JW, Byrd KK. Hepatitis B in the United States: a major health disparity affecting many foreign-born populations. *Hepatology*. 2012; 56(2): 419-421.

[14] Kahn F, Ruterbusch JJ, Gomez SL, Schwartz K. Differences in the cancer burden among foreign-born and US-born Arab Americans living in metropolitan Detroit. *Cancer Causes Control.* 2013; 24(11): 1955-1961.

[15] United States Census Bureau. Table 38. Native and foreign-born population by state:2009. *Statistical Abstract of the United States 2012*. 2011. http://www.census.gov/compendia/statab/2012/tables/12s0038.pdf [accessed 7.7.15]

[16] United States Census Bureau. Table 39. Nativity and place of birth of resident population for cities of 100,000 or more:2009. *Statistical Abstract of the United States 2012.* 2011. http://www.census.gov/compendia/statab/2012/tables/12s0038.pdf [accessed 7.7.15]

[17] Borders TF, Booth BM. Rural, suburban, and urban variations in alcohol consumption in the United States: findings from the National Epidemiologic Survey on Alcohol and Related Conditions. *J Rural Health*. 2007; 23(4): 314-321.

[18] Blot WJ. Alcohol and cancer. *Cancer Res*. 1992; 52(S7): 2119-2123.

[19] Hanson CE, Wieczorek WF. Alcohol mortality: a comparison of spatial clustering methods. *Soc Sci Med*. 2002; 5(55): 791-802.

[20] Jones AR, Shipp M, Thompson C J, Davis MK. Prostate cancer knowledge and beliefs among Black and White older men in rural and urban counties. *J Cancer Educ*. 2005; 20(2): 96-102.

[21] Oliver JS. Attitudes and beliefs about prostate cancer and screening among rural African American men. *J Cult Divers.* 2007; 14(2): 74-80.

[22] Volk RJ, Spann SJ, Cass AR, Hawley ST. Patient education for informed decision making about prostate cancer screening: a randomized controlled trial with 1-year follow up. *Ann Fam Med*. 2003; 1(1): 22-28.

[23] Davison BJ, Kirk P, Degner LF, Hassard TH. Information and patient participation in screening for prostate cancer. *Patient Educ Couns*. 1999; 37(3): 255-263.

[24] Huncharek M, Haddock KS, Reid R, Kupelnick B. Smoking as a risk factor for prostate cancer: a meta-analysis of 24 prospective cohort studies. *Am J Public Health*. 2010; 100(4): 693-701.

[25] American Lung Association. Cutting tobacco's rural roots:tobacco use in rural communities. *Disparities in Lung Health Serires*. 2012. http://www.lung.org/assets/documents/publications/lung-disease-data/cutting-tobaccos-rural-roots.pdf [accesed 7.7.15]

[26] Ron E, Lubin JH, Shore RE, Mabuchi K, Modan B, Pottern LM, Schneider AB, Tucker MA, Boice Jr JD. Thyroid cancer after exposure to external radiation: a pooled analysis of seven studies. *Radiat Res*. 1995; 141(3): 259-277.

[27] Mettler Jr FA, Thomadsen BR, Bhargavan M, Gilley DB, Gray JE, Lipoti JA, McCrohan J, Yoshizumi TT, Mahesh, M. Medical radiation exposure in the US in 2006: preliminary results. *Health Phys*. 2008; 95(5): 502-507.

[28] Enewold L, Zhu K, Ron E, Marrogi AJ, Stojadinovic A, Peoples GE, Devesa SS. Rising thyroid cancer incidence in the United States by demographic and tumor characteristics, 1980-2005. *Cancer Epidemiol Biomarkers Prev*. 2009; 18(3): 784-791.

[29] Tan GH, Gharib H. Thyroid incidentalomas: management approaches to nonpalpable nodules discovered incidentally on thyroid imaging. *Ann Intern Med.* 1997; 126(3): 226-231.

[30] Soloway LE, Boscoe FP, Schymura MJ, Kahn AR, Weinstein AL, Qiao B, McLaughlin CC. Thyroid cancer incidence in highly observant Jewish neighborhoods in metropolitan New York City. *Thyroid*. 2011; 21(11): 1255-1261.

[31] Hutchinson RN, Putt MA, Dean LT, Long JA, Montagnet CA, Armstrong K. Neighborhood racial composition, social capital and black all-cause mortality in Philadelphia. *Soc Sci Med*. 2009; 68(10): 1859-1865.

[32] Robert S. Socioeconomic position and health: the independent contribution of community socioeconomic context. *Ann Rev Sociol*. 1999;25(1):489-516.

PeerJ PrePrints | https://dx.doi.org/10.7287/peerj.preprints.1224v1 | CC-BY 4.0 Open Access | rec: 9 Jul 2015, publ: 9 Jul 2015

Table 1. Distributions of the URIC, poverty, and race/ethnic codes.

	Number	Percent
All urban - NYC	2,138	43.9
All urban - not NYC	1,746	35.8
Mostly urban	395	8.1
Mostly rural	281	5.8
All rural	310	6.4
Poverty <5%	1,006	20.7
Poverty 5% to <10%	1,092	22.4
Poverty 10% to <20%	1,397	28.7
Poverty 20%+	1,375	28.2
White majority	3,113	63.9
Black majority	609	12.5
Hispanic majority	477	10
Asian or American Indian majority	564	11.6
No majority	107	2.2

PeerJ PrePrints | https://dx.doi.org/10.7287/peerj.preprints.1224v1 | CC-BY 4.0 Open Access | rec: 9 Jul 2015, publ: 9 Jul 2015

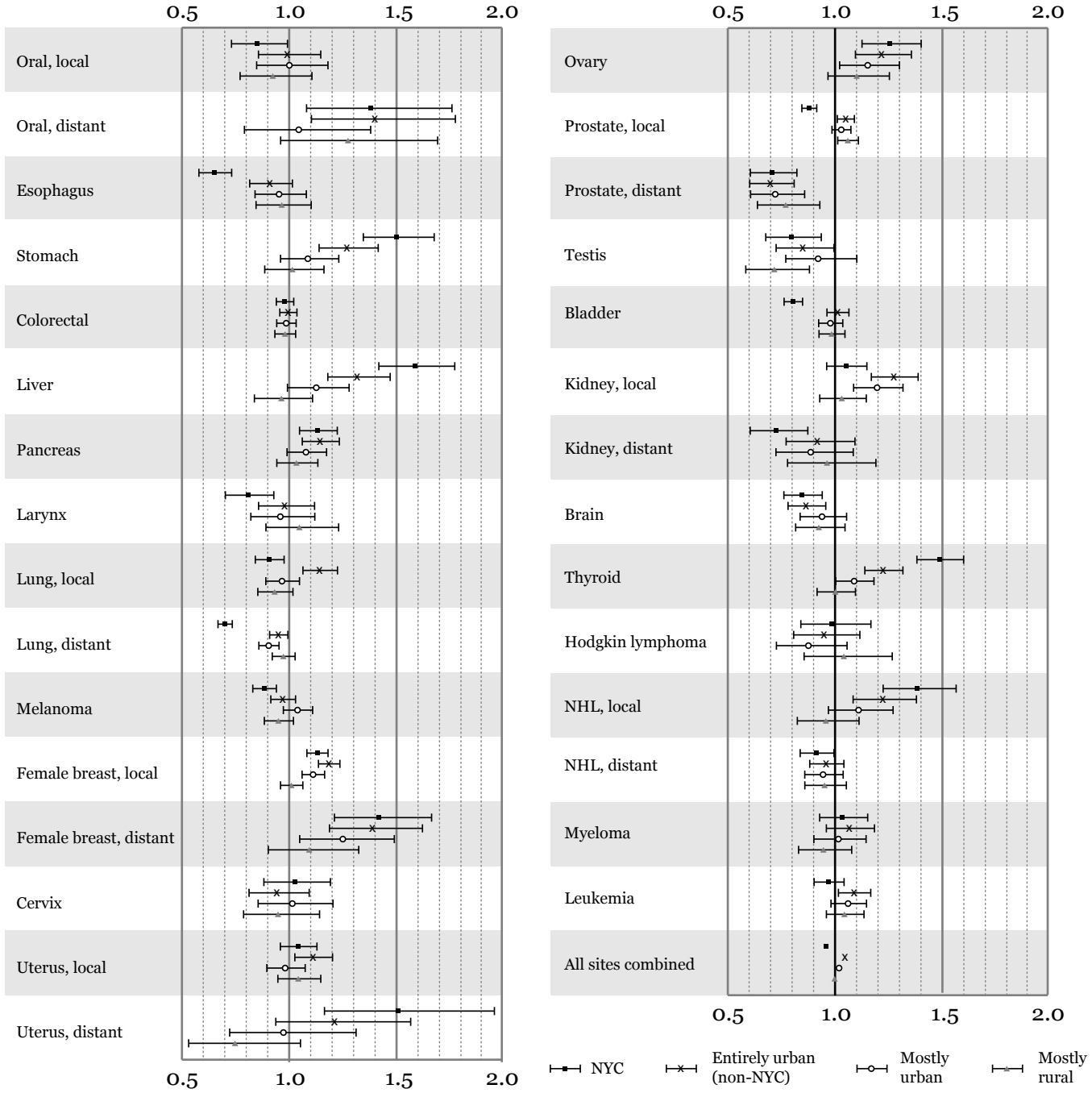

Figure 1. Relative risks of cancer incidence by site and urbanicity relative to entirely rural locations, New York State, 2008-2012.