NIH Public Access
Author Manuscript
J Expo Sci Environ Epidemiol. Author manuscript; available in PMC 2015 February 27.

Published in final edited form as:
J Expo Sci Environ Epidemiol. 2010 May ; 20(3): 237–244. doi:10.1038/jes.2009.11.

Environmental justice: A contrary finding for the case of high-voltage electric power transmission lines

Daniel Wartenberg[a,b], **Michael R. Greenberg**[c], and **Gerald Harris**[a]

[a]Division of Environmental Epidemiology, Department of Environmental and Occupational Medicine, UMDNJ—Robert Wood Johnson Medical School, 170 Frelinghuysen Road, Piscataway, New Jersey, USA

[b]Division of Epidemiology, UMDNJ—School of Public Health, 683 Hoes Lane West, Piscataway, New Jersey 08854, USA

[c]Edward J. Bloustein School of Planning and Public Policy, Rutgers University, 33 Livingston Avenue, Suite 100, New Brunswick, New Jersey 08901-1958, USA

Abstract

Environmental justice is the consideration of whether minority and/or lower-income residents in a geographic area are likely to have disproportionately higher exposures to environmental toxins than those living elsewhere. Such situations have been identified for a variety of factors, such as air pollution, hazardous waste, water quality, noise, residential crowding, and housing quality. This study investigates the application of this concept to high-voltage electric power transmission lines (HVTL), which some perceive as a health risk because of the magnetic fields they generate, and also as esthetically unpleasing. We mapped all 345 kV and higher voltage HVTL in New York State and extracted and summarized proximate US Census sociodemographic and housing characteristic data into four categories on the basis of distances from HVTL. Contrary to our expectation, people living within 2000 ft from HVTL were more likely to be exposed to magnetic fields, white, of higher income, more educated and home owners, than those living farther away, particularly in urban areas. Possible explanations for these patterns include the desire for the open space created by the rights-of-way, the preference for new homes/subdivisions that are often located near HVTL, and moving closer to HVTL before EMFs were considered a risk. This study suggests that environmental justice may not apply to all environmental risk factors and that one must be cautious in generalizing. In addition, it shows the utility of geographical information system methodology for summarizing information from extremely large populations, often a challenge in epidemiology.

Keywords

environmental justice; power lines; EMF; socioeconomic status; GIS; exposure analysis

---

[1]Address all correspondence to: Dr. Daniel Wartenberg, Environmental and Occupational Health Sciences Institute, 170 Frelinghuysen Road, Piscataway, NJ 08854, USA. Tel.: 732-445-0197. Fax: 732-445-0784., dew@eohsi.rutgers.edu.

Introduction

Environmental justice is the consideration of whether African American, Latino, native American or other minority and/or lower-income residents in a geographic area are likely to have disproportionately higher exposures to environmental toxins than those living elsewhere (USGAO, 1983; United Church of Christ, 1987; Bryant and Mohai, 1992; USEPA, 1992; Zimmerman, 1993). The underlying concern is the ethnic and economically based health disparities, such as higher cancer incidence rates, higher mortality rates, and overall poorer health (Pappas, Queen, Hadden and Fisher, 1993; Centers for Disease, 2004, 2005; Steenland, Hu and Walker, 2004) may be exacerbated by these higher exposures to environmental pollutants. Associations of environmental exposures, race and income have been shown for a variety of factors, such as areas with higher levels of air pollutants (Perlin, Setzer, Creason and Sexton, 1995), facilities that produce and/or store dangerous chemicals (Elliott, Wang, Lowe and Kleindorfer, 2004), proximity to hazardous waste sites (Davidson and Anderton, 2000), poor water quality (Wing, Richardson, Wolf, Mihlan, Crawford-Brown and Wood, 2000), and other environmental factors such as noise and socioeconomic status indices such as residential crowding, and poor housing quality (Evans and Kantrowitz, 2002). Two possible explanations for the occurrence of poorer, minority communities in areas of lower environmental quality and in close proximity to hazardous facilities are: (1) prior settlement, that is, these communities are less well connected politically and thus unable to prevent placement of potentially hazardous facilities in their proximity; and, (2) subsequent migration, that is, communities with more environmental problems have depressed property values due to these hazards and this particularly affordable housing is especially attractive to those with more limited financial resources.

Environmental justice issues often are portrayed as applying to all environmental hazards and other locally unwanted land uses such as prisons and large commercial facilities (Greenberg and Cidon, 1997). Often people do not want to live near them because they generate traffic and noise, although some studies have shown exception to this concept. For example, in a cross-sectional study of communities in New Jersey, Greenberg and Schneider (1996) found, that in a lower middle income population, a moderately poor group with limited resources chose housing that was closest to a variety of chemical storage and electric power transmission facilities in the Tremley Point section of Linden, NJ. Others have suggested that sometimes environmentally hazardous facilities are located purposefully in minority or lower-income communities (Anderton, Anderson, Oakes and Fraser, 1994; Davidson and Anderton, 2000), because there likely will be less resistance although clear-cut examples are rare.

On the basis of our research on the possible adverse health effects of living near high-voltage electric power transmission lines (HVTL) in New Jersey, we noticed that often the houses closest to the lines were some of the oldest, largest and more expensive dwellings, whereas others were new subdivisions, also often moderately to very expensive. In a small pilot project involving only five communities, we found overall that those living in US Census blocks within 100 m of a single HVTL were more likely to be white, and had more expensive and higher rent residences but were more likely to rent rather than own their residence (Wartenberg, Greenberg and Lathrop, 1993). Even though there was variability in these observations across the towns, that study suggested that those with the highest exposures were the more advantaged economically, but more likely renters.

This study builds on that previous study by examining the same issue across all of New York State, comparing the sociodemographic and housing characteristics of US Census block groups close to all 345 kV and higher voltage HVTL with those living farther away. Our null hypothesis is that home buyers and renters do not show a preference for choosing homes within or farther than 2000 ft from HVTL even though many find the lines are unsightly, and some people believe that the magnetic fields they generate may increase the risk of adverse health events, particularly childhood leukemia (National Research Council and Committee on the Possible Effects of Electromagnetic Fields on Biologic, 1997; NIEHS, 1998; Ahlbom et al., 2000; Greenland, Sheppard, Kaune, Poole and Kelsh, 2000; Wartenberg, 2001; International Agency for Research on, 2005).

Methods

This study was approved by the UMDNJ Robert Wood Johnson Medical School IRB. It is only a data analysis study, so individual consent was not applicable.

We compiled the data needed for our analyses in three main steps. First, we obtained the location of each of the 345 kV and higher voltage HVTL from each of the respective New York State electric utilities. We imported these data into a geographical information system (GIS) and then overlaid geographic data from the US Census (Figure 1). We excluded 24 of the 62 counties in New York State because they did not have any 345 kV and higher voltage HVTL. These exclusions included all of Long Island and New York City, a substantial portion of New York State’s population. We then determined the distance of each block group from the centerline of HVTL in our study area and grouped them into four distance classes: 0–500 ft, 500–1000 ft, 1000–2000 ft and greater than 2000 ft (Figure 2). Using aerial photos, we estimated that these distances were accurate to within 50–250 ft. These divisions are somewhat arbitrary, but chosen on the basis of our spatial resolution and on informal advice from engineers. These engineers told us that virtually all homes within 500 ft had elevated magnetic field levels due to the HVTL, some homes within 500–2000 ft had elevated magnetic field levels due to the HVTL, but few homes farther than 2000 ft from HVTL were influenced directly by the HVTL. For block groups that straddled distance boundaries, we subdivided the resident population and indices based upon the proportion of the geographic area of the block group within each distance class.

Second, we extracted relevant data from the 2000 US Census. We selected several indices of socioeconomic status (median household income (MHI), per capita income (PCI), percent employed, percent in poverty, percent over age 25 years with a high school education, and percent with a college education), demographics (percent white, percent less than 18 years of age, and percent greater than 64 years of age), and housing characteristics (percent owner occupied, median year built, median year moved in, median value of house and median contract rent). To estimate values for block groups that spanned more than one distance group, we weighted relevant variables by the proportional population in each distance class, as noted above (e.g., for median household income, the weight was the proportional area in that distance class times the number of households in the block group; for percent employment, the weight was the proportional area in that distance class times the total number of people 16 years or older in the block group, as percent employment counts only people 16 years or older).

Third, we compared the data in the four distance categories. For a crude analysis, we simply tabulated the mean values for each variable for each distance groups. We weighted the values for individual block groups by population or the appropriate measure for the response (e.g., number of households for median household income). Then, because we thought that certain counties might have unique characteristics that could influence the analysis, we conducted regression analyses, controlling for county. For continuous data we used linear regression. For counts (or proportions), regression errors typically follow a binomial or Poisson distribution, so we used Poisson regression.

We were also concerned that our results might reflect comparisons between urban areas that tend to have fewer above ground HVTL and rural areas that have more. Furthermore, using the US Census definition of urban areas, we found that just under half of the population within 2000 ft of a HVTL in our study lived in an urban area, but nearly two-thirds of the population farther than 2000 ft from an HVTL lived in an urban area, a possible bias. Therefore, we also controlled for urban status in the regressions. We conducted these regressions with block group weights similar to those used in the crude analysis, and without the weights, but found that weights made little difference in the results. We report only the results without weights.

To assess the possible presence of effect measure modification by urbanization, that is, that in urban areas the buffer effects might be different from those in non-urban areas, we included in the regression analyses a cross-product term modeling this interaction. However, due to low numbers of observations in the under 2000 ft buffers in some counties, the model effect estimates were unstable. Therefore, we did not include the effect measure modification of county on buffer in the final models. Instead, to address this effect, and to better understand the role urbanization may have played on the effect of distance from HVTL, we conducted separate regressions for the urban, urban/rural interface (i.e., suburban), and rural areas.

Results

Table 1 displays the results of the unadjusted analysis. Values shown for each of the measures are weighted means of the values for the individual census block groups. The socioeconomic variables show that income (using each of three measures) is substantially higher within 2000 ft of the HVTL, education at the high school and college level is higher, and employment is higher. For demographic measures, the population living within 2000 ft of the HVTL is more white and appears to have only slightly more young and slightly fewer elderly people. For the housing characteristics, the houses within 2000 ft of the buffer tend to be owner occupied, are slightly newer, have been occupied longer, are of greater value, and have higher rents. Overall, there is a consistent pattern among the measures.

Table 2 shows the results of the regression of buffer category on each measure after adjustment for county and urbanization. Although the overall patterns are similar to the crude analyses, the differences between those closer than 2000 ft to the HVTL and those farther away are smaller. Only the house value, percent younger, and percent elderly have shifted so that houses farther than 2000 ft from the buffer are slightly more expensive and there are slightly more younger and elderly residents. We calculated the statistical significance through the regression analysis, showing significant values in bold and identified with an asterisk in this table. Only percent in poverty, percent owner occupied, and the year the house was built showed statistically significant differences across distance classes.

In Table 3, we grouped the three categories for those living closer than 2000 ft from the HVTL and show the results of the regression of the two summary buffer categories, 0–2000 ft and >2000 ft, for each sociodemographic and housing characteristic measure, after adjustment for county and urbanization. We did this to increase the number of block groups in each category analyzed and thus the sensitivity of the regression, given that the differences among groups within 2000 ft tended to be smaller than those between them and that of greater than 2000 ft. Several, but not all, of the socioeconomic indices show statistically significant differences, again denoted by boldface type and an asterisk. Median household income, percent in poverty, and percent over 25 years of age with a high school education show higher socioeconomic status among those living within 2000 ft of the HVTL. The demographic measures showed more whites living closer to the lines, but no important differences in age. The housing characteristic measures show more owner occupied, newer, and lived in longer houses for those living closer to the HVTL, and the contract rents did not differ significantly by distance. However, in contrast to the unadjusted results in Table 1, the values of the houses within 2000 ft from the HVTL were of lower value than those further from the HVTL.

We also conducted a regression analysis excluding central cities and obtained largely the same results. Interestingly, we found statistically significant effect measure modification between urbanization and buffer for several variables: percent in poverty, percent white, percent owner occupied, the year housing built, and value of the house. In other words, the effect of buffer distance on those sociodemographic variables differs by the level of urbanization. However, small numbers raise concerns about the statistical stability of the results.

Table 4 shows the results for regressions run separately by degree of urbanization. The socioeconomic status variables generally show the same pattern, with higher status among those living closer to the lines, but the only statistically significant differences were for urban areas. Demographic differences were small and not statistically significant for any specific variable, except a greater proportion of whites living closer to the HVTLs in urban areas. Housing characteristics showed consistent patterns across urbanization groups, with more owner occupied, newer, lived in slightly longer, less expensive, and higher rent homes closer to the HVTLs. Only those for urban areas showed statistical significance, except for contract rent that was not statistically significant for any group and owner occupied that was higher if you lived closer to HVTLs in rural and urban areas.

Discussion

This environmental justice study was designed as an expansion of a preliminary study that found that sociodemographic characteristics varied by residential proximity to HVTL. There are three main findings to our analyses. First, and most important, populations living near HVTL are more likely to: be white, have higher incomes, have more education, and own their houses than those living farther away, although only for urban areas were the differences statistically significant. In other words, our findings run contrary to most other studies of environmental justice. Second, this difference between near and far homes is attenuated, but not overcome, when the analyses are adjusted for county of residence and degree of urbanization. Third, as sociodemographic characteristics are associated with proximity to HVTL and thus exposure to magnetic fields, investigators studying the possible adverse health effects of exposure electromagnetic fields should include sociodemographic characteristics in their analyses, as most have.

This study is different than most studies of environmental justice. Rather than looking at a small region, a single city, or a few cities, we have examined patterns in a large proportion of a populous state. In doing so, we encountered the complexity of addressing local effects (e.g., county) and a wide range of development, from rural to urban. We also addressed an environmental risk factor whose actual health impact is controversial but whose negative esthetic impact is widely accepted. We conducted our analyses for two different sets of distance classes, to address concerns about both statistical sample size and the belief by some that health effects, if they occur, are more likely over short rather than longer distances from the HVTL. Our results were robust to the choice of distance classes.

The results we found differ from many other studies of environmental justice in that those most exposed tended to be more affluent, better educated, more likely white, to own the house they live in, and to own newer houses, as compared with those that are farther from and were not exposed to the magnetic fields from the HVTL, particularly in urban areas. There are two plausible mechanisms for this pattern related to the time of HVTL construction: subsequent migration and prior settlement. First, as HVTL typically are contained within an undeveloped right-of-way, living near them provides for some open space, often a desirable attribute, and people may move there preferentially. Similarly, many of the HVTL were constructed many years before the suburban housing boom, which populated wide open, previously sparsely populated areas. Those with greater financial resources may have found these new houses and subdivisions more desirable (Bowen, Salling, Haynes and Cyran, 1995; Yandle and Burton, 1996). These both are types of subsequent migration. On the other hand, it may be that as populations have grown, and energy demand increased, new HVTL were needed in more rapidly growing and desirable areas, some ending up in more desirable neighborhoods. This is an example of earlier settlement. As we have not considered data on the age of the lines, and the housing situation before their construction, we cannot differentiate between these options. A study using longitudinal data, comparing housing age and age of HVTL could address this.

We also found that the degree of urbanization modifies the effect of sociodemographic factors on the distance from the HVTL. That is, the impact on distance differs for several measures socioeconomic, demographic, and housing characteristics, and varies at least in magnitude if not direction by whether the house is in a rural, suburban, or urban region. Further research is needed to better define this effect, as small numbers limit our inferences. It is important to note than there are no HVTL in the inner cities, an important limitation to the generalizability of this analysis. Briggs et al. (2008) who studied environmental justice in England with respect to a variety of environmental exposures found results similar to ours for HVTLs.

This study demonstrates that the concept of environmental justice may not apply equally to all environmental risk factors and that one must be cautious in generalizing. Although several examples of environmental injustice have been shown convincingly, one must look at the specifics of each environmental situation and each location to determine what processes are operating and what their likely impacts are.

In addition, we have shown the utility of using GIS methodology to summarize information for extremely large populations, often a challenging problem in epidemiology (Vine, Degnan and Hanchette, 1997; Elliott and Wartenberg, 2004). Various authors have raised concerns about methodologies used in studies of environmental justice, and application of GIS technology to the problem (Maantay, 2002). Because of the nature of HVTLs, we are confident that the houses closest to the lines (within 500 ft) were more likely to have more elevated magnetic fields, and that residents in houses closer to the lines were more likely to see the lines, raising esthetic concerns. Issues of scale generally are of concern (Cutter, Holm and Clark, 1996), and finer scale data might have been helpful in our study were it not for the small numbers problem. We did identify degree of urbanization as an important consideration, as have others (Anderton, Anderson, Oakes and Fraser, 1994; Davidson and Anderton, 2000), but found that adjusting for these differences mainly affected the statistical or quantitative results, not the qualitative ones.

A final issue is that some have called for studies that move beyond the demonstration of exposure to the assessment of exposure-related health effects. In a paper in preparation, we discuss the use of these data and this approach for the epidemiological assessment of health effects of living in close proximity to HVTL. The greatest problem we encountered in this study, and one that was of even greater concern in our study assessing health effects, was that of small numbers, even though our study spanned an entire, large state. This was because of the juxtaposition of HVTL and populations, the very issue we studied. We could improve upon this by studying a region with more people living in close proximity to HVTL, such as one that is more densely populated.

Another interesting research project would involve returning to these same areas with a survey instrument that would test the hypothesis that residents who live closer to the towers and lines were more concerned about EMF than those who lived farther away, compared with other hazards. Such a survey would also include questions about trust, efficacy, and other individual factors that influence risk perception, and would determine if more recent in-migrants had different perceptions about EMF than longer-term residents.

Acknowledgements

The early phase of this study was funded by the Empire State Electric Energy Research Corporation (ESEERCO), and later work by the National Cancer Institute (R03CA77152), NIEHS sponsored UMDNJ Center for Environmental Exposures and Disease (P30ES005022) and the Centers for Disease Control and Prevention (U61/ATU272387 and U19/EH000102). The majority of the writing of the manuscript was completed while Dr. Wartenberg was a Libra Scholar in the Department of Applied Medical Sciences, University of Southern Maine, Portland, Maine. We thank Sylvia Brown, Phil Doyle and Janet Hwang for technical assistance.

References

Ahlbom A, Day N, Feychting M, Roman E, Skinner J, Dockerty J, Linet M, McBride M, Michaelis J, Olsen JH, Tynes T, Verkasalo PK. A pooled analysis of magnetic fields and childhood leukemia. Br J Cancer. 2000; 83(5):692–698. [PubMed: 10944614]

Anderton DL, Anderson AB, Oakes JM, Fraser MR. Environmental equity: the demographics of dumping. Demography. 1994; 31(2):229–248. [PubMed: 7926187]

Bowen WM, Salling MJ, Haynes KE, Cyran EJ. Toward environmental justice: spatial equity in Ohio and Cleveland. Annals of the Association of American Geographers. 1995; 85(4):641–663.

Briggs D, Abellan JJ, Fecht D. Environmental inequity in England: small area associations between socio-economic status and environmental pollution. Soc Sci Med. 2008; 67:1612–1629. [PubMed: 18786752]

Bryant, B.; Mohai, P. Race and the Incidence of Environmental Hazards. San Francisco: Westview Press; 1992. p. 1-251.

Centers for Disease C. Health disparities experienced by Hispanics—United States. MMWR. 2004; 53(40):935–937. [PubMed: 15483525]

Centers for Disease C. Health disparities experienced by Black or African Americans—United States. MMWR. 2005; 54(1):1–3.

Cutter SL, Holm D, Clark L. The role of geographic scale in monitoring environmental justice. Risk Analysis. 1996; 16:517–526.

Davidson P, Anderton DL. Demographics of dumping II: a national environmental equity survey and the distribution of hazardous materials handlers. Demography. 2000; 37(4):461–466. [PubMed: 11086571]

Elliott MR, Wang Y, Lowe RA, Kleindorfer PR. Environmental justice: frequency and severity of US chemical industry accidents and the socioeconomic status of surrounding communities. J Epidemiol Community Health. 2004; 58:24–30. [PubMed: 14684723]

Elliott P, Wartenberg D. Spatial epidemiology: current approaches and future challenges. Environ Health Perspect. 2004; 112(9):998–1006. [PubMed: 15198920]

Evans GW, Kantrowitz E. Socioeconomic status and health: the portential role of environmental risk exposures. Annu Rev Public Health. 2002; 23:303–331. [PubMed: 11910065]

Greenberg, M.; Schneider, D. Environmentally Devastated Neighborhoods. New Brunswick NJ: Rutgers University Press; 1996.

Greenberg M, Cidon M. Broadening the definition of environmental equity: a framework for states and local governments. Population Research and Policy Review. 1997; 16:397–413.

Greenland S, Sheppard AR, Kaune WT, Poole C, Kelsh MA. A pooled analysis of magnetic fields, wire codes and childhood leukemia. Epidemiology. 2000; 11:624–634. [PubMed: 11055621]

International Agency for Research on C. IARC Monographs on the Evaluation of Carcionogenic Risks to Humans. 2005

Maantay J. Mapping environmental injustices: pitfalls and potential geographic information systems in assessing environmental health and equity. Environ Health Perspect. 2002; 110(Suppl. 2):161–171. [PubMed: 11929725]

National Research Council, and Committee on the Possible Effects of Electromagnetic Fields on Biologic S. Possible Health Effects of Exposure to Residential Electric and Magnetic Fields. Washington, DC: National Academy Press; 1997. p. 1-356.

NIEHS W.o.r.k.i.n.g.G.r.o.u.p. Assessment of Health Effects from Exposure to Power-Line Frequency Electric and Magnetic Fields. Research Triangle Park, NC: National Institute of Environmental Health Sciences, National Institutes of Health, US Department of Health and Human Services, Public Health Service; 1998. p. 508

Pappas G, Queen S, Hadden W, Fisher G. The increasing disparity in mortality between socioeconomic groups in the United States, 1960 and 1986. N Engl J Med. 1993; 329:103–109. (erratum p. 1139). [PubMed: 8510686]

Perlin SA, Setzer RW, Creason J, Sexton K. Distribution of industrial air emissions by income and race in the United States: an approach using the Toxic Release Inventory. Environ Sci Technol. 1995; 29(1):69–80. [PubMed: 22200202]

Steenland K, Hu S, Walker J. All-cause and cause specific mortality by socioeconomic status among employed persons in 27 US states, 1984–1997. Am J Public Health. 2004; 94(6):1037–1042. [PubMed: 15249312]

United Church of Christ. Toxic Waste and Race in the United States. New York: United Church of Christ; 1987.

USEPA. Volume 1: Workgroup Report to the Administrator. Washington, DC: USEPA; 1992. p. 1-43.

USGAO. Siting of Hazardous Waste Landfills and their Correlation with Racial and Economic Status of Surrounding Communities. Washington, DC: US General Accounting Office; 1983.

Vine MF, Degnan D, Hanchette C. Geographic information systems: their use in environmental epidemiologic research. Environ Health Perspect. 1997; 105(6):598–605. [PubMed: 9288494]

Wartenberg D, Greenberg M, Lathrop R. Identification and characterization of populations living near high voltage transmission lines: a pilot study. Environ Health Perspect. 1993; 101(7):626–631. [PubMed: 8143596]

Wartenberg D. Residential EMF exposure and childhood leukemia: meta-analysis and population attributable risk. Bioelectromagnetics. 2001; (Suppl. 5):S86–S104. [PubMed: 11170120]

Wing S, Richardson DB, Wolf S, Mihlan G, Crawford-Brown D, Wood J. A case control study of multiple myeloma at four nuclear facilities. Ann Epidemiol. 2000; 10:144–153. [PubMed: 10813507]

Yandle T, Burton D. Reexamining environmental justice: a statistical analysis of historical hazardous waste landfill siting patterns in metropolitan Texas. Social Science Quarterly. 1996; 77:477–492.

Zimmerman R. Social equity and environmental risk. Risk Anal. 1993; 13(6):649–666.

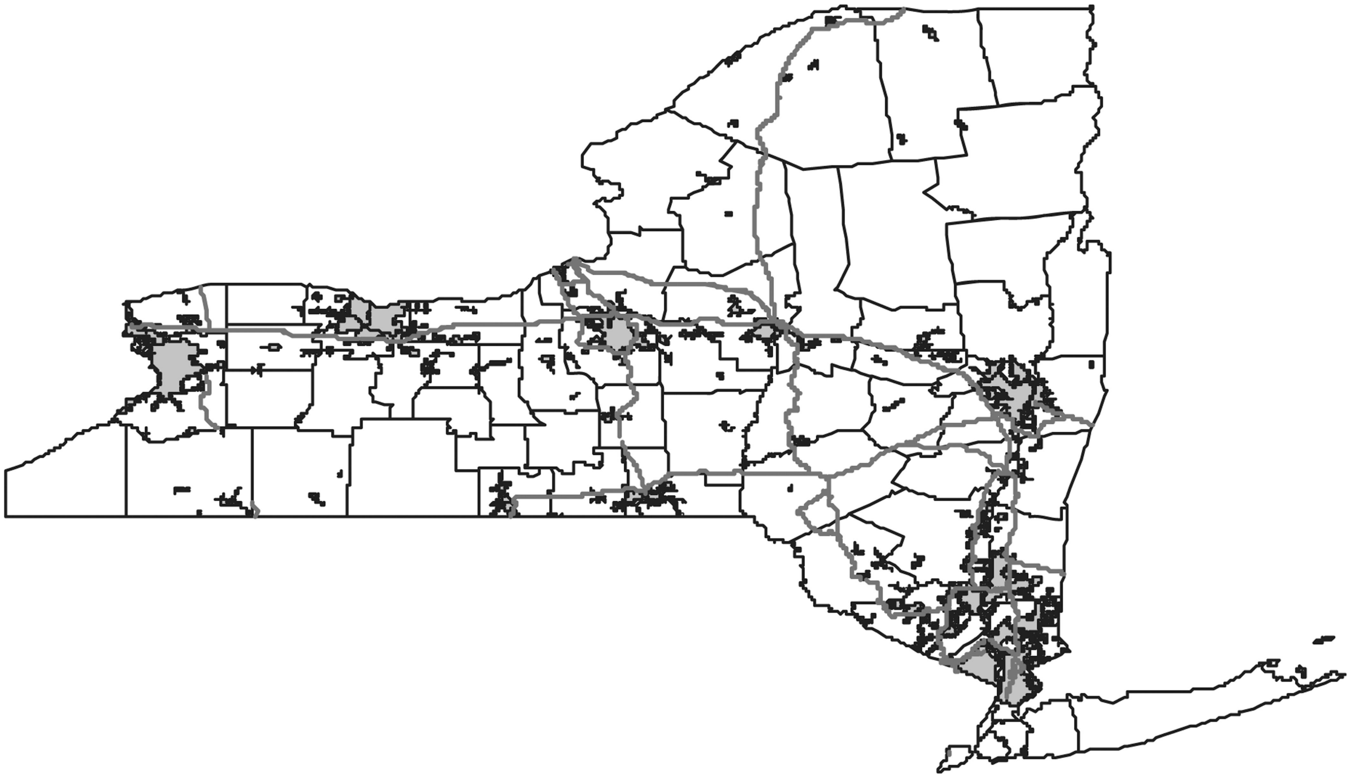

Figure 1.

Map of New York State Counties, all 345 kV and higher HVTL (red), and Urban Areas In Study (blue).

NIH-PA Author Manuscript

NIH-PA Author Manuscript

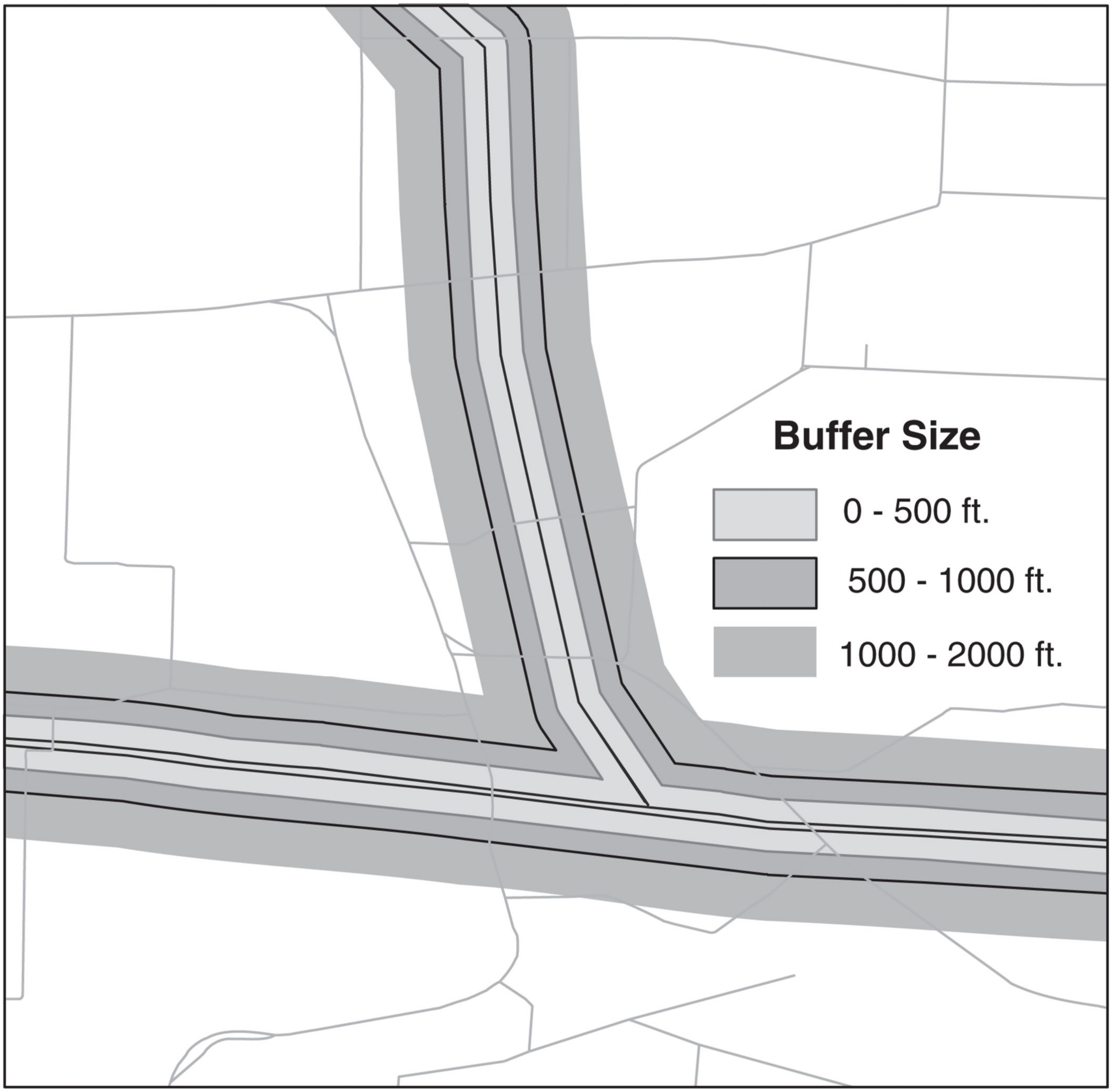

Figure 2.
Buffers: 0 ft to <500 ft; 500 ft to <1000 ft; 1000 ft to <2000 ft; ≥2000 ft.

Table 1

Crude comparisons of category means for socioeconomic measures.

Measure	0–500 (ft)	500–1k (ft)	1k–2k (ft)	>2k (ft)
No. of block groups	*535*	*576*	*665*	*6,083*
Socioeconomic status				
MHI ($)	62,850	62,827	62,139	47,431
PCI ($)	27,482	27,424	26,839	22,646
% Poverty	6.36	6.26	6.29	12.42
% High school education	87.2	87.4	86.8	82.1
% College education	39.9	40.1	39.1	34.0
% Employed[a]	63.1	62.6	62.8	59.5
Demographics				
% White	89.3	89.5	89.5	83.0
% <18 years	25.7	25.5	25.6	25.0
% >64 years	12.6	13.3	12.7	14.1
Housing characteristics				
% Owner occupied	80.1	79.6	80.1	66.3
Year the house was built	1966.7	1966.0	1965.8	1957.2
Year moved in	1986.6	1986.5	1986.3	1987.0
House value ($)[b]	165,120	163,477	164,110	129,568
Contract rent ($)[c]	650	615	654	530

[a] Percent employed among the population 16 years and over.

[2] Value of houses occupied by the owner.

[c] Median contract rent based on renter-occupied housing units paying cash rent.

Table 2

Comparisons of category means (95% confidence intervals) for socioeconomic measures adjusted for county and urban status.

Measure	0–500 (ft)	500–1k (ft)	1k–2k (ft)	>2k (ft)	*P*-value
Socioeconomic status					
MHI[a]	47.0 (41.1–52.9)	46.7 (40.6–52.7)	48.1 (43.8–52.4)	43.9 (43.2–44.6)	0.156
PCI[a]	21.0 (18.2–23.9)	21.1 (18.1–24.0)	21.2 (19.0–23.2)	20.4 (20.0–20.7)	0.855
% Poverty*	**7.4 (5.4–10.3)**	**7.3 (5.2–10.1)**	**7.1 (5.6–9.0)**	**9.9 (9.6–10.2)**	**0.002**
% High school education	84.5 (81.2–87.9)	84.6 (81.2–88.1)	84.5 (82.1–87.0)	82.4 (82.0–82.8)	0.115
% College education	31.0 (27.3–35.1)	31.0 (27.2–35.3)	31.0 (28.3–34.0)	30.3 (29.8–30.8)	0.930
% Employed	60.3 (57.2–63.7)	60.1 (56.9–63.6)	60.3 (57.9–62.7)	58.9 (58.5–59.3)	0.459
Demographics					
% White	95.7 (89.5–100.0)	96.0 (89.5–100.0)	95.6 (90.9–100.0)	91.5 (90.8–92.3)	0.110
% <18 years	24.8 (22.9–26.9)	24.7 (22.7–26.8)	24.8 (23.4–26.3)	24.9 (24.7–25.2)	0.992
% >64 years	13.4 (11.5–15.5)	13.8 (11.8–16.0)	13.4 (12.0–14.9)	13.7 (13.5–14.0)	0.958
Housing characteristics					
% Owner occupied*	**79.2 (72.2–86.9)**	**79.2 (72.0–87.1)**	**79.4 (74.2–85.0)**	**71.8 (71.0–72.6)**	**0.001**
Year the house was built*	**1964 (1960–1967)**	**1963 (1960–1967)**	**1963 (1961–1966)**	**1959 (1959–1960)**	**<0.001**
Year moved in	1990 (1989–1992)	1990 (1989–1992)	1990 (1989–1991)	1991 (1991–1991)	0.221
Value of house[a]	91.0 (72.8–109.1)	90.3 (71.7–108.9)	94.4 (81.1–107.8)	102.4 (100.0–104.7)	0.227
Contract rent ($)	478 (412–543)	457 (390–523)	489 (441–537)	464 (457–470)	0.728

[a]Values in thousands of dollars.

*$P<0.05$ (in bold).

Table 3

Comparisons of category means (95% confidence intervals) for socioeconomic measures adjusted for county and urban status using two distance classes

Measure	0–2000 (ft)	>2k (ft)	*P*-value for buffer
Socioeconomic status			
MHI[a]*	**47.4 (44.4–50.5)**	**43.9 (43.2–44.6)**	**0.025**
PCI[a]	21.1 (19.6–22.5)	20.4 (20.0–20.7)	0.379
% Poverty*	**7.23 (6.11–8.56)**	**9.90 (9.57–10.24)**	**0.001**
% High school education*	**84.5 (82.8–86.3)**	**82.4 (82.0–82.8)**	**0.015**
% College education	31.0 (29.0–33.1)	30.3 (29.8–30.8)	0.503
% Employed	60.2 (58.6–62.0)	58.9 (58.5–59.3)	0.108
Demographics			
% White*	**95.7 (92.4–99.2)**	**91.5 (90.8–92.3)**	**0.014**
% <18 years	24.7 (23.7–25.8)	24.9 (24.7–25.2)	0.757
% >64 years	13.5 (12.5–14.6)	13.7 (13.5–14.0)	0.651
Housing characteristics			
% Owner occupied*	**79.3 (75.6–83.2)**	**71.8 (71.0–72.6)**	**<0.001**
Year the house was built*	**1963 (1962–1965)**	**1959 (1959–1960)**	**<0.001**
Year moved in*	**1990 (1990–1991)**	**1991 (1991–1991)**	**0.035**
Value of house*	**92.5 (83.0–101.9)**	**102.4 (100.1–104.7)**	**0.041**
Contract rent ($)	478 (444–511)	464 (457–470)	0.417

[a] Values in thousands of dollars.

* *P*<0.05 (in bold).

Table 4

Results for separate analyses of rural, urban, and suburban block groups.

Measure	Urban	Least squares means		*P*-value[a]		Scale
		0–2k	> 2k	Buffer	County	
Socioeconomic status						
MHI ($1000)	Rural	47.9 (45.7–50.0)	46.9 (46.2–47.6)	0.3637	<0.0001	
	Urban	**46.3 (41.0–51.6)**	**37.6 (35.5–39.8)**	**0.0005**	<0.0001	
	Suburban	50.4 (47.2–53.6)	49.5 (48.5–50.6)	0.5880	<0.0001	
PCI ($1000)	Rural	21.4 (20.3–22.5)	21.3 (20.9–21.6)	0.8610	<0.0001	
	Urban	20.7 (18.2–23.3)	18.8 (17.7–19.9)	0.1108	<0.0001	
	Suburban	22.5 (20.9–24.1)	22.4 (21.9–23.0)	0.9287	<0.0001	
%Poverty[b]	Rural	7.6 (6.6–8.7)	8.2 (7.8–8.6)	0.2355	<0.0001	3.5
	Urban	**6.7 (4.9–9.2)**	**14.2 (12.9–15.6)**	**<0.0001**	<0.0001	10.4
	Suburban	6.8 (5.9–7.9)	7.2 (6.9–7.5)	0.4468	<0.0001	4.6
% High school education	Rural	83.3 (81.2–85.4)	83.4 (82.7–84.0)	0.9285	<0.0001	1.7
	Urban	**85.4 (82.6–88.2)**	**80.3 (79.1–81.5)**	**<0.0001**	<0.0001	3.6
	Suburban	84.8 (82.5–87.2)	83.9 (83.1–84.7)	0.4205	<0.0001	2.8
% College education	Rural	27.9 (25.7–30.3)	28.6 (28.0–29.3)	0.5603	<0.0001	3.25
	Urban	**33.3 (30.1–36.7)**	**30.2 (28.7–31.8)**	**0.0315**	<0.0001	7.3
	Suburban	33.0 (30.6–35.6)	33.0 (32.1–34.0)	0.9949	<0.0001	5.0
% Employed[c]	Rural	61.4 (59.2–63.7)	61.3 (60.6–62.0)	0.9402	<0.0001	2.3
	Urban	56.9 (54.4–59.6)	55.0 (53.9–56.2)	0.1051	<0.0001	4.4
	Suburban	62.0 (59.5–64.6)	60.1 (59.2–60.9)	0.1337	<0.0001	3.8
Demographics						
% White	Rural	96.1 (93.7–98.6)	96.0 (95.2–96.8)	0.9377	<0.0001	2.3
	Urban	**97.9 (91.4–100)**	**86.7 (84.3–89.2)**	**0.0002**	<0.0001	9.0
	Suburban	94.1 (92.1–96.2)	93.9 (93.2–94.6)	0.8490	<0.0001	2.8
% <18 years	Rural	26.0 (24.9–27.2)	26.3 (26.0–26.7)	0.5716	<0.0001	2.1
	Urban	22.3 (20.6–24.1)	23.2 (22.4–24.0)	0.2848	<0.0001	5.4
	Suburban	25.7 (24.4–27.0)	24.7 (24.3–25.2)	0.1419	<0.0001	3.4

Measure	Urban	Least squares means		*P*-value[a]		Scale
		0–2k	> 2k	Buffer	County	
% >64 years	Rural	12.1 (11.1–13.2)	12.4 (12.1–12.8)	0.4926	<0.0001	2.75
	Urban	16.3 (14.5–18.3)	15.9 (15.2–16.6)	0.6761	<0.0001	6.5
	Suburban	12.5 (11.3–13.7)	13.0 (12.7–13.4)	0.3547	<0.0001	4.3
Housing characteristics						
% Owner occupied	**Rural**	**84.5 (82.3–86.8)**	**81.7 (81.2–82.2)**	**0.0138**	<0.0001	1.35
	Urban	**72.1 (65.8–79.0)**	**56.0 (53.7–58.4)**	**<0.0001**	<0.0001	6.7
	Suburban	79.9 (77.2–82.7)	78.9 (78.0–79.8)	0.4689	<0.0001	2.5
Year the house was built	Rural	1964 (1961–1967)	1962 (1961–1963)	0.1121	<0.0001	
	Urban	**1959 (1956–1962)**	**1949 (1948–1951)**	**<0.0001**	<0.0001	
	Suburban	1966 (1964–1968)	1965 (1964–1965)	0.2903	<0.0001	
Year moved in	Rural	1990 (1989–1990)	1990 (1990–1990)	0.3378	<0.0001	
	Urban	**1990 (1989–1992)**	**1992 (1992–1992)**	**0.0024**	<0.0001	
	Suburban	1990 (1990–1991)	1991 (1990–1991)	0.7254	<0.0001	
Value of house[d]	Rural	108 (100–116)	111 (109–113)	0.4410	<0.0001	
	Urban	**77.2 (60.5–93.9)**	**95.1 (87.4–103)**	**0.0198**	<0.0001	
	Suburban	108 (96.4–120)	114 (110–118)	0.3484	<0.0001	
Contract rent[e]	Rural	486 (464–508)	478 (471–484)	0.4739	<0.0001	
	Urban	483 (434–531)	454 (437–471)	0.2171	<0.0001	
	Suburban	492 (462–522)	490 (480–500)	0.9014	<0.0001	

[a] *P*-value based on Type III sum of squares.

[b] Based on number of individuals (as opposed to number of families, e.g.).

[c] % Employed among the population 16 years and over.

[d] Value of houses (thousands of dollars) occupied by the owner.

[e] Median contract rent is based on specified renter-occupied housing units paying cash rent.

[*] $P<0.05$ (in bold).