Published in final edited form as:
Clin Thyroidol. 2014 October ; 26(10): 273–276.

Cold Climate Is a Risk Factor for Thyroid Cancer

Steven Lehrer and **Kenneth E. Rosenzweig**

Abstract

Background—The incidence rates of differentiated thyroid cancers of all sizes increased between 1988 and 2005 in both men and women. Exposure to ionizing radiation is the best-established environmental risk factor for thyroid cancer. Nonionizing radiation from cell phones has also been implicated. A positive correlation between all-cancer incidence rates and latitude and an inverse correlation between all-cancer incidence rates and temperature have been reported. In the present study, we examined the relationship between thyroid cancer incidence and average temperature in 50 U.S. states.

Methods—The age-adjusted incidence of thyroid cancer is from U.S. Cancer Statistics Working Group, United States Cancer Statistics: 1999–2010, Incidence and Mortality Web-based Report (Atlanta: Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2013, available at: www.cdc.gov/uscs). Average temperature by state is from the National Climatic Data Center, National Oceanic and Atmospheric Administration (http://www.ncdc.noaa.gov). Information on high-impact exposure to nuclear radiation by state is from the National Radiation Exposure Screening and Education Program, U.S. Health Resources and Services Administration (http://www.hrsa.gov/gethealthcare/conditions/radiationexposure). Cell-phone subscriber data for 2007 is from the *Governing State and Local Sourcebook* (http://sourcebook.governing.com). Mean elevation and latitude of U.S. states is from "Elevations and Distances in the United States," Reston, VA: U.S. Geological Survey, April 29, 2005 (http://pubs.er.usgs.gov).

Results—There was a significant negative correlation between average temperature by state and the age-adjusted incidence of all thyroid cancers ($r^2 = -0.212$, $P = 0.001$). Because of the possible effects of ionizing radiation exposure from nuclear testing and nonionizing radiation exposure from cell phones, multiple linear regression analysis was performed. The analysis was done only for all thyroid cancers and for thyroid cancers in whites. The data from blacks and Hispanics were too fragmentary to analyze. In all thyroid cancers and thyroid cancers in whites, there was a significant negative correlation between average temperature and incidence that was unrelated to nuclear testing, cell-phone use, altitude, and latitude and was independent of the significant correlation of cell-phone subscriptions per population with thyroid cancer in whites.

Conclusions—Living in a cold-climate state, such as Alaska, doubles the risk of thyroid cancer as compared with a warm state such as Texas. Because of climate change, a significantly raised risk of heat-related and cold-related mortality is expected in the years to come. The elderly will be most at risk. No doubt, incidence patterns of thyroid cancer and other cancers may be affected.

Correspondence to: Dr. Steven Lehrer, Department of Radiation Oncology, Icahn School of Medicine at Mount Sinai, Mount Sinai Medical Center, Box 1236, New York 10029 or steven.lehrer@mssm.edu.

The incidence rates of differentiated thyroid cancers of all sizes increased between 1988 and 2005 in both men and women. The incidence has more than doubled since the early 1970s, and for women, it is the cancer with the fastest-growing number of new cases. The increased incidence across all tumor sizes suggests that increased diagnostic scrutiny is not the sole explanation. Other explanations include environmental influences and molecular pathways (1).

Background

Exposure to ionizing radiation is the best-established environmental risk factor for thyroid cancer (2). The thyroid gland of children is especially vulnerable to the carcinogenic action of ionizing radiation (3). Exposure to radiation from the Chernobyl nuclear power plant accident in 1986 and radioactive fallout from nuclear weapons testing in the 1950s have long been linked to thyroid cancer, but they would not account for all the new cases. Cell-phone radiation has been implicated (4–6).

The environmental factors of latitude and temperature have been correlated with overall cancer incidence rates. There is a positive correlation between cancer incidence rates and latitude and an inverse correlation between cancer incidence rates and temperature. The reason for these correlations is not clear (7).

We examined the relationship between thyroid cancer incidence and average temperature in 50 U.S. states.

Methods

The age-adjusted incidence of thyroid cancer, including nonthyroid epithelial cancer such as medullary thyroid cancer, is from the U.S. Cancer Statistics Working Group, United States Cancer Statistics: 1999–2010, Incidence and Mortality Web-based Report (Atlanta: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention and National Cancer Institute; 2013, available at: www.cdc.gov/uscs). Average temperature by state is from the National Climatic Data Center, National Oceanic and Atmospheric Administration (http://www.ncdc.noaa.gov). Information on high-impact exposure to nuclear radiation by state is from the National Radiation Exposure Screening and Education Program, US Health Resources and Services Administration (http://www.hrsa.gov/gethealthcare/conditions/radiationexposure). Cell-phone subscriber data for 2007 is from the *Governing State and Local Sourcebook* (http://sourcebook.governing. com). Mean elevation and latitude of US States is from *Elevations and Distances in the United States*, Reston, VA: U.S. Geological Survey, April 29, 2005 (http://pubs.er.usgs.gov).

Results

There was a significant negative correlation between average temperature by state and age-adjusted incidence of all thyroid cancers ($r^2 = -0.212$, $P = 0.001$) (Figure 1). Because of the possible effects of ionizing radiation exposure from nuclear testing and non-ionizing radiation exposure from cell phones, multivariate linear regression was performed (Table 1). The analysis was done for all thyroid cancers and for thyroid cancers in whites. The data

NIH-PA Author Manuscript

NIH-PA Author Manuscript

from blacks and Hispanics were too fragmentary to analyze. There was a significant negative correlation between average temperature and incidence of all thyroid cancers (P = 0.007) and thyroid cancers in whites (P = 0.009), unrelated to nuclear testing, altitude, and latitude and independent of the significant correlation of cell-phone subscriptions per population with thyroid cancer in whites (P = 0.026).

Discussion

This study shows a significant inverse correlation between temperature and thyroid cancer incidence, thus suggesting a protective effect of warm climate on the development of thyroid cancer. All subtypes of thyroid cancer were included, but the analyses were substratified and confirmed only in whites because data for other races were incomplete.

Living in a cold climate state, such as Alaska, doubles the risk of thyroid cancer as compared with living in a warm state such as Texas. While latitude, rather than temperature, might be the deciding factor, Steiner found that the incidence of all cancers correlated mostly strongly with temperature (7). We found no significant correlation between thyroid cancer incidence and latitude.

The basis of the association between cancer incidence and ambient temperature is not entirely clear. One theory holds that some component of the drinking of water might prevent cancer. Ambient temperature determines the amount of perspiration needed to maintain normal body temperature and, consequently, it determines the amount of water consumed. The warmer the climate, the more water is necessary to maintain body temperature through perspiration. People living in warmer temperatures would therefore consume more water (7). However, no one has shown that drinking water has anticancer properties (8).

Another possible basis of the association is change in thyroid activity with ambient temperature. Thyroid activity is known to be related to resting metabolic rate and is up-regulated in a cold environment (9).

The data would be strengthened by further analyses confirming whether the temperature–cancer trend persists in other regions of the world with similarly differing climate patterns, as well as over a longer timeframe and among other races. It would be interesting to assess whether the correlations remain significant according to temperature fluctuations within each state over a much longer period of time, as the present study assessed only temperature differences observed between states (with the differences between states assumed to be fairly constant over time). Inherent limitations of the study also include the generalization of temperatures for some regions that are quite large and lack of adjustment for known risk factors for thyroid cancer, including sex, family history, and direct personal head and neck radiation exposure.

Another weakness in the analysis presented above is possible confounding by the ecologic fallacy (or ecologic inference fallacy), a logical fallacy in the interpretation of statistical data in which inferences about the nature of individuals are derived by inference for the group to which those individuals belong (10). In this case, inferences about individuals are being drawn from the characteristics of U.S. states where they reside, rather than from the individuals themselves. An intrinsic difficulty with correlational studies is that two variables may be associated, even if there is no causal link between them, if each is associated with some other variable.

Nevertheless, the implications of the association between thyroid cancer incidence and ambient temperature are apparent. The incidence of thyroid cancer continues to rise, and this study presents novel data that should be further investigated as a potential additional mechanism for the increase. Because of climate change, a significantly raised risk of heat-related and cold-related mortality is expected in the years to come, with the elderly most at risk. No doubt, incidence patterns of thyroid cancer and other cancers may be affected.

References

1. Chen AY, Jemal A, Ward EM. Increasing incidence of differentiated thyroid cancer in the United States, 19882013;2005. Cancer. 2009; 115:3801–3807. [PubMed: 19598221]
2. Dal Maso L, Bosetti C, La Vecchia C, Franceschi S. Risk factors for thyroid cancer: an epidemiological review focused on nutritional factors. Cancer Causes Control. 2009; 20:75–86. Epub September 3, 2008. [PubMed: 18766448]
3. Ron E, Lubin JH, Shore RE, Mabuchi K, Modan B, Pottern LM, Schneider AB, Tucker MA, Boice JD Jr. Thyroid cancer after exposure to external radiation: a pooled analysis of seven studies, 1995. Radiat Res. 2012; 178:AV43–AV60. [PubMed: 22870979]
4. Mortavazi S, Habib A, Ganj-Karami A, Samimi-Doost R, Pour-Abedi A, Babaie A. Alterations in TSH and thyroid hormones following mobile phone use. Oman Med J. 2009; 24:274–278. [PubMed: 22216380]
5. Hilly O, Silva V, Mizrachi A, Ariel O, Raiter A, Hauptman Y, Hardy B, Feinmesser R. Effect of non ionizing electromagnetic radiation at mobile phone frequency on human thyroid cells. Presented at the World Thyroid Cancer Congress. 2013 abstract 22.
6. Esmekaya MA, Seyhan N, Omeroglu S. Pulse modulated 900 MHz radiation induces hypothyroidism and apoptosis in thyroid cells: a light, electron microscopy and immunohistochemical study. Int J Radiat Biol. 2010; 86:1106–1116. Epub September 1, 2010. [PubMed: 20807179]
7. Steiner GG. Cancer incidence rates and environmental factors: an ecological study. J Environ Pathol Toxicol Oncol. 2002; 21:205–212. [PubMed: 12435073]
8. Morris RD. Drinking water and cancer. Environ Health Perspect. 1995; 103(Suppl 8):225–231. [PubMed: 8741788]
9. Plasqui G, Kester AD, Westerterp KR. Seasonal variation in sleeping metabolic rate, thyroid activity, and leptin. Am J Physiol Endocrinol Metab. 2003; 285:E338–E343. [PubMed: 12857676]
10. Schwartz S. The fallacy of the ecological fallacy: the potential misuse of a concept and the consequences. Am J Public Health. 1994; 84:819–824. [PubMed: 8179055]

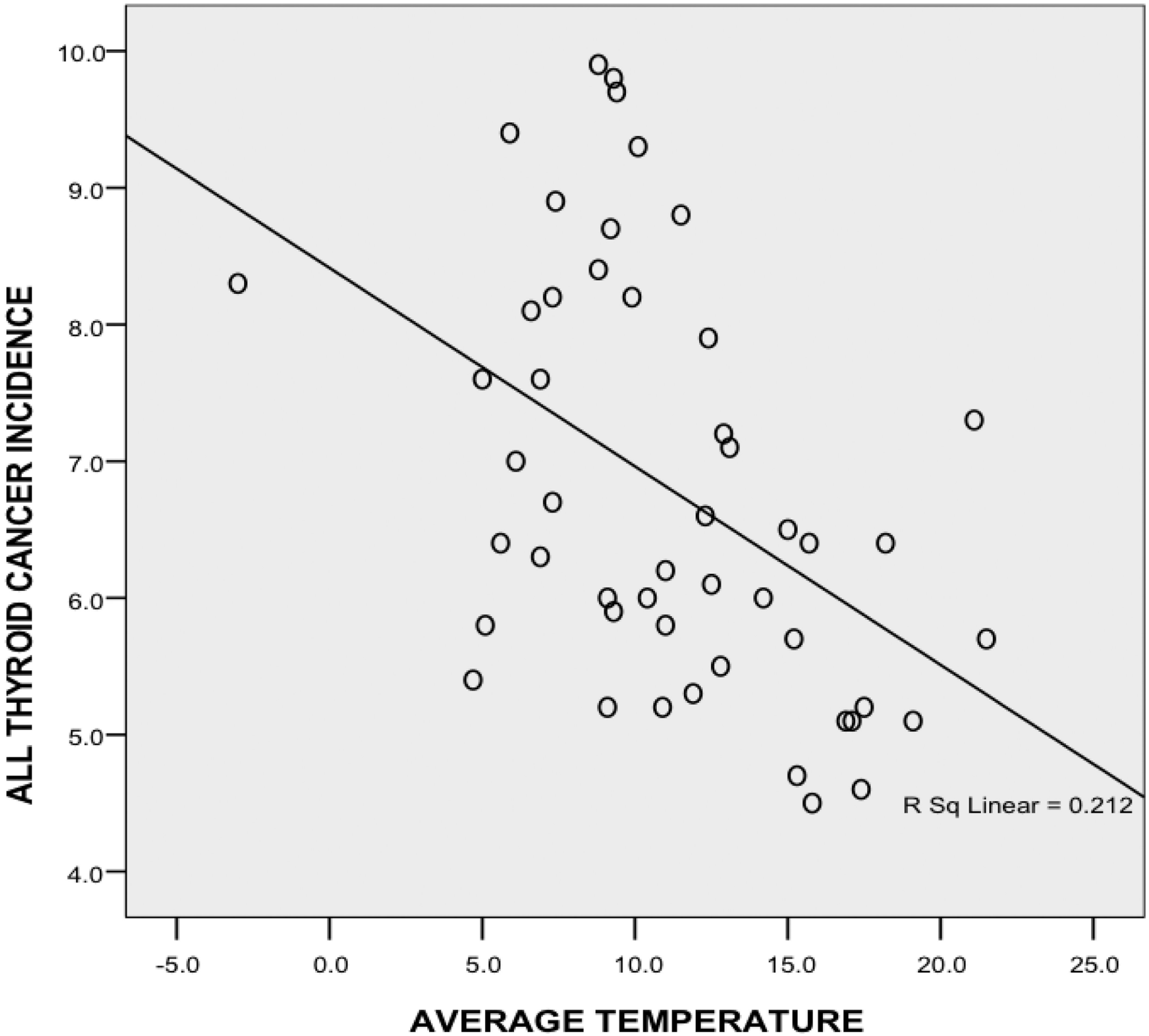

Figure 1.

Average Temperature of 50 U.S. States versus Age-Adjusted Incidence of All Thyroid Cancers (Cases per 100,000). The association is significant (P = 0.001).

Table 1

Results of Multivariate Linear Regression Analysis with Thyroid Cancer Incidence as the Dependent Variable.*

Independent Variable	Partial Correlation Coefficient (β)	P Value
All Thyroid Cancers		
Temperature	−1.285	0.007
Radiation exposure	−0.239	−0.242
Cell-phone subscription	0.256	0.077
Altitude	0.044	0.85
Latitude	−0.715	0.106
Whites		
Temperature	−1.241	0.009
Radiation exposure	−0.322	0.12
Cell-phone subscription	0.33	0.026
Altitude	0.055	0.815
Latitude	−0.694	0.119

* Blacks and Hispanics could not be analyzed separately because too much data were missing. Note that the effects of temperature and cell-phone subscriptions for whites were significant.