



Translating Research into Practice

Using Air, Water, and Lead Exposure as Measures of the Physical Environment: The Wisconsin County Health Ranking

by Matt Landis, Angela Kempf, Patrick L. Remington, Paul E. Peppard, Jane McElroy

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INTRODUCTION

The physical environment is an important determinant in the overall health of individuals and communities.¹ Though numerous studies have demonstrated an association between human health and specific environmental contaminants, there is a lack of consensus on how to quantify the overall effect environmental contaminants have on human health. This is due, in part, to the interplay among an array of environmental contaminants, the lack of comparable measurements in each community, and also uncertainty about their significant concentration level.

In an initial comparison of environmental health among Wisconsin communities, the Wisconsin Public Health and Health Policy Institute's 2003 Wisconsin County Health Rankings used lead poisoned children as the sole proxy measure to gauge the environmental health of Wisconsin's counties.² The Institute received feedback indicating that this single measure does not adequately reflect the overall health of the environment. Accordingly, as part of the evolution and refinement of the County Health Rankings, we propose three additional measures of the physical environment to incorporate into the Rankings addressing environmental health hazards associated with air, water, and lead exposure.

Three criteria must be satisfied for an environmental measure to be used in our health ranking. First, the contaminant in question has a reported impact on health demonstrated in literature and by policy. Second, the measurements of the contaminant must be publicly available by county and be updated periodically. Third, the data must be of sufficient quality and completeness.

METHODS

Literature reviews and consultations with environmental health experts were conducted to compile a list of potential measures. Based on our criteria, in addition to the lead poisoning measure, the next edition of the health rankings will include a measure of outdoor air quality, a measure of water quality, and a supplementary measure of potential lead exposure. Detailed methods and data sources can be found on the Institute website (www.pophealth.wisc.edu/wphi).

RESULTS

Outdoor Air Quality: Emissions and Monitoring Data

The EPA's National-Scale Air Toxics Assessment (NATA) looks at 33 air pollutants and their potential health effects in the United States. These pollutants are irritating and possibly damaging to the lungs, and are associated with many respiratory issues such as allergies, asthma, chronic bronchitis, lung cancer, and other ailments.³ This assessment is based on emissions estimates from hundreds of sources including point sources, area sources, on road and off road mobile sources. EPA modeling of these emissions data provides an estimate of cancer and non-cancer risk, with lifetime cancer risk is reported as "N" in a million likely cases due

to a lifetime (70 years) of continuous exposure, and a hazard index describes non-cancer risk. Median values for both are reported at the county level and were obtained online.

Ozone and fine particulate matter (PM_{2.5}) were selected for the Rankings because of their well established negative health impact. The 2001-2003 "annual average 4th highest peak daily running 8-hour ozone values" were available from Wisconsin DNR ozone monitoring sites in 29 counties. Three years of annual PM_{2.5} values were available from Wisconsin Federal Reference Method monitoring sites in 18 counties between 2000 and 2003. For counties having more than one monitoring site, an average of the most recent county site values was used. Counties without measurements were assigned a value equal to the average of the counties within their region.

Water Quality: Percent of Residents With Elevated Drinking Water Nitrate Concentrations

The ingestion of nitrates found in groundwater can result in methemoglobinemia or cyanosis in infants, a result of nitrate toxicity. This condition can progress rapidly to coma or death if left untreated.^{5,6} Given Wisconsin's reliance on groundwater, it is acceptable to suggest the possibility of an elevated health risk associated with nitrate concentrations beyond the federally set Preventative Action Level (>2mg/L). Also, nitrate concentrations exceeding the federal Enforcement Standard of 10mg/L bring about further elevations in risk. Groundwater supplies approximately 70% of the water used in Wisconsin households and the municipal water used

Patrick Remington, MD, MPH, Director
D. Paul Moberg, PhD, Deputy Director
David Kindig, MD, PhD, Senior Consultant

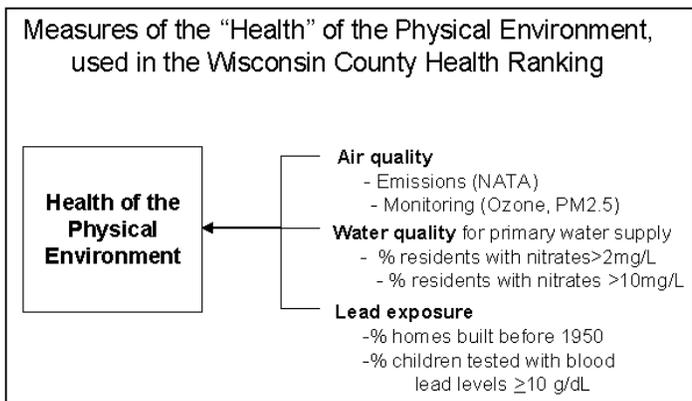
Department of Population Health Sciences
University of Wisconsin Medical School
Suite 760, 610 Walnut Street
Madison, WI 53726-2397
Phone: (608) 263-6294 • Fax: (608) 262-6404
[Http://www.pophealth.wisc.edu/wphi](http://www.pophealth.wisc.edu/wphi)

the municipal water used by 608 cities and villages.⁷ Testing of nitrate contamination in drinking water from community water supplies was mandated in the 1986 Safe Drinking Water Act Amendment. Therefore, the many data points available for nitrates at the county level make it an excellent contaminant measure to incorporate into the County Ranking. We have developed an approach in which both municipal sources and private wells are used to estimate the percent population in each county exposed to excessive nitrates from their primary water supply.

Two rankings weighted by relative county population equally contribute to our report card. The first involves using all nitrate concentrations exceeding 2mg/L, reflecting the percent county population exposed to levels greater than the Preventive Action Limit and Enforcement Standard. The second ranking includes only detects over the Enforcement Standard. These calculations are made to address both municipal and private sources of contamination while acknowledging that there is increased risk for detections over the Enforcement Standard. Over a year of measurements, no municipal water source had an average concentration exceeding 10mg/L, and therefore detects over this level are reflective only of the county population using private wells as the main source of drinking water. This is achieved for all counties except Menominee County, for which data is not available as the DNR does not report monitored levels publicly or privately.

Lead exposure: Percent of Housing Stock Built Before 1950 and Percent of Positive Lead Tests

One source of environmental contamination is lead in paint or in the soil. Communities with higher levels of lead contamination are likely to have higher rates of lead exposure among children. Therefore, we use the percent of children who are tested for lead levels, who are above 10µg/dL. These data come from the Wisconsin Division of Public Health and are collected from over 50 state labs as well as health care groups and out of state labs testing individuals in the state. The sample from which numbers are drawn is not random; it is a result of targeted screening of high risk children primarily in Medicaid and WIC programs and ad hoc testing of other children. Results must also be reported when families and/or physicians believe there is some impetus to test. This leaves the possibility that counties actively encouraging testing of high risk children may look worse due to higher detection rates. To offset this



problem of screening bias, a proxy of lead risk will be included with equal weight: percentage of housing stock built before 1950.^{8,9,10} The data are available from the US Census Bureau’s American Fact Finder.

The Summary Measure of Environmental Health

Wisconsin’s counties are ranked individually on each measure of air, water, and lead exposure. These ranks are then incorporated such that each aspect of the physical environment contributes 1/3 to the overall summary ranking. The summary measure and resulting county rank ultimately contributes to 10% of health determinants² (See Figure).

DISCUSSION

We propose a single measure of environmental health using air, water, and lead measures available for Wisconsin Counties. Although incomplete this measure serves to better assess the physical environment’s contribution to overall community health, as well as encourage discussion on further efforts to improve environmental monitoring and eventually health improvement initiatives.

Several caveats need to be considered when interpreting these measures. First, the measures themselves are not random measurements – private well testing focuses mainly on new wells being built, families living on farms, and on families with pregnant women or young children. Blood tests for lead are usually directed at high risk populations. Second we arbitrarily weight the air, water, and lead exposure aspects equally.

Further, other environmental factors certainly contribute to community health. Exposure to indoor air pollutants, toxic chemical releases, and unsafe food are other important examples of environmental health threats. However, difficulties arise when attempting to incorporate such measures into the Ranking. Such data may not be available on the county level, are based on environmental releases and not

human exposures, or are sporadic and rare in that only certain counties are affected.

In summary, our effort to improve the environmental aspect of the County Health Ranking has produced additional measures with direct ties to human health. These measures can be updated in the future to monitor environmental change as a health determinant. The addition of these measures to the 2004 Ranking provides a cohesive and straight forward framework which policymakers can use to assess the contribution of the environment to overall community health. Future goals are to continue to identify and evaluate county-level environmental health measures and their potential impacts on human health.

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