



HHS Public Access

Author manuscript

J Public Health Manag Pract. Author manuscript; available in PMC 2017 November 02.

Published in final edited form as:

J Public Health Manag Pract. 2015 ; 21(Suppl 2): S23–S35. doi:10.1097/PHH.0000000000000181.

A Decade of Environmental Public Health Tracking (2002-2012): Progress and Challenges

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Abstract

Background—The creation of the Centers for Disease Control and Prevention Environmental Public Health Tracking Program spawned an invigorating and challenging approach toward implementing the nation’s first population-based, environmental disease tracking surveillance system. More than 10 years have passed since its creation and an abundance of peer-reviewed articles have been published spanning a broad variety of public health topics related primarily to the goal of reducing diseases of environmental origin.

Objective—To evaluate peer-reviewed literature related to Environmental Public Health Tracking during 2002-2012, recognize major milestones and challenges, and offer recommendations.

Design—A narrative overview was conducted using titles and abstracts of peer-reviewed articles, key word searches, and science-based search engine databases.

Main Outcomes—Eighty published articles related to “health tracking” were identified and categorized according to 4 crossed-central themes. The Science and Research theme accounted for the majority of published articles, followed by Policy and Practice, Collaborations Among Health and Environmental Programs, and Network Development.

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The authors declare no conflicts of interest.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conclusions—Overall, progress was reported in the areas of data linkage, data sharing, surveillance methods, and network development. Ongoing challenges included formulating better ways to establish the connections between health and the environment, such as using biomonitoring, public water systems, and private well water data. Recommendations for future efforts include use of data to inform policy and practice and use of electronic health records data for environmental health surveillance.

Keywords

environmental health; epidemiology; exposure; surveillance

In 2000, the Pew Environmental Health Commission's landmark report, *America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network*, identified the lack of a national, coordinated system that could track environmental health hazards, exposures, and health outcomes.¹ In response, Congress appropriated funding to the Centers for Disease Control and Prevention (CDC) to develop the first national public health system that would assist in preventing diseases caused by environmental health threats. In 2002, CDC's National Environmental Public Health Tracking Program (Tracking Program)² was established with a purpose to "provide information from a nationwide network of integrated health and environmental data that would drive actions to improve the health of communities."³ For more than a decade, the CDC has engaged stakeholders from local, state, and other federal health and environmental agencies, universities, and not-for-profit organizations to assist with developing this effort. Since that time, active communities of partners have demonstrated multidisciplinary approaches toward successfully creating and implementing the nation's first Environmental Public Health Tracking Network (Tracking Network). In 2009, the CDC and several local and state-funded health department partners launched their Environmental Public Health Tracking Web portals on the World Wide Web (<http://www.cdc.gov/ephrtracking>). The CDC national portal and state/local Web portals offer the ability to readily display environmental hazards, exposures, and health outcomes data and information over the Internet. Tremendous collaborative efforts among the CDC and its partners have resulted in the successful development of the first nationally coordinated, integrated environmental public health surveillance system. Presently, the National Tracking Network provides easy-to-find data and information on a variety of environmental public health topics for scientists, researchers, health entities, and the general public to explore and examine. For more than a decade, the combination of federally funded city, state, and local health departments and university partners have worked to develop the Tracking Network to its current state. Since that time, an abundance of peer-reviewed articles have materialized on a variety of topics related to these efforts. Many publications have been written in the context of disease surveillance, with an emphasis on reducing diseases of environmental origin using population-based epidemiologic methods and techniques. Other publications include policy development, collaborations, and practice-based public health actions. In 2008, the *Journal of Public Health Management and Practice* featured an entire publication on articles specific to Environmental Public Health Tracking.⁴ With the Tracking Program surpassing its 10th year of development, the authors set forth to provide an overview of the progress and challenges through a review of the published literature. This comprehensive review attempts to

summarize these efforts while identifying central themes, temporal trends, key milestones, and future recommendations for the Tracking Program.

Methods

Search strategy

Major databases and search engines including PubMed, Web of Science, Ovid, CINAHL, and Web of Knowledge were used to search and identify articles related to environmental public health tracking. Search criteria included publication dates between January 1, 2002, and December 31, 2012. Medical subject headings (MeSH) and key word searches including “health tracking,” “tracking,” and “environmental public health tracking” were used to limit citations. The titles and abstracts of the articles were identified from searches and then developed into a master list of citations. Cited references from full-text articles were also reviewed to locate any additional articles. To be considered as a reference, an article must have met inclusion/exclusion criteria for the following conditions: (1) written in English, (2) published in a peer-reviewed journal, and (3) describe, refer, or make specific mention to the CDC, National Center for Environmental Health, Environmental Public Health Tracking Program. Because the Tracking Program is a nationally funded program and operates primarily through cooperative agreements and contract mechanisms, the authors anticipated that most articles would originate from CDC Tracking Network partners including state and local health departments, not-for-profit organizations, and universities. As an additional measure, CDC Project Officers, responsible for managing Tracking Program partnerships, were contacted and asked to provide publications that may have been otherwise missed through the electronic database search.

Selection process

For the selection process, the authors read each of the full-text articles from a master citation list to determine whether the article met the aforementioned inclusion/exclusion criteria. As part of the review process, the authors reviewed each of the articles independently and then collectively categorized the articles on the basis of their primary subject content. Following the review of the published articles, the authors identified 4 emerging central themes and grouped them accordingly: (1) Science and Research, (2) Policy and Practice, (3) Network Development, and (4) Collaborations Among Health and Environmental Programs. Working definitions were developed to assist with categorizing each article into 4 distinct groups as follows:

- *Science and Research*—Identify patterns of disease, adverse health effects, biomonitoring, public health surveillance, or scientific methods.
- *Policy and Practice*—Related actions to protect or improve health; provide a better understanding of what is occurring in communities; provide information that informs or evaluates legislative actions and policy decision making and effective risk communication at state and/or local levels.
- *Network Development*—Highlight information technology (IT) capability or functionality, software architecture, or improving electronic data methods and data content on the Tracking Network.

- *Collaborations*—Workgroup initiatives, interactions, or strengthening partnerships to improve the overall Tracking Program or Tracking Network.

The quality of evidence and conclusions from each article were summarized. Publications that contained multiple themes were listed in 2 or more categories.

Results

As shown in Figure 1, the initial literature search retrieved a total of 297 citations. After screening titles and abstracts, conducting journal-specific searches, and reviewing any reference citations, a total of 80 articles were considered for review and are listed in the Table.

As shown in Figure 2, the percentage of articles according to their central theme(s) is as follows: Science and Research, 71%; Policy and Practice, 24%; Network Development, 16%; and Collaborations, 11%.

Summaries of publications by themes

The results of each of the reviewed publications were summarized on the basis of its central themed category. The articles that had more than 1 central theme were placed into more than 1 category. First, Science and Research category included a collection of scientific and epidemiologic applications, accounting for the overall largest number of published articles. The most commonly recurring topic areas among those articles reviewed in this category related to 1 or more of the following: evaluating environmental hazards, adverse health outcomes, epidemiologic methods, or approaches for conducting disease surveillance.* Generally, the articles reviewed in this category demonstrated or offered modeled approaches of epidemiology and/or surveillance methods for estimating disease risk, inferences, or single case studies. Overall, a majority of the articles focused on outdoor air pollution and accounted for 37% of publications in this category. The articles that demonstrated a specific adverse health outcome or health effect associated with outdoor air pollution is as follows: asthma (38%),^{14,19,42,43,48,55,66,69} acute myocardial infarction (19%),^{14,57,58,69} cancer (10%),^{21,34} adverse birth or reproductive outcomes (10%),^{68,75} other respiratory diseases (10%),^{42,56} and other cardiovascular disease outcomes (10%).^{61,68} Nine percent of the articles in the Science and Research category focused on water contaminants. Two of these articles discussed contaminants in water and the association with health effects.^{33,35} One article associated nitrates in surface water with cardiovascular disease,³³ and the other associated trichloroethylene in ground water with cancer.³⁵ Biomonitoring measurements in populations^{27-29,39,53,77} accounted for 11% of articles in this category, with 1 article linking data measurements of blood lead levels in children and developmental disabilities.³⁹

Second, 19 articles met the definition of *Policy and Practice*.[†] Ninety-five percent of these publications related to guiding policy, public health practice, or public health actions toward

*References 8, 9, 11, 13-16, 19-23, 26-29, 31, 33-35, 39, 41-44, 48-50, 53-69, 72, 74-84.

†References 5, 6, 8, 10, 12, 17, 18, 34, 36, 37, 40, 45, 46, 62, 64, 70, 71, 73, 78.

improving health outcomes.[‡] One article advocated for a risk assessment framework to communicate individual and community-wide air pollution study results.⁷¹

Third, 13 articles reviewed had a central theme and met the definition of *Network Development*.[§] Among those articles reviewed, 46% of the publications described state and local efforts for building information surveillance systems for various health outcomes such as cancer and birth defects.^{7,32,41,50-52} Thirty percent of the articles in this group were related to best practices and offered guidance related to disease surveillance techniques for the Tracking Network.^{15,30,45,54} Twenty percent of the publications described the accomplishments and challenges of developing the National Tracking Network.^{12,38,47}

Fourth, 9 articles reviewed identified efforts that were focused on Collaborations.^{||} Sixty-seven percent of the articles reviewed in this category related to collaborative efforts among local, state, and/or federal government agencies,^{9,12,24,37,40,44} 11% among Tracking grantees,⁵⁴ and 11% among community leaders.¹⁸ One article (11%) described linking environmental data from an environmental agency with health data from health agencies to form a sustainable partnership.³⁶

Chronological trends in publication themes

To examine progress and challenges chronologically over the 10-year review period, the reviewed publications were separated into 3 distinct time periods: 2002-2005, 2006-2008, and 2009-2012. These time periods correlated with the general developmental stages of the Tracking Program. From 2002 to 2005, the Tracking Program focused primarily on infrastructure and technical specifications for the Network, workforce-capacity building, and data linkage pilot projects. The period from 2006 to 2008 focused on building and implementing the national and state/local networks, and that from 2009 to 2012 focused on enhancing and using the national and state/local Tracking Networks to inform others (Figure 3).

Publications from the first time period (2002-2005) included Science and Research (55%), Network Development (27%), Policy and Practice (45%), and Collaborations (18%). The primary trend of articles published during this time highlighted work activities related to capacity building and developing the infrastructure for the Tracking Program. For example, many publications focused on pilot projects conducted by funded partners and demonstrated the use of existing data sources for environmental public health surveillance. Several articles emerged during this time that conceptualized the design principles of how the future Tracking Network should be structured.

Publications from the second time period (2006-2008) were as follows: Science and Research (67%), Network Development (23%), Policy and Practice (19%), and Collaborations (16%). Articles from the time period primarily entailed data linkage projects and investigating relationships between disease outcomes and environmental hazards. Several articles described data sources and development of indicator measures as tools for

[‡]References 5, 6, 8, 10, 12, 17, 18, 34, 36, 37, 40, 45, 46, 62, 64, 70, 73, 78.

[§]References 7, 12, 15, 30, 32, 38, 41, 45, 47, 50, 52, 54.

^{||}References 9, 12, 18, 24, 36, 37, 40, 44, 54.

environmental health surveillance. Other articles from this time period included moving from concept to implementation to build and develop a model for the Tracking Network.

The third time period (2009-2012) included the period when national, state, and local health departments launched their Tracking Network Web portals. Many of the publications focused on increasing the use of environmental, health, and exposure data within state Tracking Programs. Articles and related themes identified during that time were as follows: Science and Research (85%) and Policy and Practice (23%). There were no published articles related to Collaborations or Network Development during this time period.

Discussion

The 2000 Pew companion report (*America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network*) was instrumental in recognizing the need for developing a national environmental public health surveillance system. Although several issues identified in the report still remain relevant, this literature review documents the significant progress and achievements made for improving the integration of environmental public health surveillance at local, state, and national levels. On the basis of this review, the authors collectively summarized and identified articles from each of these 4 themes that they felt represented milestones, key issues, important highlights, and challenges for the Tracking Program and present them in the following text.

Science and Research

In general, outdoor air quality and health issues were the highest number of published articles. Early explorations of data linkages between cardiovascular and respiratory health with outdoor air quality by Boothe et al¹⁴ and Chinery and Walker⁵⁹ were followed in 2006 by an organized symposium on air pollution and health. This event appeared somewhat pivotal, bringing together the Environmental Protection Agency, CDC, and many Environmental Public Health Tracking stakeholders together to address air quality and health issues while developing strategies for building capacity across agencies and communities. Following the conference, McKone et al⁶⁵ and Ozkaynak et al⁶⁷ summarized and reported that workgroup participants' recommendations included obtaining better exposure information for evaluating health effects and improving data linkage and data integration in exposure assessment approaches.

Other science and research articles by Mather et al¹¹ described novel statistical approaches for evaluating environment-disease relationships and enhanced environmental disease surveillance. Later, a trend toward methods for data linkage of exploring health outcomes with exposure and hazards and how to improve upon them become more prevalent. Another milestone noted was the introduction of environmental public health indicators, measures, and software tools for assessing health outcomes, exposure, or environmental hazards.²¹ Using more refined health-level data, Beale et al⁷⁴ and Ball et al³⁵ demonstrated the utility of using a geographic information system tool (The Rapid Inquiry Facility) for assessing spatial relationships between selected health outcomes and diseases. Aggregated health data, which are supplied by state and local health departments, represent the majority of

environmental public health indicators and measures. Indicators play a vital role for comparing health outcomes, exposures, and hazards data on the Tracking Network.

From our review of the science and research articles, we noted 1 article related to biomonitoring and 2 articles on drinking water. The biomonitoring publication demonstrated the linkage between blood lead levels in children with developmental disabilities.³⁹ One drinking water article linked nitrates in water with cardiovascular disease,³³ and the other article examined trichloroethylene in ground water with cancer.³⁵ We recognize drinking water and biomonitoring as areas where data linkages could be expanded, and more work is recommended in these areas.

Network Development

Information technology and the ability to access surveillance data are critical components of the Tracking Program. The early development of the Tracking Program included several articles that discussed IT network development and the functions of how an ideal national tracking system could function. These articles discussed the development of using standardized data from multiple hazard, exposure, and health information systems; tools to link these data; and role-based access to sensitive health data.^{12,38,45} The development of disease-specific health tracking systems was presented in some of these articles. For example, a Web-based birth defects registry in New York State demonstrated the completeness, timeliness, and quality of birth defects registry data.^{32,51} In a separate article, the Wisconsin Department of Health developed a childhood cancer surveillance system that automated data exchange between hospital and public health–based cancer registries.⁷ This approach appeared well developed. However, as noted, challenges included substantial resources needed to develop these types of systems; data sharing; the need to improve public health infrastructure; and the need to develop environmental public health workforce.

Other publications in this category identified the technical aspects of building the Tracking Network and describing major functions of developing a secure and Web-based information system. These functions included data visualization techniques, compliance with public health information network standards, and providing exchange of data between states and the national network and between federal agencies.^{7,12,38,41,50} Challenges facing design and implementation of tracking systems were identified and could be addressed, for example, systems compatibility issues because of several and varying existing data standards.¹² In some cases, the existing standards were not adequate. For example *International Classification of Diseases, Ninth Revision*, codes did not provide unique information for reportable birth malformations.⁵¹

Additional publications we identified as being fundamental articles for the Tracking Network recommended best practices for building tracking systems (eg, taking advantage of existing active, passive, or sentinel surveillance systems),¹⁵ using scientific and theoretical methodologies for prioritizing and selecting content for an environmental public health surveillance system,⁴⁵ taking advantage of common area and population linking variables similar in time and space,³⁰ and using existing data standards (eg, metadata standards) instead of developing new standards.⁴⁷

Policy and Practice

Many articles reviewed in this area offered information that could be used to help guide public health policy and actions. Several significant articles recognized in this category included strategies for developing new partnerships between health departments and data stewards for obtaining relevant public health surveillance data.^{8,17} For example, Knorr et al⁸ demonstrated a unique partnership among a local health department and school districts to provide community-level pediatric asthma surveillance data and identify components and methodologic issues for a nationwide tracking system for pediatric asthma. Athens et al³⁴ demonstrated Tracking as a mechanism to inform health policy by developing county health profiles in Wisconsin to portray potential associations between patterns of health determinants and health outcomes. Charleston et al³⁷ identified and derived information on calculating return on investment for sustaining a Tracking program. In another article, Wartenberg and Thompson⁷⁸ described the consequences of restrictive health data access policies on public health surveillance and epidemiologic research. Their article highlighted the impact of restricting data fields such as “mother’s residential address” and “date of birth,” which are essential for linking environmental exposures with health outcomes, and restricting access to data from educational records necessary for linking to risk factor data. The article also placed emphasis on the impact of privacy protection on public health research and the need for an agreed approach to keep selected data variables anonymous. Wartenberg⁷¹ also presented a risk assessment framework for communicating individual and community-wide air pollution study results. As described, this model could be used to refine important environmental health communication messages between scientists, policy makers, and stakeholders and to present information in formats that would include nonscientific and scientific communities. Conclusions from this article articulated that the Tracking Program offers valuable opportunities for developing, testing, and improving important health communication messages to others.

Collaborations

Initially, the Tracking Program attempted to build capacity and collaborations among local, state, and federal governments, academic partners, and key stakeholders (eg, advocacy groups, community leaders, public health practitioners, and researchers). Collaborations show the importance of engaging community stakeholders in using environmental and public health data to provide context and meaning regarding the health of a community. As a result, several articles were published proposing partnerships or attempts to broaden the National Tracking Program among state/local grantees. Laflamme and Vanderslice⁹ examined partnerships between state and federal agencies and suggested the use of environmental health-related modules as part of state BRFSS (Behavioral Risk Factor Surveillance Systems). Wartenberg et al⁵⁴ proposed an integrated regional, multistate collaboration between health departments using adverse birth health outcomes and outdoor air quality as a proposed model. Once developed, a collaborative environmental health surveillance would allow states to share standard data among themselves and analyze data for regional interpretations. In other collaborative projects, Glad et al⁸ assessed health indicators among a local community and the Massachusetts Department of Health worked to implement a statewide school health surveillance program among children with asthma.⁶

Temporal trends in publication themes

Publications from the first phase (2002-2005) focused primarily on capacity building, methods, and infrastructure. A majority of the articles reviewed in the second phase (2006-2008) of the Tracking Program focused more specifically on data linkage projects with suggestions for enhancing collaboration opportunities and better defining what type of adverse health outcomes, exposures, or environmental hazards to track. The ability to use these data for increased public health actions within each state was also emphasized. In the third phase (2009-2012), a majority of publications focused on associations between health effects (ie, cardiovascular diseases, congenital malformations, and respiratory diseases) with outdoor air pollution. An increase in the number of data linkage articles surfaced primarily from grantees (in academia and health departments) using refined or individual level health data (eg, daily counts of hospitalizations below the county level). Nonsensitive health data are available on the Tracking Network to protect confidentiality. Data at the aggregated level may be less robust for some data linkage projects but good when comparing disease rates or conducting ecologic type studies. The temporal trend provides strong evidence of a concerted and collaborative partnership between Environmental Protection Agency and CDC scientists to address data gaps and improve our ability to link health and environmental data. This is best demonstrated by work started in 2004 to provide modeled ozone and PM_{2.5} (particulate matter) estimates to fill spatial and temporal gaps in monitoring data.⁸⁵ These data and their continued evaluation and enhancement over time are a product of this collaboration.

Conclusion

Over the past 50 years, the health burden has made a dramatic shift from infectious to chronic diseases in the US population.¹² In several cases, research has confirmed disease outcomes with environmental exposures, however, causality is difficult to establish and many environmental and health connections remain unproven⁴⁶ Prior to establishment of the Tracking Network's infrastructure, detailed health and environmental data were maintained in separate silos from different agencies and organizations and were largely unavailable. From our review, the availability of data, tools, standards, and support for improving capacity among local, state, and federal health and environmental agencies for environment and disease surveillance has increased. Examples include collaborations among federal, state, and local agencies; generation of new questions and research to better understand the health-environment link; and availability of data to inform decision making for public health programs and policies. To further illustrate, researchers and public health practitioners at local and state health departments now have better access to nationally consistent data on hospitalization and emergency department visits data and the ability to perform data linkage studies using modeled air pollution concentrations.^{2,86}

Despite the great strides that the Tracking Program has made, several challenges identified by the Pew companion report still remain. Examples include lack of data on specific health conditions such as neurologic disorders and environmental contaminants such as persistent organic pollutants. Our review shows a need for formulating ways to better establish the connections between health and the environment, such as using biomonitoring, public water

systems, and private well water data. In moving forward, there are issues intrinsic to environmental epidemiology that will need to be considered when linking health and environmental data to produce meaningful results. Examples include length of latency periods for certain diseases and, obtaining accurate exposure data. In addition, a robust, national surveillance system should include all states. However, not all state health departments are represented or participate in the Tracking Network and therefore, data and measures for certain health, environment and exposure indicators are not available.

However, opportunities exist in the coming decade to further address both these data gaps and methodologic issues. With ongoing efforts to implement the use of electronic health records in clinical practice increasing, the Tracking Network may be able to capitalize on these efforts to enhance environmental health surveillance.^{87,88} Efforts to provide more spatially and temporally refined data measures on environmental hazards, exposures, and health outcomes may help to better answer questions regarding health-environment linkages. In summary, the Tracking Program has made huge strides by developing an infrastructure for making health, exposure, and environmental hazards data available and increasing capacity for understanding associations of diseases of environmental cause.

Acknowledgments

There was no funding received for this work.

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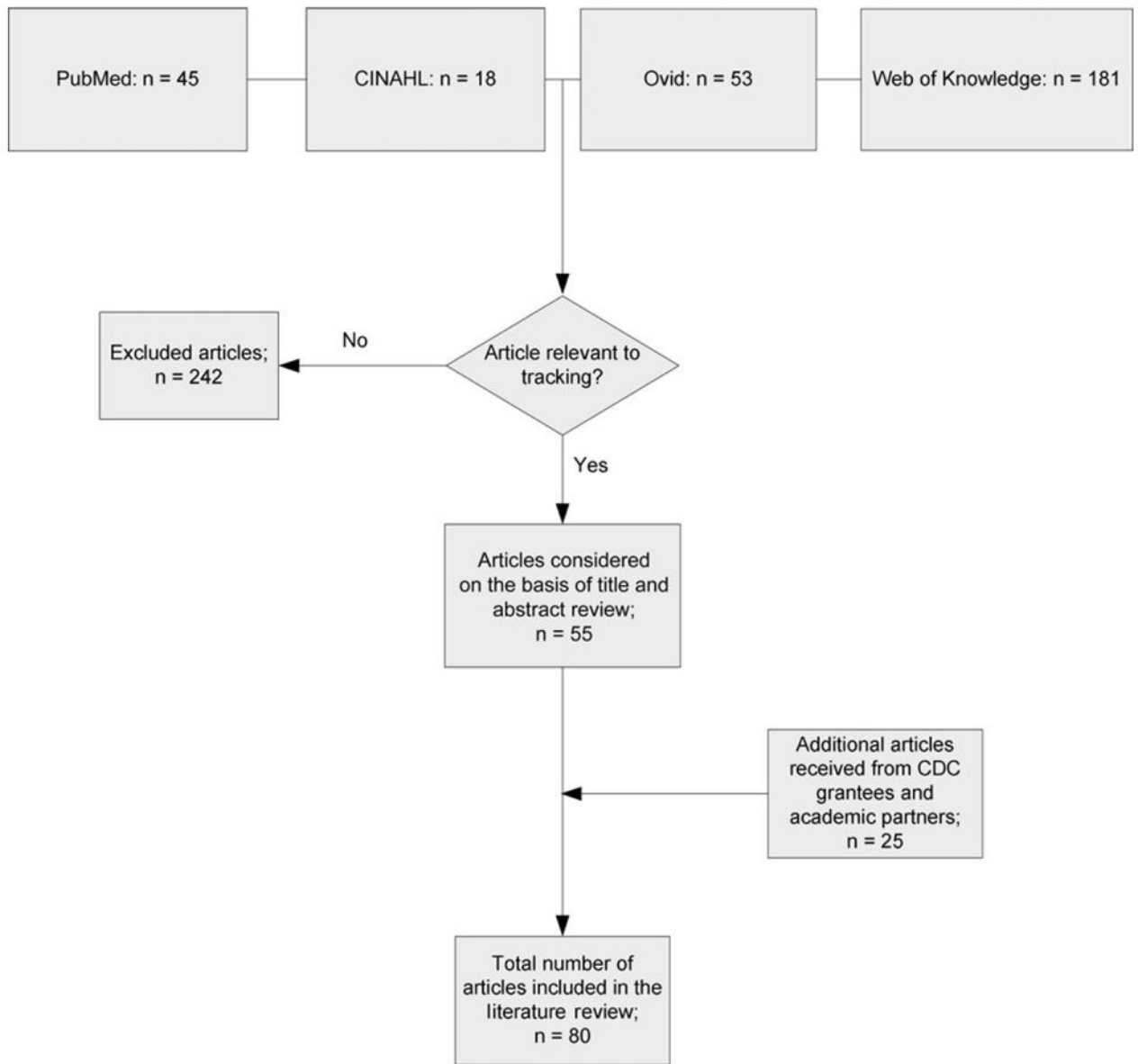


FIGURE 1. Search and Selection Strategy for Literature Review for Publications Related to Environmental Public Health Tracking (2002-2012)

Abbreviation: CDC, Centers for Disease Control and Prevention.

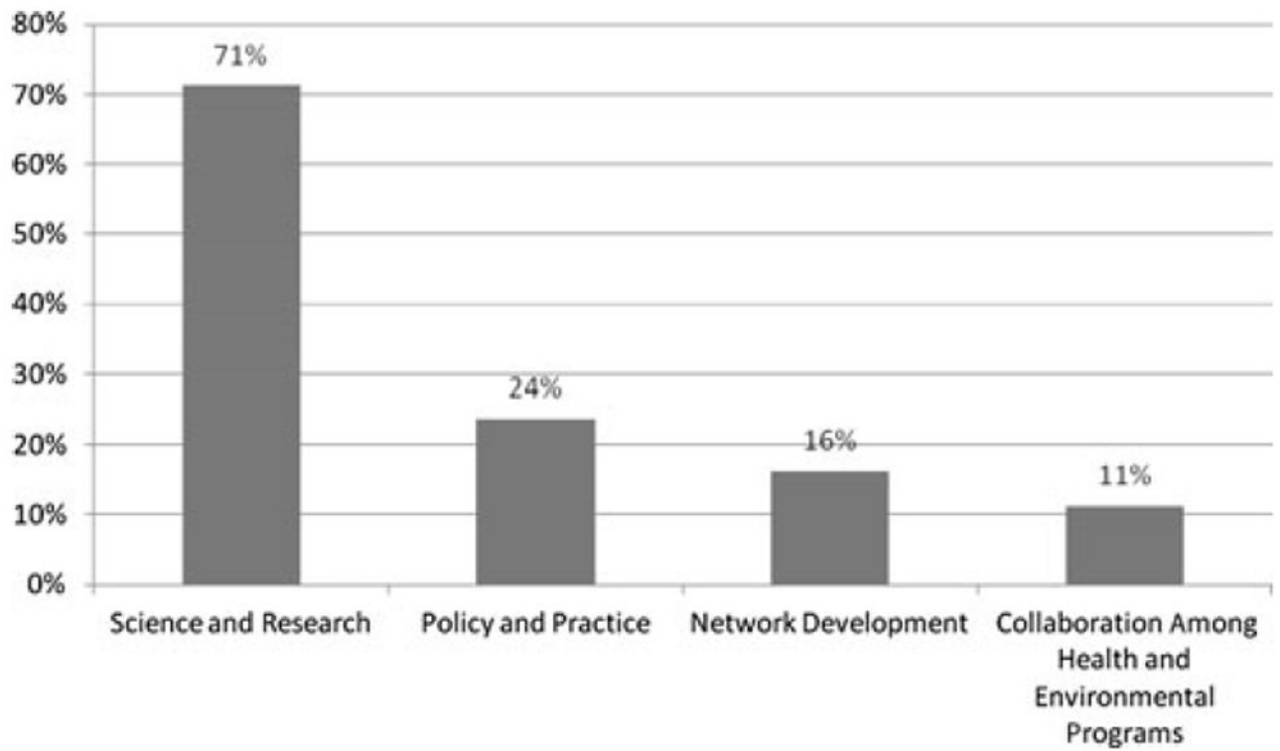


FIGURE 2. Percentage of Publications According to Central Themes Among Articles Reviewed (N = 80)^a

^aSeveral articles were recognized in more than 1 category; therefore, the total exceeds 100%.

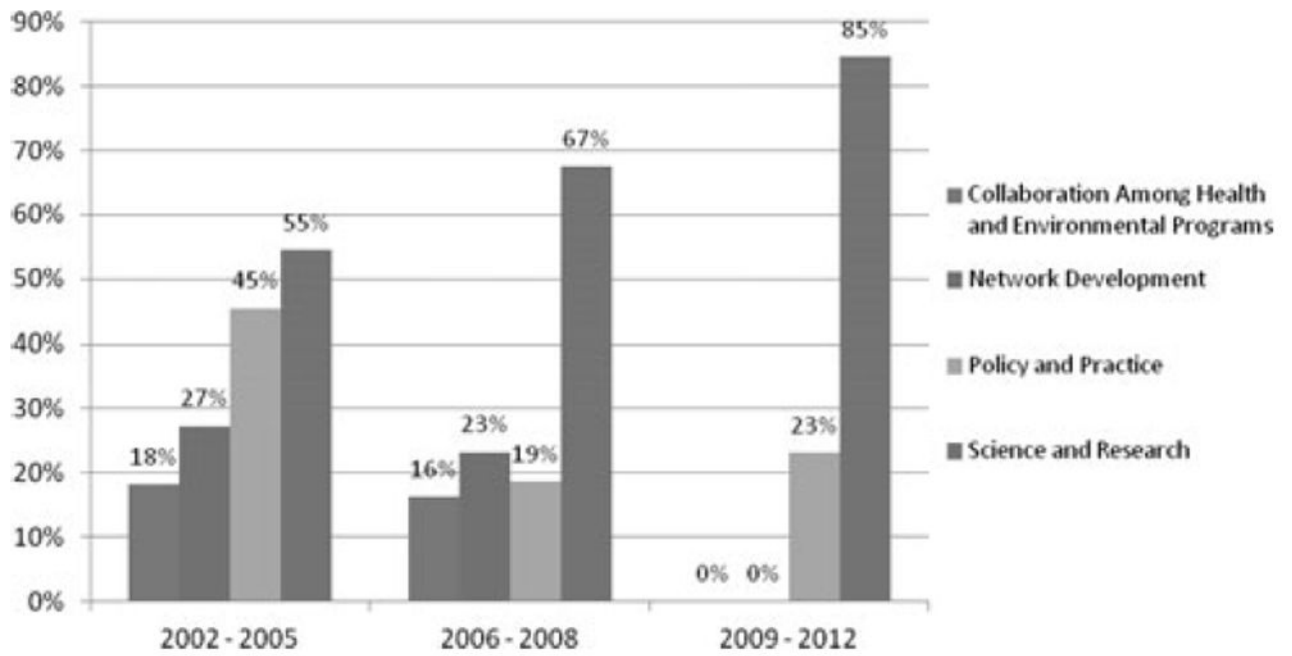


FIGURE 3. Trends of Environmental Public Health Tracking by Central Themes From 2002 to 2012^a

^aSeveral articles were recognized in more than 1 category; therefore, the total exceeds 100%.

TABLE

Published Studies Related to Environmental Public Health Tracking (2002-2012)

Year of Publication	Title of Publication	Author(s)
2003	Public Health's Response to a Changed World: September 11, Biological Terrorism, and the Development of an Environmental Health Tracking Network	Marmagas et al ⁵
2004	Developing a Local Comprehensive Environmental and Health Tracking System: Using What We Know to Improve Health and the Environment	Glad et al ⁶
2004	Wisconsin's Environmental Public Health Tracking Network: Information Systems Design for Childhood Cancer Surveillance	Hanrahan et al ⁷
2004	Tracking Pediatric Asthma: The Massachusetts Experience Using School Health Records	Knorr et al ⁸
2004	Using the Behavioral Risk Factor Surveillance System (BRFSS) for Exposure Tracking: Experiences From Washington State	Laflamme and Vanderslice ⁹
2004	Identifying Priority Health Conditions, Environmental Data, and Infrastructure Needs: A Synopsis of the Pew Environmental Health Tracking Project	Litt et al ¹⁰
2004	Statistical Methods for Linking Health, Exposure, and Hazards	Mather et al ¹¹
2004	National Environmental Public Health Tracking Program: Bridging the Information Gap	McGeehin et al ¹²
2005	Use of CUSUM and Shew Charts to Monitor Regional Trends of Birth Defect Reports in New York State	Babcock et al ¹³
2005	Relating Air Quality and Environmental Public Health Tracking Data	Boothe et al ¹⁴
2005	Can Lessons From Public Health Disease Surveillance be Applied to Environmental Public Health Tracking?	Ritz et al ¹⁵
2006	Evaluation of Five Data Sources For Inclusion in a Statewide Tracking System for Accidental Carbon Monoxide Poisonings	Bekkedal et al ¹⁶
2006	Integrating Research, Surveillance, and Practice in Environmental Public Health Tracking	Kyle et al ¹⁷
2007	Connecting Environmental Health Data to People and Policy: Integrating Information and Mobilizing Communities for Environmental Public Health Tracking	Ali et al ¹⁸
2007	Pediatric Patient Asthma-Related Emergency Department Visits and Admissions in Washington, DC, From 2001-2004, and Associations With Air Quality, Socio-Economic Status and Age Group	Babin et al ¹⁹
2007	Summary of Selected U.S. Geological Survey Data on Domestic Well Water Quality for the Centers for Disease Control's National Environmental Public Health Tracking Program	Bartholomay et al ²⁰
2007	Tracking Health and the Environment: A Pilot Test of Environmental Public Health Indicators	Dreyling et al ²¹
2007	Carbon Monoxide: The Case for Environmental Public Health Surveillance	Graber et al ²²
2007	Adequacy of State Capacity to Address Non-communicable Disease Clusters in the Era of Environmental Public Health Tracking	Juzych et al ²³
2007	An Update on Cancer Cluster Activities at the Centers for Disease Control and Prevention	Kingsley et al ²⁴
2007	Advancing Health and Environmental Disease Tracking: A 5-Year Follow-up Study	Litt et al ²⁵
2007	Pennsylvania's Asthma School Project and Descriptive Pilot Investigation: A Focus on Environmental Health Tracking	Logue et al ²⁶
2007	The Association Between Demolition Activity and Children's Blood Lead Levels	Rabito et al ²⁷
2007	Mercury Exposure in Young Children Living in New York City	Rogers et al ²⁸
2007	Using Biomarkers to Inform Cumulative Risk Assessment	Ryan et al ²⁹
2007	Can the Concept of Environmental Public Health Tracking Work in a Real-Life Setting?	Talbot ³⁰
2007	Additive versus Multiplicative Models in Ecologic Regression	Thompson and Waterberg ³¹

Year of Publication	Title of Publication	Author(s)
2007	Development of a Web-Based Care Reporting Management and Communications System for the Statewide Birth Defects Registry in New York	Wang et al ³²
2007	Linking Spatial Data From Different Sources: The Effects of Change of Support	Young and Gotway ³³
2008	Measuring the Environmental Health of Wisconsin's Counties	Athens et al ³⁴
2008	Comparison of Different Methods of Spatial Analysis of Cancer in Utah	Ball et al ³⁵
2008	Using a Partnership Barometer to Evaluate Environmental Public Health Tracking Activities	Bekkedal et al ³⁶
2008	Measuring Success: The Case for Calculating the Return on Investment of Environmental Public Health Tracking	Charleston et al ³⁷
2008	Implementing the Environmental Public Health Tracking Network: Accomplishments, Challenges and Directions	Charleston et al ³⁸
2008	Tracking Childhood Exposure to Lead and Developmental Disabilities: Examining the Relationship in a Population-Based Sample	Kaiser et al ³⁹
2008	From Patchwork to National Network: Working Collaboratively to Create a National Environmental Public Health Tracking Network	Li and Dawson ⁴⁰
2008	Creation of Environmental Health Information System for Public Health Service: A Pilot Study	Li et al ⁴¹
2008	Ambient Ozone Concentration and Hospital Admissions Due to Childhood Respiratory Diseases in New York State, 1991-2001	Lin et al ⁴²
2008	Chronic Exposure to Ambient Ozone and Asthma Hospital Admissions Among Children	Lin et al ⁴³
2008	Lessons Learned in Using Hospital Discharge Data for State and National Public Health Surveillance: Implications for Centers for Disease Control and Prevention	Love et al ⁴⁴
2008	Effective Environmental Public Health Surveillance Programs: A Framework for Identifying and Evaluating Data Resources and Indicators	Malecki et al ⁴⁵
2008	National Environmental Public Health Tracking Program: Providing Data for Sound Public Health Decisions	McGeehin ⁴⁶
2008	Describing Environmental Public Health Data: Implementing a Descriptive Metadata Standard on the Environmental Public Health Tracking Network	Patridge and Namulanda ⁴⁷
2008	Tracking Associations Between Ambient Ozone and Asthma-Related Emergency Department Visits Using Case-Crossover Analysis	Paulu and Smith ⁴⁸
2008	Spatially Continuous Local Rate Modeling for Communication in Public Health: A Practical Approach	Roberts et al ⁴⁹
2008	The California Environmental Health Tracking Program: New Online GIS Tools for Investigating Diseases and the Environment	Smordinsky et al ⁵⁰
2008	Implementing a Web-Based Case Reporting and Communication System Among Hospitals Reporting to the Birth Defects Registry in New York State	Steen et al ⁵¹
2008	Development of an Interactive Environmental Public Health Tracking System for Data Analysis, Visualization, and Reporting	Talbot et al ⁵²
2008	Screening for Lead Poisoning: A Geospatial Approach to Determine Testing of Children in At-Risk Neighborhoods	Vaidyanathan et al ⁵³
2008	Developing Integrated Multistate Environmental Public Health Surveillance	Wartenberg et al ⁵⁴
2008	Environmental Public Health Tracking of Childhood Asthma Using California Health Interview Survey, Traffic, and Outdoor Air Pollution Data	Wilhelm et al ⁵⁵
2008	Case-Crossover Analysis of Air Pollution and Cardiorespiratory Hospitalizations: Using Routinely Collected Health and Environmental Data for Tracking: Science and Data	Xu et al ⁵⁶
2009	Assessing Uncertainty in Support-Adjusted Spatial Misalignment Problems	Young et al ⁵⁷
2008	Assessing the Association Between Environmental Impacts and Health Outcomes: A Case Study from Florida	Young et al ⁵⁸
2009	Development of Exposure Characterization Regions for Priority Ambient Air Pollutants	Chinery and Walker ⁵⁹
2009	Birth and Fetal Death Records and Environmental Exposures: Promising Data Elements for Environmental Public Health Tracking of Reproductive Outcomes	Fitzgerald et al ⁶⁰

Year of Publication	Title of Publication	Author(s)
2009	Surveillance of Short-term Impact of Fine Particle Air Pollution on Cardiovascular Disease Hospitalizations in New York State	Haley et al ⁶¹
2009	The 2006 CA Heat Wave—Impacts on Hospitalizations and ED Visits	Knowlton et al ⁶²
2009	Extreme High Temperatures and Hospital Admissions of Respiratory and Cardiovascular Diseases	Lin et al ⁶³
2009	Summary of the Workshop on Methodologies for Environmental Public Health Tracking of Air Pollution Effects	Matte et al ⁶⁴
2009	Exposure Information in Environmental Health Research: Current Opportunities and Future Directions for Particulate Matter, Ozone, and Toxic Air Pollutants	McKone et al ⁶⁵
2009	Outdoor Air Pollution and Uncontrolled Asthma in the San Joaquin Valley, California	Meng et al ⁶⁶
2009	Summary and Findings of the EPA and CDC Symposium on air Pollution Exposure and Health	Ozkaynak et al ⁶⁷
2009	Ambient Air Pollution and Cardiovascular Malformations in Atlanta, Georgia, 1986-2003	Strickland et al ⁶⁸
2009	Developing Consistent Data and Methods to Measure the Public Health Impacts of Ambient Air Quality for Environmental Public Health Tracking: Progress to Date and Future Directions	Talbot et al ⁶⁹
2009	Use of Health Information in Air Pollution Health Research: Past Successes and Emerging Needs	Thurston et al ⁷⁰
2009	Some Considerations for the Communication of Results of Air Pollution Health Effects Tracking	Wartenberg ⁷¹
2009	Environmental Justice: A Contrary Finding for the Case of High-Voltage Electric Power Transmission Lines	Wartenberg et al ⁷²
2009	Towards a New U.S. Chemicals Policy: Rebuilding the Foundation to Advance New Science, Green Chemistry and Environmental Health	Wilson and Schwarzman ⁷³
2010	Evaluation of Spatial Relationships Between Health and the Environment: The Rapid Inquiry Facility	Beale et al ⁷⁴
2010	Oral Cleft Defects and Maternal Exposure to Ambient Air Pollutants in New Jersey	Marshall et al ⁷⁵
2010	Hospital Emergency Department Visits for Carbon Monoxide Poisoning Following an October 2006 Snowstorm in Western New York	Muscatiello et al ⁷⁶
2010	Concentration of Metals in Blood of Maine Children 1-6 Years Old	Rice et al ⁷⁷
2010	Privacy Versus Public Health: The Impact of Current Confidentiality Rules	Wartenberg and Thompson ⁷⁸
2011	Spatio-temporal Patterns of Bladder Cancer Incidence in Utah (1973-2004) and Their Association With the Presence of Toxic Release Inventory Sites	Fortunato et al ⁷⁹
2012	U.S. Census Unit Population Exposures to Ambient Air Pollutants	Hao et al ⁸⁰
2012	Multifaceted Comparison of ArcGIS and MapMarker for Automated Geocoding. Geospatial Health	Kumar et al ⁸¹
2012	Excessive Heat and Respiratory Hospitalizations in New York State: Estimating Current and Future Public Health Burden Related to Climate Change	Lin et al ⁸²
2012	Evaluation of a Heat Vulnerability Index on Abnormally Hot Days: An Environmental Public Health Tracking Study.	Reid et al ⁸³
2012	Population-Based Case-Control Study of Extreme Summer Temperature and Birth Defects	Van Zutphen et al ⁸⁴