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Data to Action: Using Environmental Public Health Tracking to Inform Decision Making

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Abstract

Context—Public health surveillance includes dissemination of data and information to those who need it to take action to prevent or control disease. The concept of data to action is explicit in the mission of the Centers for Disease Control and Prevention's (CDC) National Environmental Public Health Tracking Program (Tracking Program). CDC has built a National Environmental Public Health Tracking Network (Tracking Network) to integrate health and environmental data to drive public health action (PHA) to improve communities' health.

Objective—To assess the utility of the Tracking Program and its Network in environmental public health practice and policy-making.

Design—We analyzed information on how Tracking has been used to drive PHAs within funded states and cities (grantees). Two case studies illustrate such use.

Setting—Analyses included all grantees funded between 2005 and 2013.

Participants—The number of grantees varied from 17 for 2006–2008 to 24 for 2010–2013.

Main Outcome Measures—We categorized each PHA reported to determine how grantees became involved, their role, the problems addressed, and the overall action.

Results—Tracking grantees reported 178 PHAs from 2006–2013. The most common overall action was "provided information in response to concern" (n=42) followed by "improved a public health program, intervention, or response plan" (n=35). Tracking's role was most often to enhance

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surveillance (24%) or to analyze data (23%). In 47% of PHAs, the underlying problem was a concern about possible elevated rates of a health outcome, a potential exposure, or a potential association between a hazard and health. PHAs were started by a request for assistance (48%), in response to an emergency (8%), and though routine work by Tracking programs (43%).

Conclusion—Our review shows that the data, expertise, technical infrastructure, and other resources of the Tracking Program and its Network are driving state and local PHAs.

Keywords

Tracking; Environmental Public Health Surveillance; Information System Integration; Environmental Monitoring; Environmental Surveillance; Surveillance System; Environmental Public Health Actions

Introduction

Former Surgeon General, Dr. David Satcher stated “In public health, we can’t do anything without surveillance. That’s were public health begins.”[1](p838). Public health surveillance is the ongoing, systematic collection, analysis, and interpretation of health data for the planning, implementation and evaluation of public health practice and is integrated with dissemination of these data to prevent and control disease[2]. It is a critical component of the assessment function of public health[3]. In 1996, Thacker, et al[4] expanded this concept, noting that surveillance of hazards and exposures, in addition to health outcomes, was critical to environmental public health practice and that monitoring of these data provided opportunities for early interventions. More recently, a workgroup under the auspices of the Council of State and Territorial Epidemiologists identified surveillance as an essential environmental public health service. Specifically, Stanbury, et al (2012)[5] reinforced the need to collect and use data to identify and solve community environmental public health problems and support other essential services.

In 2000, the Pew Environmental Commission outlined the need for a nationwide network to track health and environmental data, as well as a skilled workforce to collect and interpret data, translate information for action, and provide response capacity[6,7]. This landmark report described the fragmentation of environmental health systems within the United States and the need to better understand and respond to environmental health threats. The Pew Report supported previous Institute of Medicine findings (1988)[3] for improved coordination, assessment and control of health conditions related to environmental issues. Further, the report stimulated development of the Centers for Disease Control and Prevention’s (CDC) National Environmental Public Health Tracking Program (Tracking Program) in 2002.

The mission of the Tracking Program, with the National Environmental Public Health Tracking Network (Tracking Network) as its cornerstone, is “to provide information from a nationwide network of integrated health and environmental data that drives actions to improve the health of communities”[8(p10),9]. Building on Thacker, et al’s[4] original framework for environmental health surveillance and the principles underlying knowledge management[10], CDC and its partners developed the Tracking Network as a multi-tiered, Web-based system with components at the local, state, and federal (CDC) level. The

Network integrates and synthesizes large amounts of data to address information needs that were ascertained through user testing and stakeholder involvement. It includes a core set of spatially and temporally standardized data to enable better assessment of environmental public health issues. Funded programs in 23 states and New York City (NYC) (referred to as grantees) have developed their own networks which contain these standard data as well as data specific to their own local needs[11,12]. In addition to the Tracking Network, the program has enhanced environmental public health expertise and the workforce and has established collaborations among public health practitioners and researchers to share expertise and lessons learned (a people network).

In their 1988 review of public health surveillance, Thacker and Berkelman stated "No public health surveillance system is complete without being linked to action"[2](p174). As with traditional public health surveillance, Tracking Network data and other program resources (e.g. workforce expertise, tools) are used to drive public health actions (PHAs) with the ultimate goal of reducing the burden of environmentally-related health conditions. Since 2005, CDC has monitored Tracking Program performance by gathering information on how its Tracking Network, workforce, and other resources (all program components hereafter referred to generally as "Tracking") have been used to drive PHAs within funded jurisdictions. In the first year, PHAs were drawn from grantee progress reports. In 2006, CDC's Tracking Program established a process to monitor all performance measures including PHAs. The program defines a PHA based on traditional uses of surveillance data[13] to include activities that impact any of the following:

- identifying populations at risk;
- responding to outbreaks, clusters, and emerging threats;
- examining the relationship between hazards and disease (hypothesis generating);
- guiding interventions;
- identifying, reducing and preventing environmental hazards;
- improving the public health basis for policymaking; and
- informing policy-makers, communities, and/or individuals regarding potential environmental health risks[14].

In this article, we examine information on Tracking-related PHAs to assess the utility and impact of Tracking in environmental public health practice.

Methods

To monitor program success, CDC requires grantees to report PHAs quarterly. CDC provides grantees guidance, training and a template for reporting performance measures as part of ongoing project management. Grantees are asked, "How many PHAs during the current reporting period can be directly associated with your activities and findings?" They were also asked to provide a description of the PHA including what the problem was, what their role was, who took the action, and what action was taken to resolve the problem. CDC reviews actions to ensure that:

- The PHA is completed.
- Multiple steps or parts of an action are not counted as multiple PHAs.
- The method of educating or disseminating information is not a PHA.
- Program operations, such as setting priorities, are not PHAs.
- Results of a data linkage project are used to inform activities meeting the PHA definition.

We compiled a list of available PHAs reported to CDC from October 1, 2004 through September 29, 2013 (federal fiscal years 2005–2013) in an Excel database and cross-referenced these with information from other grantee reporting to ensure the database represented a list of completed PHAs known to CDC. All actions were again reviewed and confirmed to fit the criteria set by CDC by two people (RB and SR). No follow-up was conducted with grantees to further expand the list of PHAs or fill any information gaps in reporting. We obtained information from internal CDC program documents on which health departments received funding under separate CDC grant cycles, their scope of activities, time period, and levels of funding.

For this review of actions, we categorized each PHA by answering the following questions:

- What was the final, overall action taken?
- Who completed the final action?
- What was Tracking's role?
- What was the health outcome(s)?
- What was the environmental issue(s)?
- How did the PHA get started?
- What was the underlying problem?

We answered the questions for each PHA based on the wording in the grantee reports versus scripting the answers a priori. We grouped similar answers and created standard categories for the analysis. Categories for overall action reflect the language in the program's definition of a PHA but include additional types of actions and are at times more detailed (e.g.: issued health alerts and advisories). Two team members (HS and EA) reviewed and coded all actions. A third member (JQ) reviewed a 20% sample. When disagreements occurred(less than 5% of actions reviewed), we discussed the action and categorized it by majority opinion. We conducted descriptive analyses using Excel and R. Using Pearson's method, we calculated the correlation between the number of PHAs reported by each grantee and total funding received. We included actions from 2005 in analysis of overall counts and the correlation, but, excluded them from more descriptive analyses because they were not collected according to the process established in 2006. We use case studies for NYC and Maine to illustrate the impact of Tracking and demonstrate how enhanced surveillance and expertise in a specific topic, pesticides in NYC and carbon monoxide in Maine, can result in multiple PHAs.

Results

From 2005 through 2013, 201 actions were available for analysis. 178 actions were reported from 2006–2013 that met CDC's criteria for PHAs (Figure 1). The number of grantees, their funding, and their scope of activities varied over time. Seventeen states, 3 cities, and the District of Columbia were funded in 2002. Early activities focused on capacity building, infrastructure enhancement, indicator assessment, and data linkage. By 2013, 23 states and NYC received program funding with a focus on Tracking Network maintenance, enhancement, and use. Average annual funding ranged from $557,000 in 2005 to $923,000 in 2011. The total number of actions reported by grantee is moderately, but significantly, correlated with the total funding received by each grantee (correlation = 0.6, p-value <0.001).

The most common overall action completed was "provided information in response to concern" (n=42) followed by "improved a public health program, intervention, or response plan (n=35) (Figure 2-A). Other PHAs which occurred frequently included "provided education, training, or outreach" to other health officials, partners, or the general public (n=33), "informed a public health program or intervention" (n=18) and "informed policy, legislation, or regulation" (n=13). Most PHAs were completed by Tracking grantee staff, either on their own (n=108; 61%) or in collaboration with others (n=22; 12%). Other governmental programs completed the PHA 21% of the time.

When the overall action was "provided information in response to concern" (n=42), concerns were abated 64% (n=27) of the time (Figure 2-A1). Among the 35 PHAs that resulted in an "improved public health program, intervention, or response plan", the improvement was most frequently in the delivery of the intervention (n=15), for example the program or intervention was able to better identify the population at risk (Figure 2-A2). Other improvements included enhanced capacity for identifying problems and expansion of existing interventions as well as improved methods, protocols, operations, timeliness, and efficiency. For example, in 2013, the New Mexico Tracking Program, in collaboration with the state health department's Health Alert Network, developed an alert system to quickly notify key audiences about real-time environmental health issues such as dust storms, extreme heat events, and pollen bursts.

Understanding Tracking's Role

In 24% (n=42) of all PHAs reported, Tracking's role was to enhance surveillance (Figure 2-B). Tracking enhanced surveillance by creating and sharing a tool for data management or analysis, improving technical infrastructure of department data systems, or addressing a gap in data (Figure 2-B1). Most frequently, the resulting PHA when Tracking enhanced surveillance was an improved public health program, intervention, or response plan (n=21) (Figure 2-A) where the program was able to better deliver an intervention (n=7, 33%) (Figure 2-A2). For example, in 2012, the California Tracking Program created a tool to digitize boundaries of drinking water systems in customer service areas. A local board used the map of the boundaries to identify private well users at risk for nitrate exposure and deliver an appropriate intervention.

In 36% (n=64) of all PHAs reported, Tracking analyzed a dataset or linked multiple datasets on health, environment, or other factors (Figure 2-B). When this occurred, it most frequently resulted in information being provided in response to concerns (n=24)) (Figure 2-A). By analyzing or linking data, Tracking was able to quickly allay concerns 67% (n=16) of the time (Figure 2-A1). For example, in 2008, the Utah Tracking Program quickly answered a community's concern about exposures to uranium milling contaminants by determining that the rates of multiple health outcomes in the community over time were within the expected range.

Health or environmental issue addressed

Among the PHAs reported, Tracking was most often involved in addressing a health issue where no corresponding environmental issue was specified (n=30) or an environmental issue with no health problem specified (n=42) (Figure 3). Cancer was the most frequently identified health outcome of concern (n=30) and was evaluated in connection to 11 different environmental issues (n=20) or with no particular environmental issue (n=10). Climate change, extreme weather, or natural disasters were the most frequent environmental issues of concern (n=23), with a focus on preparedness and response as well as specific problems around carbon monoxide poisoning, heat-related illness, or social vulnerability. Among those PHAs involving both a health outcome and an environmental issue, the frequent combinations were: cardio-respiratory health outcomes related to specific facilities (n=6); biomonitoring results related to foods consumed (n=6); and asthma related to outdoor air or emissions from facilities or hazardous waste sites (n=11). Three PHAs were not specific to any health outcome or environmental issue and improved public health practice in general.

Differences in actions by how they originated

The event that originated the PHA influenced Tracking's role and the overall action taken (Figure 4). PHAs were initiated by request for assistance from communities, state or local government, or other state or local agencies; in response to an emergency or incident; or through routine work undertaken by the grantee. Routine work included tasks such as building or enhancing their technical infrastructure, processing data for the Tracking Network, or engaging partners or populations at risk. When the PHA was the result of an emergency or incident (n=15, 8%), the most common underlying problem was a potential exposure (n=10, 67%). Most frequently, Tracking's role was to enhance surveillance (n=4, 27%) and the resulting PHA was education, training, or outreach (n=7, 47%).

When the PHA originated from routine work (n=77, 43%), a gap in data or information was the most common problem (n=50, 65%). In 32% of these (n=25), Tracking enhanced surveillance. In 20% (n=15), the program tracked data which means processed and disseminated data, typically through their tracking network, for others to analyze. These PHAs resulted in improved (n=22, 29%) or otherwise informed public health programs or interventions (n=13, 17%). For example, in 2008, the New York Tracking Program provided funding to improve the timeliness and quality of data in the state birth defects registry. This allowed the state birth defects program to identify children at a younger age and provide more families with information about support programs. It also allows the Tracking Program to track birth defects and investigate potential associations with environmental hazards.

When a PHA originated with a request for assistance (n=86, 48%), the underlying problem was most frequently a concern about possible elevated rates of a health outcome, a potential exposure, or a potential association between a hazard and a health outcome (n=59, 69%). In 30% (26) of these PHAs, Tracking analyzed health, exposure, or environmental data, meaning they used data to answer a statistical question about the scenario under investigation. In 26% (22), other programs or partners analyzed Tracking. For example, in 2006, the Wisconsin Tracking Program addressed a community concern about exposures to air toxics released by a local facility. The staff collaborated with the state's Department of Natural Resources to evaluate emissions from the facility and cancer risk in the community. Although the emissions were in compliance with regulations, cancer risks associated with the emissions prompted the facility to change the manufacturing process to reduce emissions.

Underlying problems related to PHAs

The most frequent problem addressed was a concern about possible elevated rates of a health outcome, a potential exposure, or a potential association between a hazard and a health outcome (n=84) (Figure 5). Other problems addressed included a need for technical expertise (n=25) or a gap in data or information (n=69). Concerns about rates, exposures, or associations (n=84) were more often identified by a community (39%) or by the government, another agency, or a partner (31%). In these PHAs, cancer was the most common health outcome of concern, specifically the perception of elevated cancer rates or exposures which could result in elevated cancer rates (n=26, 31%). The most common environmental issue was a concern about a local facility or site (n=26, 31%). In 48% (n=40) of the PHAs, Tracking analyzed or linked data to address the concern while in 31% (n=26) other programs or partners analyzed Tracking data. In the end, Tracking provided information and recommendations to the requestor or population at risk (n=40, 48%). Among the actions originating with concerns from communities, state or local government, another agency, or a partner about specific sites (n=55), data confirmed concerns about elevated rates, exposures, or proximity between elevated rates and an environmental hazard 33% of the time. In contrast, data confirmed concerns initiated by Tracking through routine work in 11 of 12 (92%) such PHAs.

Case study: New York City (NYC) Pesticide Tracking

Kass, et al (2004)[15] documented the case for conducting pesticide-related surveillance in an urban environment and the initial steps to do so as part of the NYC Tracking Network. They evaluated fifteen datasets, covering sales and use, housing, exposures, and health for inclusion in an integrated system. The system was tested in 2003 and operational by 2006. "The surveillance system involved investing in information technology infrastructure; developing analytical and programing skills among staff; and conducting ongoing communication with other health and environment programs, academic institutions, and community-based organizations with experience working on examining pesticides and associations with health and the environment".[16] Integration of these data into their Tracking Network has strengthened NYC's ability to generate public reports; evaluate progress towards reducing exposures; deliver effective interventions by identifying high-risk neighborhoods and potential point-sources of exposure; inform city-wide policy and

practice; and support national regulations. Sensitive data are available securely to staff of relevant programs. Pest and pesticide indicators and measures are readily available to the public through NYC's Tracking Network (www.nyc.gov/health/tracking).

Seven of the 22 PHAs reported to CDC by NYC since 2006 related to the use of pesticide data and technical expertise. For example, NYC collaborated with CDC to quantify and identify the pathway for acute health effects and injuries resulting from the use of total release foggers (TRFs). The most common exposure scenario among the NYC cases was failure to notify neighbors prior to activating a TRF product in multi-unit housing. NYC also showed that people living in low-income neighborhoods are more likely to use foggers and sprays than safer bait stations and gels. This led the health department, in collaboration with the state, to pursue restrictions on sales of TRFs to the public. The NYC Tracking Program has also used pesticide surveillance information to inform federal and local regulations, train and educate individuals responsible for pesticide application in public areas, and improve compliance with local laws requiring reporting of pesticide applications.

Case Study: Maine (ME) CO Poisoning Tracking

After a cluster of CO poisonings during a winter-storm power outage[17], the ME Tracking Program analyzed multiple datasets to understand trends and burden of the condition, affected populations, and risk factors to guide prevention strategies[18,19]. CO poisoning surveillance includes data from hospitals, emergency departments, poison centers, healthcare providers, and death certificates as well as the National Electronic Disease Surveillance System (NEDSS), Google search alerts (power outages, CO poisoning events), newspapers, and the ME Behavioral Risk Factor Surveillance System (BRFSS). ME Tracking staff worked with BRFSS staff to develop a state module to identify the prevalence of CO poisoning risk factors (e.g., using a gas-powered generator) and household preventive measures (e.g., CO detector).

CO poisoning data are readily available to the public through ME's Tracking Network (https://data.mainepublichealth.gov/tracking/co-content). Additionally, case-based data are securely available to ME program staff that use the data to describe risk factors and burden of CO poisoning, identify intervention needs, and evaluate existing interventions. Nine of 12 PHAs reported to CDC by ME since 2006 relate to use of CO poisoning data and technical expertise. For example, the ME Tracking Program used data to inform the adoption of a 2009 state law requiring CO detectors in all rental units, new single family homes, and existing homes whenever a property transfer occurs. They demonstrated that CO poisoning was a statewide issue; that age, income, gender, and region of the state affect prevalence; and that in most cases of CO poisoning, victims did not have a CO detector. They have also collaborated with other programs to incorporate CO poisoning prevention in storm preparedness guidance; educate and issue alerts to the public; respond to and identify causes of non-storm related CO poisonings; and implement interventions to reduce occupationally-related cases.

Discussion

To understand its impact, CDC has collected information on PHAs by grantees for the past decade. The results of our analysis demonstrate that Tracking's data, expertise, and other resources are used by grantee programs and others to address a variety of environmental health issues. Tracking grantees are frequently engaged in activities to respond to concerns from communities and others about possible elevated rates of a health outcome, a potential exposure, or a potential association between a hazard and a health outcome or to fill gaps in data, information, or technical expertise. These activities mirror the core functions of the essential environmental public health services identified by Stansbury et al (2012)[5].

Cancer was the health concern addressed in over half (n=29) of the PHAs initiated in response to concerns about potential elevated rates, exposures, or associations between health and environment. Only 4 of the 29 activities positively identified elevated rates and in most cases, these elevations could potentially be explained by occupational, behavioral, or demographic characteristics of the area. Two of 29 activities identified exposures of concern but not elevated rates. The high number of such requests to Tracking for cancer or other outcomes, likely reflects 3 factors: (1) the Tracking Network allows easy access to health, environmental and other risk factor data to facilitate timely responses; (2) the Tracking Program supports or is associated closely with environmental epidemiologists who have experience working with various data; and (3) the Tracking Program has developed tools to assist analysts (and sometimes the public) in providing quick responses. For example, the Massachusetts Tracking Program created a standardized incidence calculator that they use to quickly generate cancer rates for any community, census tract, and planning region in the state.

While almost half of the PHAs analyzed resulted from a request for assistance, a significant proportion (43%) resulted from routine work. This demonstrates proactive efforts to assess and monitor the environmental public health status of communities and produce information and knowledge for program staff and others to use. Our case studies from NYC and ME both provide examples of how bringing data together on specific topics allows Tracking to identify problems proactively and take steps to prevent exposures, illness, and deaths. The technical infrastructure developed through Tracking allows CDC and its partners to better organize data and is flexible to allow the addition of new data, tools, and other capabilities to address user needs on public and professional levels. A 2011 survey administered by the Association of State and Territorial Health Officials found that Tracking had a prominent role in integration of state environmental health data systems and that the Tracking Network ranked at the highest level of satisfaction for its ability to manage different data types within states[20].

By definition and in practice, public health surveillance is limited to the collection, analysis and dissemination of data. It does not include responsibility for control activities or delivery of public health services or training[2,21,22]. Perhaps surprisingly, therefore, Tracking grantee staff completed PHAs, either on their own or in collaboration with others, 72% of the time. This percentage indicates that the Tracking Program has built not only environmental health surveillance capacity, but also environmental health workforce capacity. The Pew

Commission reported that translating data to action would require "a revitalization of the public health infrastructure by providing adequately trained health professionals to collect and interpret the data at local, state, and national levels; to respond to concerns and to ensure a healthy environment"[6](p7). The Commission also emphasized the need for trained practitioners to respond to concerns identified through the network. The Tracking Program and Network are closely integrated into environmental health practice within funded jurisdictions. As such, program staff not only disseminate information for implementation by other service delivery programs, but they often have responsibilities in service delivery themselves.

Our analyses have a number of limitations. First, the data included only represent PHAs documented by Tracking grantees and likely under-represent the total PHAs. We are unable to track actions that may have resulted from individuals or organizations accessing Tracking data that are publicly available on the CDC or state/local Tracking Networks. The Web statistics we gather only tell us the number of visits, the countries and cities accessing the site, the referring domains, and the most popular pages views and data queried. On average, the CDC National Tracking Network receives over 18,000 hits per month, with data on asthma and air pollutants receiving the most queries. Second, we had some concerns about completeness of reporting from grantees. Cross-referencing the list of reported PHAs against other program materials identified activities that would have qualified as PHAs, but were not reported. Conversely, PHAs that met the criteria set by the Tracking program represent only about 70% of all activities grantees reported to CDC to demonstrate the success of their program. Based on our review, we estimate up to 40% of these other activities reported would meet the definition of a PHA with additional follow-up (unpublished data). Further, the quality and depth of reporting for each PHA varied across grantees and years and may have impacted our results. We attempted to fill in additional details on PHAs by cross – referencing these data with other program reports. Finally, in attempting to quantify these data we had decide how to code some PHAs that, based on their descriptions, were multifaceted and could have fit into more than one broad category of overall PHA. We made the decision to code to the category where the work described seemed to have the largest impact. These issues indicate some changes in CDC processes for feed-back and follow-up on PHAs with grantees may be needed. Additional guidance and training on criteria for acceptable PHAs may help improve not only the completeness, but also the quality of reported information.

Conclusion

As we move into the second decade of the 21st Century, a number of factors are impacting how we think about and conduct public health surveillance and, in turn, Tracking.[23,24,25]. These factors include rapid changes in information technology and tools; changing data and information needs and expectations; changes in the population; disease and environment "globalization"; changing methods for analysis; and the impact of health care reform and electronic medical records[24,25]. Despite these changes, the basic tenets of public health surveillance and the definition established more than a quarter of a century ago remains valid. Key to the practice of surveillance is a clearly defined purpose that will result in actionable public knowledge[26]. Our review shows that the data, expertise, technical

infrastructure, and other resources of the Tracking Program and its Network are driving state and local PHAs.

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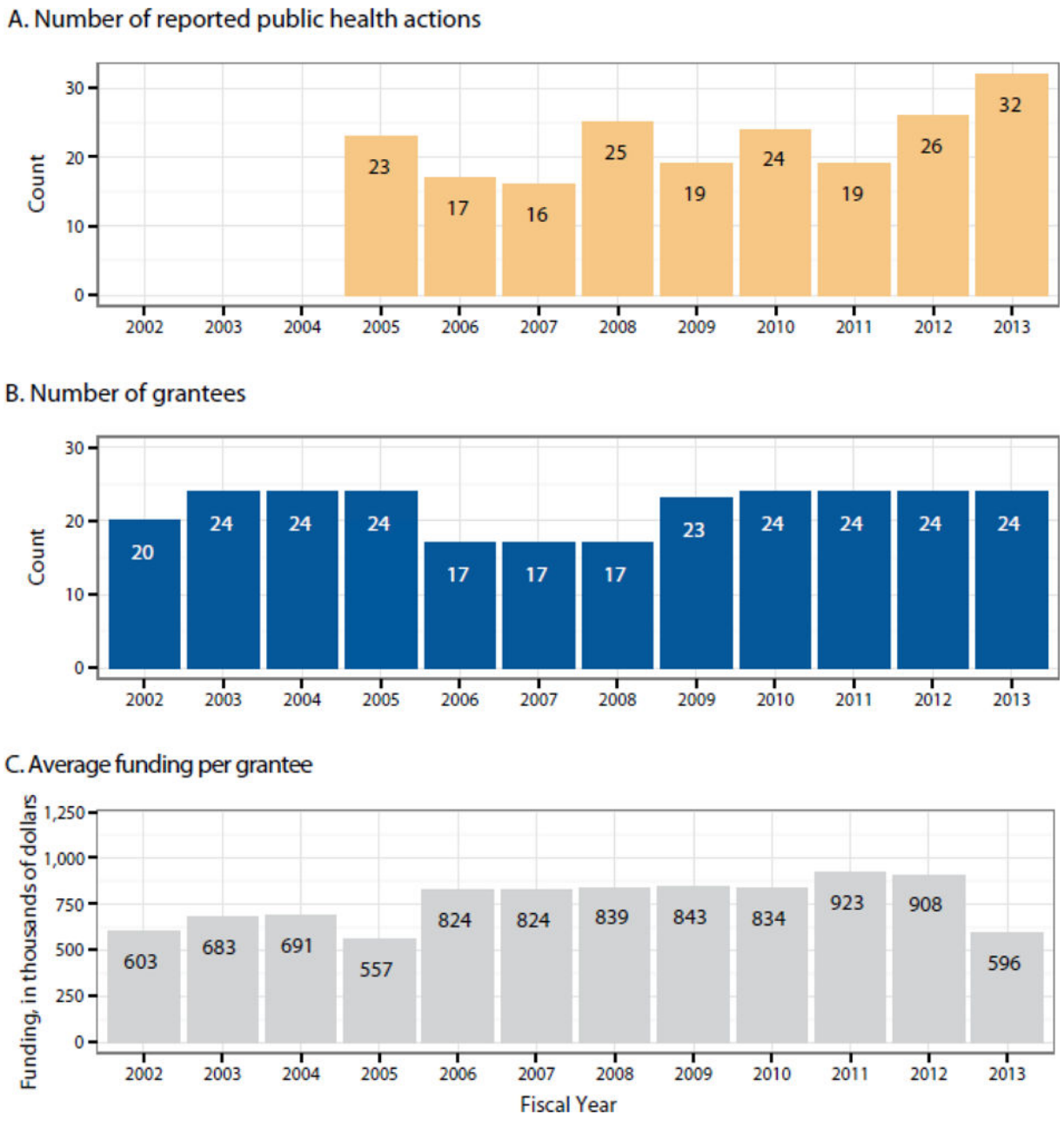

Figure 1.
Number of Reported PHAs, Grantees, and Funding Levels by Year

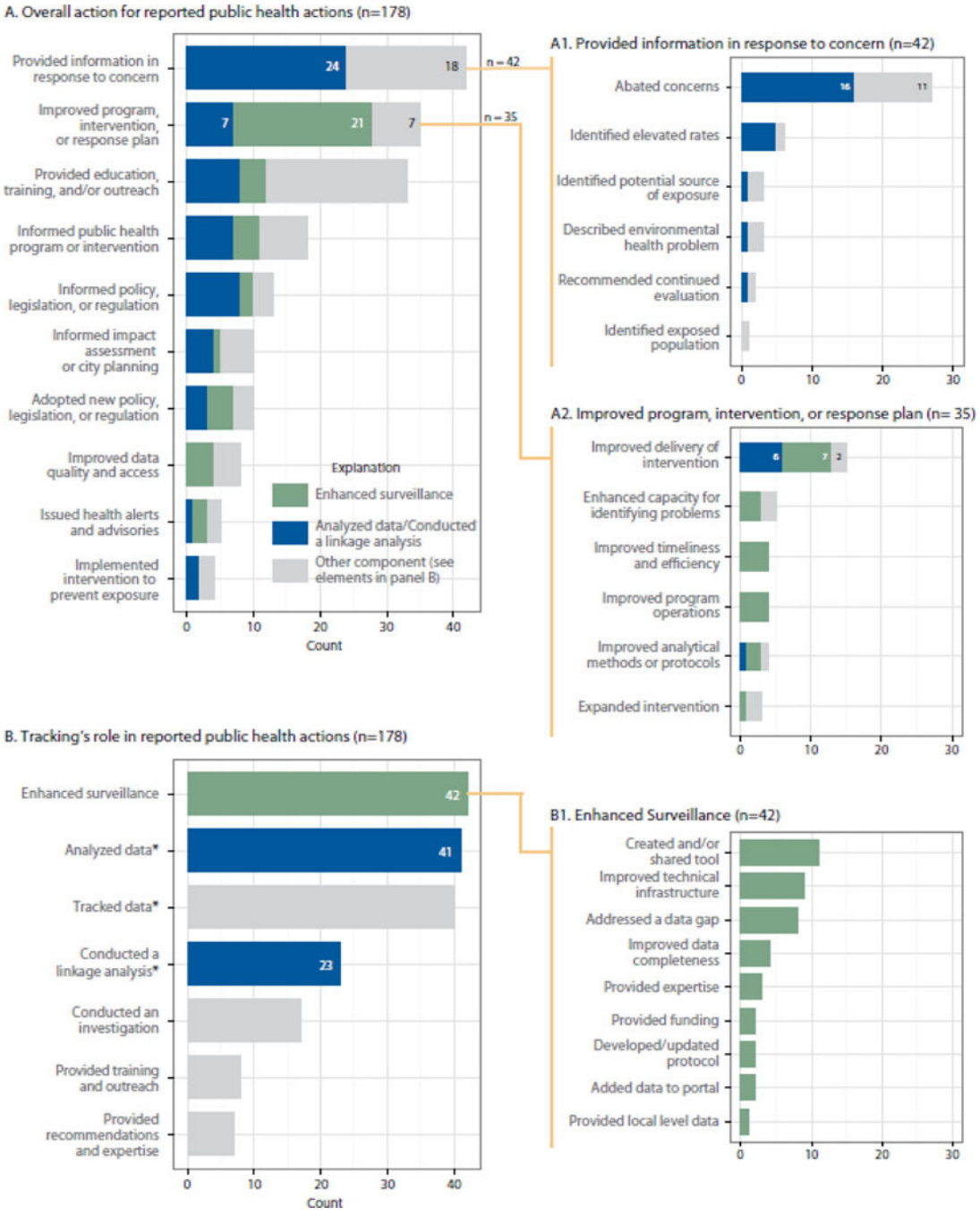

Figure 2. Number of PHAs by Category of Overall Action Taken and Tracking's Role*

*__Analyzed data__ means Tracking used a single dataset (about health, exposure, environmental, or other factors) to answer a statistical question about the scenario under investigation. **Tracked data** means Tracking processed and disseminated data, typically through their Tracking Network, for others to analyze in order to answer a statistical question about the scenario under investigation. **Conducted a linkage analysis** means Tracking temporally and spatially linked multiple datasets (about health, exposure,

environmental, or other factors) to answer a statistical question about the scenario under investigation.

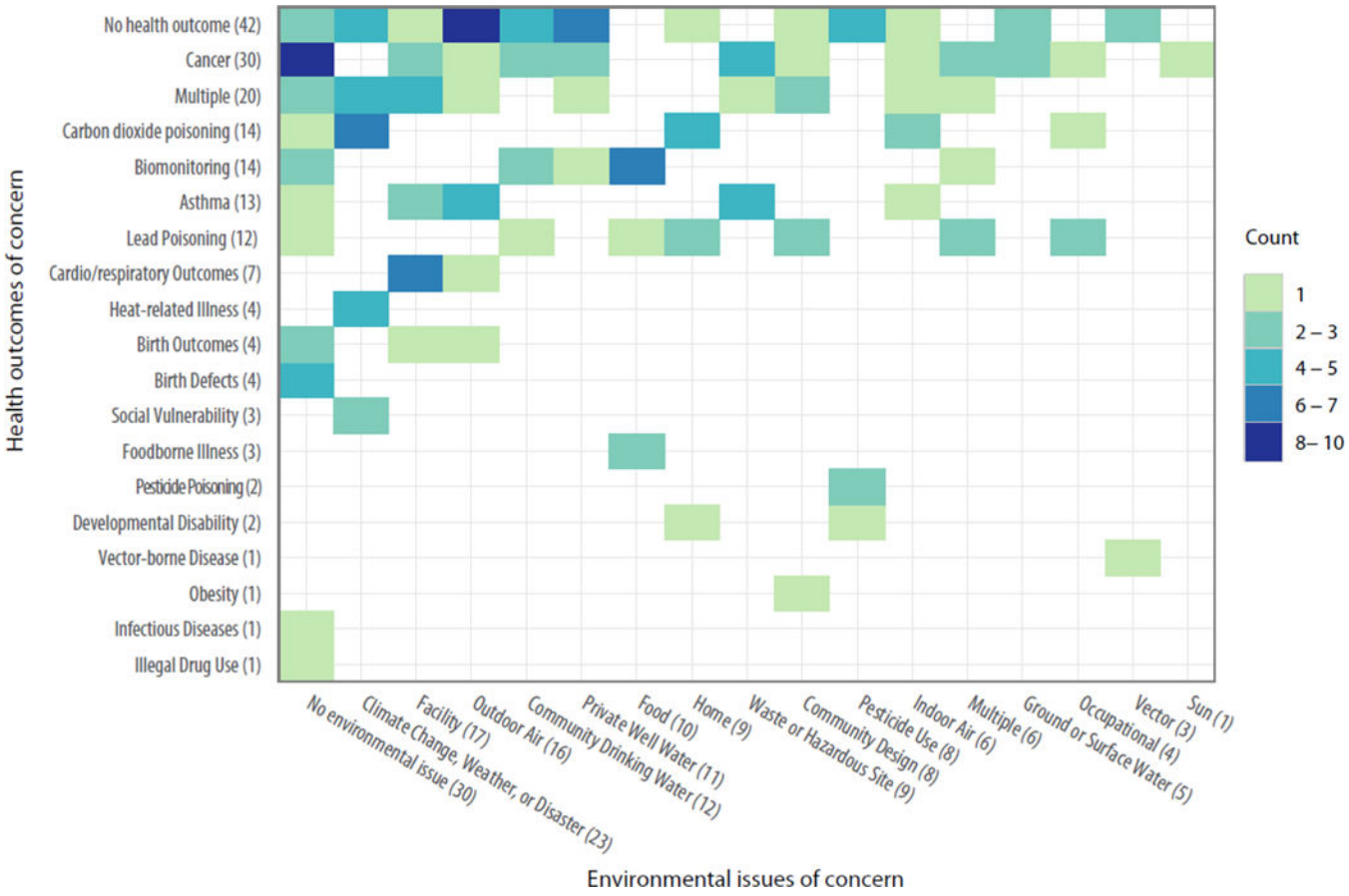

Figure 3. Number of PHAs by Health Outcome and Environmental Issue of Concern*

*The numbers in parentheses represent total number of public health actions for each health outcome or environmental issue. Health outcomes are sorted highest to lowest from top to bottom. Environmental issues are sorted highest to lowest from left to right. The color represents the number of public health actions for each x-y (Health outcome-Environmental issue) pair.

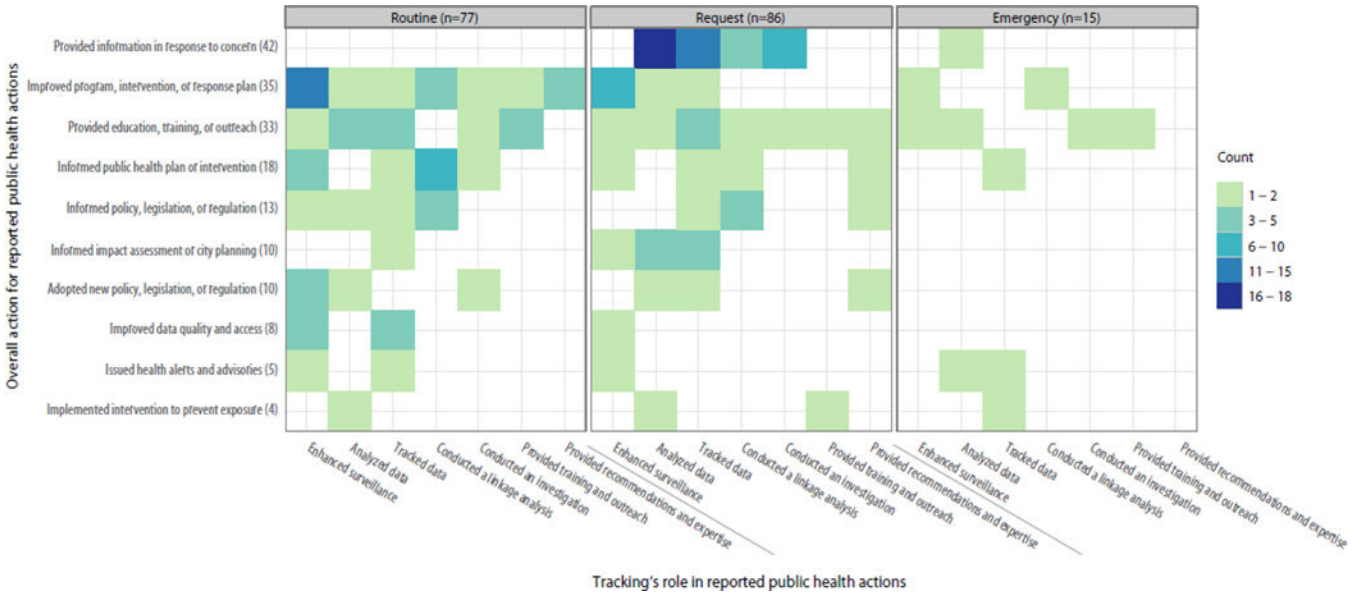

Figure 4. Distribution of PHAs by How the PHA Started, Category of Overall Action, and Tracking's Role*

*Both axis are sorted based on total number of public health actions for each category. Overall action categories are sorted highest to lowest from top to bottom. Tracking's role categories are sorted highest to lowest from left to right. The color represents the number of public health actions for each x–y (Tracking's role-Overall action) pair.

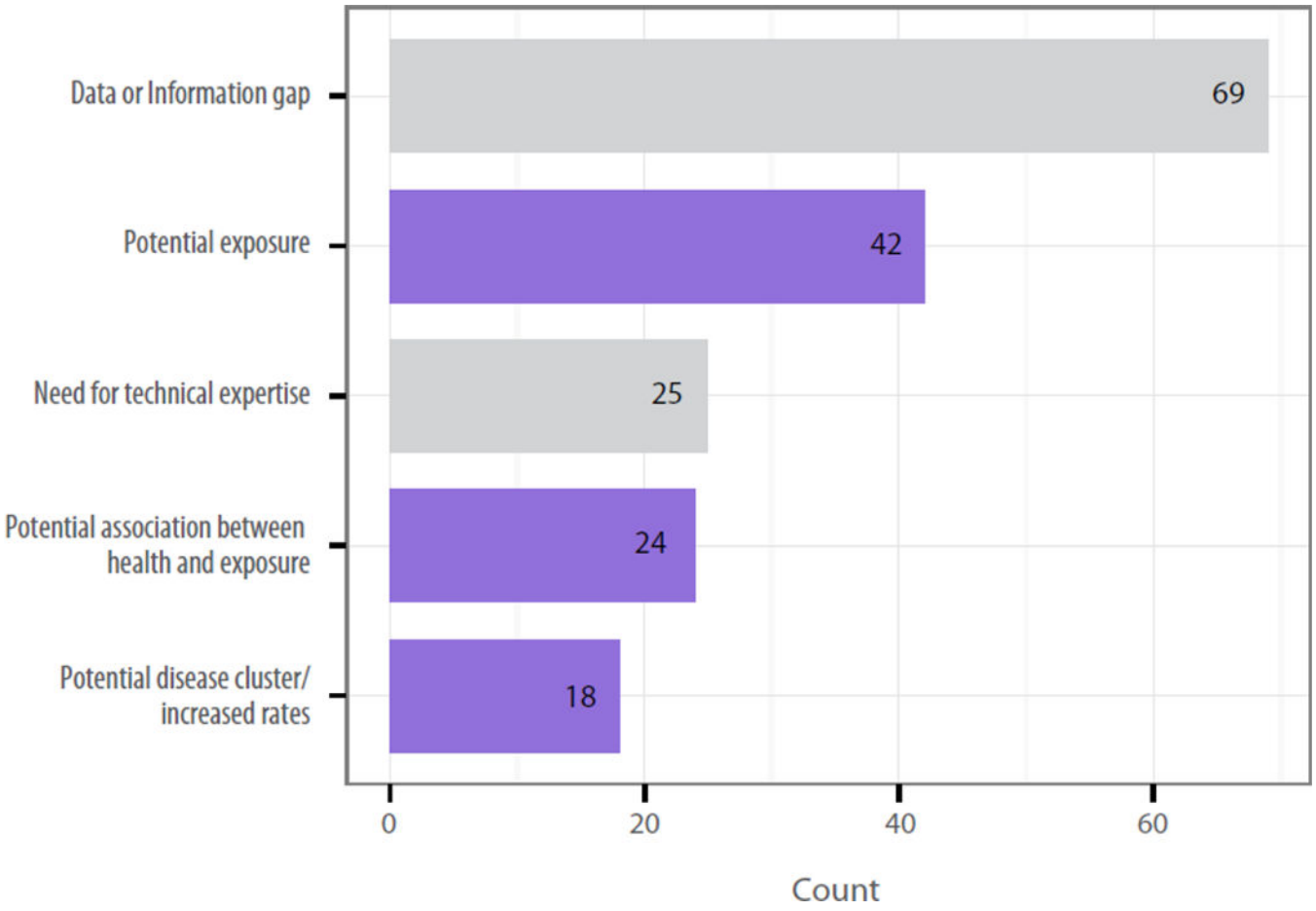

Figure 5.
Number of PHAs by Underlying Problem