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The Environment in Environmental Surveillance

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Abstract: *The environment, as a space where multifaceted drivers of collective health events occur, requires an interdisciplinary analytical approach. To evaluate how the monitoring of such complexity has been addressed, a descriptive critical review of the literature under the terms Environmental Surveillance and Exposome was conducted. The methodology included categorizing articles according to Subject, Sample, Method, and Objective. Under Subject, the Abiotic subcategory includes radiation, emissions, molecules, and physical events. Within Sample, the Air-Soil subcategory includes dust, fomites, surface analyses, and physical variables. The Epidemiological subcategory covers outbreak investigations, risk assessments, and program updates. The development of the concept of Environmental Surveillance was reviewed chronologically across representative periods, along with the changing health-related contexts. The results showed that most papers regarded the environment merely as a sampling substrate—pathogen- or noxa-specific, monocausal—and used surveillance primarily to design or implement effective control interventions. The discussion, based on the multidisciplinary framework of eco-epidemiology and the intersectoral operational One Health approach, concludes by proposing a strategy for Surveillance of Environment focused on critical variables, with attention to the lags between threshold values and their health impacts. To operationalize this Surveillance of Environment approach, the steps required to delimit the workspace of the landscape as a Health Territory are summarized, enabling timely preventive interventions at the early-warning stage.*

Keywords: Eco-epidemiology; one health, environmental water surveillance; risk assessment; preventive monitoring

Introduction and Methods

The title of this review paraphrases that of the article "The eco- in eco-epidemiology" (March & Susser, 2006), which explains the scope of the term ecology within the eco-epidemiology framework proposed by Susser & Susser (1996)—a broader concept than that used in works based on Pavlovski's (1966) natural nidality concept. Similarly, the literature on Environmental Surveillance (ES) has tended to narrow the definition of environment, without diminishing its methodological rigor, significance, or impact on monitored health events.

However, just as the Sussers sought to reestablish public health as the core objective of epidemiology, the development of ES as a discipline has relegated Surveillance of the Environment (SoE)—a more comprehensive approach that integrates eco-epidemiology as its theoretical framework and One Health as its operational strategy.

To analyze trends in ES and to propose a complementary or alternative approach through SoE, a descriptive review was conducted using articles retrieved from MEDLINE with the search term "environmental surveillance." Only a single database was used, as the goal was not to produce an exhaustive review but to examine the conceptual evolution of the term. In this context, the retrieved publications were analyzed according to representative periods reflecting historical and thematic developments, contrasting their distinctive characteristics as ES in each period, and subsequently integrating them into the eco-epidemiological framework of SoE. Finally, a strategy for its operationalization was proposed through the characterization of the sampling health territory.

From the first article in July 1964 to March 31, 2025, a total of 1,404 titles were retrieved. Abstracts were reviewed, and full articles were consulted when necessary to assign methodological categories. Three periods were distinguished in the analysis: 1964–2000, 2001–2019, and 2020–2025. This chronological segmentation was based on contextual dominant research themes rather than on the quantitative distribution of publications over time. As a preliminary simplification, the first period (N=98) was characterized by radiological surveillance; the second period (N=565) focused on microbiological studies, including antimicrobial resistance; and the third period (N=741) emphasized virological studies in the context of pandemics and Type 2 Vaccine-Derived Poliovirus outbreaks.

For each period, the articles were categorized according to *Subject*, *Sample*, *Method*, and *Objective* (Fig. 1). These categories, along with their respective subcategories, are neither mandatory nor mutually exclusive, meaning that a single publication could fall into none or multiple subcategories within the same category. Under *Subject*, the Abiotic subcategory includes radiation, emissions, molecules, and physical events such as earthquakes; while Eukaryota excludes Fungi, which are assigned to their own subcategory. In *Sample*, the Air-Soil subcategory includes dust, fomites, surface analyses, and physical variables such as noise; whereas Biotic encompasses organisms such as algae and insects, together with clinical samples and biofilms. Within *Method*, Molecular Biology incorporates molecular epidemiology; Biological includes taxonomy, cultures, neutralization, and electrophoresis; Physical, in the later periods, incorporates MALDI-TOF, non-biological filtration–concentration methods, and biosensors (when the biological molecule is used solely to capture the target analyte); and Social-Modeling brings together surveys, secondary data analysis, and modeling. Finally, within *Objective*, the Epidemiological subcategory covers outbreak investigations, risk assessments, and program updates; Strategic includes programmatic recommendations; and Tactical assesses new methodologies.

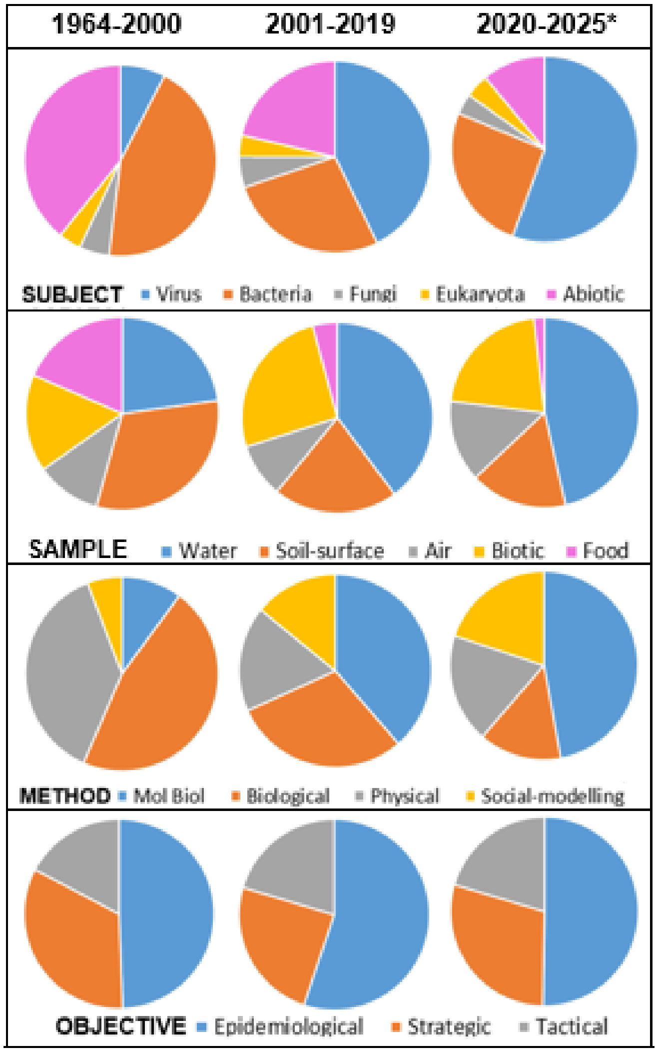

Figure 1. Proportional distribution of articles retrieved from MEDLINE under the search term 'environmental surveillance' up to March 31, 2025 by period, and categories

Exclusion criteria: Articles retrieved from MEDLINE but deemed unrelated to ES mainly concerned environmental monitoring by the nervous system and homeostatic processes (Freemon 1970; Kamei et al., 2023; Bischer et al., 2023). Additionally, certain publications were excluded from the ES analysis despite their association with so-called environmental surveillance agencies, as their focus was on activities such as vector control, home inspections, animal incidents, spatial mapping of oncological cases and vaccinations, natural disaster mitigation, or occupational health (Maciel, 2023; Yuan et al., 2024; Livanainen et al., 2024;

Chaves et al., 2004; Brazil, 2025a, b). However, these sources were considered when they involved ES of pathogens in vectors or reservoirs (Machado et al., 2018; da Costa et al., 2018; Tchuem Tchuenté et al., 2018). The number of publications identified as unrelated to ES was 3 (3.1%) in the first period, 20 (3.5%) in the second period, and 21 (2.8%) in the third period.

Results and Discussion

Period 1964-2000

The first article retrieved by MEDLINE under ES was by Baratta et al. (1964), focusing on radiological monitoring around reactors—an exclusive topic until 1972, with 11 publications. The first recorded expansion of ES topics appeared in 1973 with the analysis of mercury contamination in fish (Ball et al., 1973). Subsequent studies on mutagens, insecticides, and particularly occupational hazards aligned ES with the broader field of environmental health (Neefus, 1975; Buffer & Aase, 1982; Hunter & Lenz, 1982). Over time, ES began incorporating pathogen surveillance into traditional epidemiological monitoring schemes. This included studies on nosocomial outbreaks (Hazuka et al., 1977), cases of *Aspergillus* infection (Barst et al., 1981), and *Legionella* monitoring (Korvick et al., 1987). The programmatic approach to Wastewater Surveillance (EWS) was also introduced during this period, primarily for cholera detection (WHO, 1980).

Between 1980 and 1990, three key methodological advances emerged, shaping the further development of ES: 1. Risk modeling: based on monitoring specific sources (e.g., water, air, food) rather than adopting an integrated environmental approach (Gallegos & Wenzel, 1989). 2. Molecular biology: particularly PCR, applied to virological surveillance and EWS (Katz & Middle, 1990; Katz, 1990; Marques et al., 1993). 3. Recognition of social, cultural, and economic drivers: especially in risk communication (Robert et al., 1989) and occupational health (Yassi et al., 1991; Vézina & Saint-Arnaud, 1994).

Regarding multi-stakeholder participation, proposals included participatory monitoring of air in schools (Hant et al., 1997) and the use of ES as a training tool for zoonosis surveillance within the framework of so-called ecosystem health (Ribble et al., 1997), which aligns closely with the interdisciplinary eco-epidemiological approach of SoE. This comprehensive perspective, parallel to the broader ES trend of pathogen-case surveillance, proposed incorporating environmental risks into health analysis. Moreover, guidelines and opinion articles began advocating for the quantification and modeling of environmental pressures using indicators such as pollution levels, deforestation, urbanization, and industrial activity (Corvalan et al., 1997). However, these insights were rarely translated into operational strategies, which required defining the spatio-temporal scales involved, as well as the recording designs and agents at each scale and variable, as highlighted in studies on birth defect clustering (Dolk, 1999).

Period 2001-2019

Comparing the relative distribution of subcategories between this period and the previous one (Fig. 1), in the category *Object*, Virus increased, driven by polio eradication initiatives and outbreaks of Ebola and influenza; Eukaryota (e.g., *Legionella*, antimicrobial resistance) and Fungi (*Aspergillus*, *Candida*) also increased, although not proportionally to the total; while Abiotic noxae continued to be monitored mainly due to nuclear accidents (e.g., Chernobyl) and the potential adverse effects of emerging technologies (e.g., mobile phones).

The relative increase in microbiological studies was accompanied by a greater emphasis on the Water and Biotic subcategories of *Sample*, while Food declined after having been boosted in the first period by systematic activities of the Environmental Surveillance Unit, Public Health Laboratory Service of London, UK. In the *Method* category, Molecular Biology and Modeling expanded in response to new epidemic scenarios, while physical methods declined due to reduced emphasis on emissions monitoring. In line with studies of emerging outbreaks, within the *Objective* category, a slight increase was observed in the Epidemiology subcategory, using traditional epidemiological and risk factor modeling approaches.

Regarding conceptual development from ES to SoE during this period, the need to establish broad, generic environmental monitoring was advocated. Such surveillance should include socio-demographic, economic, and ecosystem well-being indicators alongside acute and chronic exposure assessments. However, when concrete drivers and factors to be monitored were described, social and environmental determinants were often omitted or imprecisely addressed, replaced instead by individual health and broad socio-demographic indicators (Hodge et al., 2002; Castro et al., 2018). In these articles, ecology was used in the sense applied in epidemiology and eco-epidemiology, for instance, relating asthma or birth weight to air pollutants, socio-economic status, or practices (Ito et al., 2015; Shmool et al., 2015).

Technological advancements in this period introduced new methodological approaches that incorporated climatic and environmental variables, including remote sensing and geospatial statistics for modeling natural nidality and risk factors in order to prioritize sampling sites. Applications included epidemiological corridors of non-human primates for yellow fever; cutaneous leishmaniasis and deforestation; *Ehrlichia* and *Anaplasma* nidality; leptospirosis and flooding; algal blooms; insecticides in surface waters; and indicators of environmental quality (Correia et al., 2004; Coops et al., 2004; Fritz et al., 2005; Schiller et al., 2007; Menezes & Heller, 2008; Zeichnaer & Adams, 2010; Ortega-García et al., 2016; Veiga Gonçalves et al., 2019). However, while these studies successfully identified spatial patterns, they often presented dynamic environmental processes as static datasets, revealing the limitations of relying on single spatio-temporal scales. From an eco-epidemiological perspective, overlooking the dynamic, interconnected complexity of a multiscale environment results in missed opportunities for designing concrete intervention strategies. The steps for longitudinal, multiscale monitoring of explanatory direct variables and socio-environmental causal factors in areas defined by geographical, epidemiological, environmental, and social criteria will be outlined in the development of the SoE concept.

Implementing multi-stakeholder risk factor surveillance that accounts for the complexity of the social environment requires appropriate health system structures, interdisciplinary collaboration, and integrated information systems for timely decision-making, with special attention to vulnerable populations (Barcellos & Quinteros, 2006; Maree et al., 2025). Despite this, surveillance methodologies remained primarily pathogen-centric and based on traditional epidemiology, even within the integrated One Health framework, focusing on vector–reservoir–individual human cases or climate and vegetation indices, rather than broader environmental determinants (Patnaik et al., 2007; Monge-Corella et al., 2008; Bellini et al., 2014; Jutlta et al., 2015; Leifels et al., 2022; Tsali et al., 2024).

On the other hand, the results obtained through ES could be adapted and modeled to develop preventive strategies within SoE, depending on whether they were recorded at the appropriate scales and whether field interventions could be validated. In this sense, many datasets could be used as baselines or modeling inputs for preventive designs, such as the multifactorial nidality described for influenza A subtypes (climate, demographics, migratory birds, wetlands, markets, and poultry processing industries) (Xu et al., 2016; Henning et al., 2019); the dynamics of environmental changes in rare health events (Prospero et al., 2008; Okezie et al., 2010); the temporal lags between recorded variables and cases of leptospirosis or influenza (Guimarães et al., 2014; Lau et al., 2019); and the proactive surveillance of antimicrobial resistance and *Legionella* (Alexandropoulou et al., 2019).

Modeling began to show substantial analytical development starting in 2001, for example in optimizing the selection of monitoring sites in EWS based on pathogen-independent variables (Takane et al., 2016). Other developments toward the end of this period that would gain importance in the following one included the use of artificial intelligence for monitoring dam leaks (Cheng et al., 2018) and the integration of Geographic Information Systems (GIS) into functional surveillance programs (Dixit et al., 2018).

Period 2020-2025 (up to 03/31/2025)

Between the second and third periods, publications on the Virus subject continued to increase proportionally (Fig. 1), driven by COVID-19 since its first recorded mention in this search and by the consequent movement restrictions analyzed as a natural experiment (Cheng et al., 2020; Chakraborty et al., 2021). Additional contributing events to this increase included the emergence of monkeypox (de Jonge et al., 2022), outbreaks of Type 2 Vaccine-Derived Poliovirus, and the persistence of pandemic influenza. Other subject subcategories also reported emergent events, such as sporotrichosis in Fungi (Eudes et al., 2020), while in the Abiotic subcategory, EWS applications expanded to include illicit drug monitoring (Carnevale Miino et al., 2023).

The increase in Water and Air within the *Sample* category aligns with responses to the COVID-19 pandemic. In the *Methods* category, Molecular Biology techniques for viral detection and antimicrobial resistance became well-established, whereas in the Physical subcategory, the adoption of MALDI-TOF, biosensors, and filtration–concentration systems gained traction. Similarly, in Modeling, there was a growing focus on EWS risk factor analysis. The *Objective* category remained largely unchanged across periods, as new transmission scenarios further stimulated studies on foci, strategic recommendations, and the evaluation of new tools.

Efforts to standardize EWS terminology resulted in distinctions such as 'wastewater-based epidemiology,' which links wastewater analytes and pathogens to public health outcomes; 'wastewater tracking/tracing,' which focuses on targeted searches of analytes and pathogens; 'wastewater surveillance,' referring to continuous monitoring; and 'wastewater monitoring,' which assesses discharge quality (Larsen et al., 2021). Other authors, particularly in relation to COVID-19, differentiated between 'community-based passive wastewater surveillance' and 'surface-environmental surveillance' (Fielding-Miller et al., 2023), or distinguished between EWS and ES using surface swabs for antimicrobial resistance surveillance in abattoirs (Heljanko et al., 2024).

These refinements in terminology enhance instrumental specificity but simultaneously narrow the conceptualization of the environment. Articles retrieved under ES typically examine few isolated environmental variables rather than conceptualizing the environment as a complex space, where interconnected biological, physical, and social dynamic relationships occur. Numerous publications and ES guidelines emphasize the need for systematic data collection, analysis, and interpretation to inform the planning, implementation, and evaluation of public health measures. Moreover, handbooks, when referring to sources of information, include determinants of population health status, environmental variables (climate, topography, vegetation cover, water availability), human intervention on the environment (air quality, waste disposal), and socio-economic, political, health system, and individual susceptibility indicators (Parrish & MacDonell, 2000). However, these sources are often compartmentalized according to the structure of surveillance systems, complicating efforts to achieve synergies across different scales and between variables.

As previously noted, the limitations identified in this review do not imply a critique of the quality or significance of the publications. For instance, the inclusion of social components in ES has improved the efficiency and sustainability of even basic technologies, such as providing hygiene kits to cohabitants of cholera cases (D'Mello-Guyet et al., 2021), promoting social justice in rural and disadvantaged communities (Medina et al., 2022), and defining a limited set of climatic risk factors to contribute to real-time monitoring algorithms (Lin et al., 2022).

Many original articles, reviews, and strategic proposals continue to emphasize the cost-effectiveness of ES and EWS without conducting comparative cost analyses (Molejon et al., 2023; Uzzell et al., 2024; Khan et al., 2025), or by modeling costs for highly specific pilot areas, such as EWS at military installations (Sanjak et al., 2024). The cost-benefits of ES have been highlighted as an adaptive, continuous-use multi-platform approach versus on-demand clinical diagnosis (Ngwira et al., 2022), or in prioritization for vaccination programs versus whole-population immunization (Hagedorn et al., 2024). On the other hand, the cost-effectiveness of new sampling, isolation, and concentration tools and technologies is evident whether in biosensors, filtration systems of electrostatic fabrics (Brown et al., 2021; 2024; Viegas et al., 2022; Balash et al., 2023). The latter had already been proposed in the previous period as an electrostatic dust cloth for community participation (Cozen et al., 2008).

Exposome

Since its introduction, the exposome concept has advanced significantly (Wild, 2005, 2011; Miller & Jones, 2014; Jones, 2015; Uppal, 2016). Although the term warrants a dedicated review, here we focus solely on its convergence with ES and SoE concepts. In this context, the exposome encompasses the cumulative temporal monitoring of environmental impacts on health, primarily from a mechanistic perspective centered on individual health and chronic pathologies, with disease as the ultimate endpoint.

The environment is defined as the "non-genetic" component and the "nature of nurture," according to the cited authors. This conceptualization stems from the exposome's origins in toxicology and oncology, later influenced by the rise of omics sciences and epigenetics. Consequently, the detection of physico-chemical analytes and biomarkers (signatures, fingerprints) has been interpreted as a "complement to the genome." This definition of the environment aligns closely with traditional occupational and environmental health frameworks. Individual factors such as lifestyle behaviors related to tobacco and alcohol consumption, socio-economic indicators (e.g., education, financial status), and mental stress are readily incorporated into such analyses.

While interdisciplinary studies integrating ecology and social sciences are recommended, they are often included only as theoretical premises, analyzing select physical and biological variables independently rather than as integrated socio-environmental factors. For example, when modeling the long-term cumulative effect on lung function (pre-bronchodilation FEV1) based on residence, the environmental variables considered include air pollution, vegetation, and ambient temperature (Jeong et al., 2025). This mechanistic linearity has been reinforced by the incorporation of high-resolution metabolomics, bioinformatics, and AI in efforts to "sequence the exposome." Additional emerging technologies proposed to monitor lifestyle components of the exposome must avoid evolving into tools for social control, such as real-time recording of electronic diaries or videos and mobile phone usage, which have been suggested as indicators of psychosocial stress or social interaction.

Considering the limitations of this approach, some authors highlight the socio-spatial component, acknowledging the existence of vulnerable subpopulations and disadvantaged neighborhoods with differing levels of exposure and healthcare access (Jang et al., 2025; Ma et al., 2025). Geographic and occupational disparities have been observed in relation to Alzheimer's disease and residential or military service history in biobanked samples (Powell et al., 2023; Melcher et al., 2024), while the use of data from social networks has been proposed again (Peters et al., 2011). The Area Deprivation Index, as an indicator of spatial differences in the social exposome, has been related to a lack of understanding of swallowing care recommendations for people with dementia (Robinson et al., 2024), while social trajectories and inequity have been connected to adolescent health outcomes (Wang et al., 2024). Moreover, social stress and behavior have been correlated with genetic aging or delirium (Arias et al., 2021; Nielsen et al., 2024), with delirium also associated with parental blue- or white-collar background (Shift et al., 2022).

Thus, when applied to specific cases, the social aspects of the exposome risk losing the broader, theoretical framework of integrated multiple exposures. As in ES, "the social" enables the incorporation of perspectives on equity, vulnerability, and justice (Jackson & Arah, 2020; Nwanaji-Enwerem et al., 2021; Deguen et al., 2022; Gudi et al., 2023), while once again raising the issue of appropriate analytical scales (Buckingham et al., 2024).

Towards a theoretical eco-epidemiological approach

Let us return to Susser's approach mentioned at the beginning of this review, in which they points out that epidemiology has lost the collective health objective outlined by John Snow. To address this, they proposed a multi-scale and interdisciplinary eco-epidemiology to overcome the problems of atomism and mechanistic thinking (Susser & Susser, 1996). Similarly, applying the eco-epidemiological framework to SoE will restore the environment as a multi-causal, comprehensive factor and as a temporal and spatial landscape where many simultaneous health events occur. While the ES approach developed since the 1960s has contributed to generating ex post mitigation and control actions, SoE allows for the generation of ex ante preventive strategies using the time lags of critical variables.

As noted above, a MEDLINE search using the terms "environmental surveillance" retrieved about 1,800 articles in March 2025, whereas a search using "environmental AND surveillance" yielded approximately 363,000. In this broader category of papers, the concept of environment is more comprehensive than in ES works and aligns more closely with the SoE approach, from early articles on apple scab control (Keitt, 1926) to river pollution related to schistosomiasis (Cawston, 1946). However, the temporal and spatial scales used are often fixed, independent of variable dynamics and recording agents, and usually constrained by political and sanitary jurisdictional boundaries (Rosenbaum, 1945; Sallstrom, 1945). This trend has persisted for a century, even as new technologies associated with microbiota and metagenomics have emerged as surveillance topics (Ast et al., 2025; Fumagalli et al., 2025; Teigen et al., 2026; You et al., 2025; Zhu et al., 2025). Even with participatory construction methodologies, the jurisdictional conception of space remains dominant (Bezerra & Bitoun, 2017).

Regarding the interdisciplinary approach in articles retrieved using *environment and surveillance*, the social sciences have become increasingly relevant, particularly concerning mental health, health behavior, and lifestyles (Eriksson et al., 2025; Hao et al., 2025; Kounnavong et al., 2025; Ugai et al., 2025). Studies examining the relationship between psychosocial stress, immunological competence, vector-borne diseases, and anthropogenic changes—such as forced migration, droughts, or disasters—reflect this broader conceptualization of the environment (Espinoza et al., 2025; Straight et al., 2025; Wilke et al., 2025; Yetim et al., 2025).

A multiscale approach, as in eco-epidemiology, has been proposed for addressing Influenza A virus across humans, domestic animals, feral animals, and wild bird interfaces (Goel et al., 2025). Models of foot-and-mouth disease nidality incorporate interconnected climatic, topographical, and land-use risk factors, as well as population density and road density (An et al., 2025). Multi-sectoral agents have also been integrated, utilizing expert-curated information from the Program for Monitoring Emerging Diseases (ProMED); however, 98% of the reports pertain to events in humans or animals, with none referencing environmental factors (Rocha et al., 2025). Another approach to managing diverse stakeholders has been to restrict their involvement to specific health promotion and communication topics (Oliveira et al., 2019), community participation (Howard et al., 2018; Carvalho et al., 2021), or risk assessments related to land use (Duong et al., 2021).

One example more aligned with the SoE proposal is the Georeferenced Wildlife Health Information System (SISS-Geo, *Sistema de Informação em Saúde Silvestre Georreferenciado*) developed in Brazil. This system involves the collaborative participation of citizens, health and environmental agents, researchers, diagnostic laboratories, and expert networks. The spatiotemporal predictive models generated by SISS-Geo have proven effective for spatial prioritization and decision-making in yellow fever epizootics. However, this system also highlights governance challenges and the complexities of multiscale modeling (Chame et al., 2019; Brazil, 2025c). The difficulty of achieving interoperable information systems from various sources has been discussed by Oltean et al. (2025) concerning One Health, primarily in genomic surveillance, without identifying variables in the environmental data compartment.

The complexity of eco-epidemiological factors has been explored in studies analyzing the relationship between landscape structure and bacterial exposure in animals (Dos Santos et al., 2023), socio-demographic and vector variables associated with Chikungunya fever (Aguiar-Santos et al., 2023), human behavior and household structure variables in antimicrobial resistance interventions (Sammarro et al., 2023), and sea temperature and marine wildlife pathology (Maynard et al., 2016). These studies reinforce the importance of accurately defining operational scales to implement effective preventive actions (Alvarez Valdés et al., 2007).

Even at the focal level, it is often necessary to distinguish between micro- and macro-habitat environmental variables when modeling risk factors (Santini et al., 2015). This issue underscores that each variable has an optimal scale or scales for monitoring, and that each scale requires specific collection methodologies. Similarly, different time scales and capture frequencies are necessary for each variable, along with a sustainable and continuous monitoring design for potential emergent events, akin to "archival science" in climate change and conservation studies (Raby, 2015).

Regarding the actors involved in surveillance, each variable at each spatiotemporal scale also implies different monitoring media and agents, with varying levels of responsibility. For fieldwork at the focal level, it is essential to incorporate communities, which requires understanding their social structure and fostering prior relationships of trust, valid for both monitoring and emergencies (Sharma et al., 2023). This inclusion must respect individual and collective rights, as already proposed for ES and exposome studies (Bonefille et al., 2023), and consider the Open Science framework (UNESCO, 2021). In this sense, when incorporating technological advances, such as open-source dashboards or Artificial Intelligence (Naughton et al., 2023; Hill et al., 2023; Irrgang et al., 2023), special attention must be paid to the ethical issues involved.

From Environmental Surveillance to an operative Surveillance of the Environment

To operationalize the SoE, the Health Territory to be monitored should be defined based on socio-environmental criteria. In this context, “territory” refers to the spatial, ecological, social, and political locus where dynamic health events of interest are monitored. The SoE approach, therefore, entails monitoring the critical physical and biological variables within a Health Territory characterized by landscape vulnerability and heterogeneity. At each spatial scale, recording quantitative thresholds or qualitative risk events of these critical variables, with an appropriate time lag, enables effective preventive interventions.

From this perspective, the concept of Eco-epidemiological Momentum was developed to describe the convergence of multiscale biological, physical, and social drivers, where biological drivers determine epidemic potential, while social and physical drivers trigger epidemic probabilities (Salomon, 2019). Consistently, a preventive surveillance strategy at various scales was proposed for leishmaniasis outbreaks in Argentina. For Cutaneous Leishmaniasis, monitoring is based on the knowledge that outbreaks occur in domestic-wild ecotones due to environmental modifications and human settlements. For urban Visceral Leishmaniasis, monitoring sites are prioritized based on vector habitat suitability and socio-environmental risk, utilizing satellite imagery, secondary sources, and community-generated data at different spatial scales (Salomon & Quintana, 2022).

The methodology for defining Health Territory and SoE variables follows a structured chronological sequence outlined in Box 1. This process involves characterizing the Geographical Area based on epidemiological criteria (similar to ES) and further refining it to define the Health Territory by incorporating eco-epidemiological variables.

Box 1 Steps for Surveillance of the Environment (SoE) strategy

1	Definition of Geographical Area: History of risk endemics and epidemics
2	Definition of Health Territory within the Geographical Area 2.1 Landscape structure 2.1.1 Ecological landscape units where events of interest occur 2.1.2 Socio-demographic, domestic and wild animal distribution 2.1.3 Interfaces and their dynamics 2.1.4 Risk of potential environmental modification 2.1.5 Geopolitical and socio-economic risk

	2.2 Prioritised events to monitor 2.2.1 Sub-populations vulnerability and capacity of agency. 2.2.3 Feasibility of surveillance and integrated surveillance 2.3 Variables according to risk and event 2.3.1 Critical. physical, social and biological variables 2.3.2 Measurement method, lags for intervention. 2.3.3 Design, implementation, governance feasibility
3	Preventive Intervention: One Health Risk Management

The potential environmental risk refers to planned infrastructure or urbanization projects, as well as unplanned but highly probable events such as land encroachment on interfaces or increased extreme weather events. The geopolitical and socioeconomic perspective incorporates an additional risk factor for spatial prioritization within the landscape study unit: the existence of jurisdictional borders, which may imply different health systems, health policies, biodiversity conservation and extractive laws, the presence of migratory routes, and differential social disturbances.

Regarding prioritized events for monitoring, in addition to the classic epidemiological criteria of incidence, prevalence, and number of people affected, vulnerable subpopulations that could experience different impacts on their quality of life due to various events should be identified. The feasibility of integrating other events into the same SoE initiative should also be considered, even if they do not carry priority epidemiological weight. For example, rainfall and hydrological data, from regional records to local and peri-domiciliary flooding at the microscale, can be used to integrate surveillance for leptospirosis, enteroviruses and waterborne bacterial infections, vector-borne diseases transmitted by mosquitoes and mollusks, and accidents involving poisonous animals.

The selection of variables to monitor involves a literature review and risk factor modeling to define critical variables and their threshold or triggering events, representing the "perfect storm" or Eco-epidemiological Momentum of an epidemic. However, the variable selection criteria must also consider the feasibility of recording and whether there are time lags between the threshold or event and the peak of transmission that would allow for effective preventive interventions. For this selection, it is also necessary to define who will conduct surveillance, how, and how frequently, taking into account, as indicated above, that each variable for the same event may differ in monitoring methods depending on the scale.

The preventive SoE strategy for leishmaniasis cited above (Salomon & Quintana, 2022) proposed monitoring environmental modifications that generate risk with the participation of the community, environmental NGOs and rangers, municipal urban development areas, the federal meteorological and forestry services, and national and international agencies that finance the construction of dams or roads, each at its scale and level of responsibility. The capacity to implement multiscale monitoring implies a large number of additional activities, such as management, analysis, discussion, and periodic review-feedback, again adapted to the actors and the scale.

Similarly, it is necessary to identify strategies and timelines for anticipatory interventions when alert thresholds or risk events are reported by a functional SoE. These interventions can range from the micro-target level, involving an informed and participatory community, to the entire Health Territory, including programmatic actors from more than one country when borders are present. Interventions must be designed in advance, discussed, and agreed upon by the stakeholders involved, described in accessible sources, feasible to implement, and include process and impact indicators that can be evaluated.

Designing concrete, effective, and efficient prevention or mitigation strategies and implementing them on the ground constitutes a crucial step in the eco-epidemiological framework of SoE. In addition to defining the Health Territory and the eco-epidemiological momentum, the One Health Risk Management concept—still under development—could serve as a theoretical and practical guide for this final step, leveraging existing One Health coordination tools. The Risk Management methodology, in turn, will help structure flowcharts, analyses, assessments, planning, and evaluation of preventive activities. Furthermore, this approach could mirror risk analysis in production chains, identifying weak links as targets for intervention within the One Health–SoE framework.

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References

Aguiar-Santos, M., Mendes, L. G. D. C., Passos, D. F. D., Santos, T.G.D.S., Lins, R.H.F.B., & Monte, A.C.P.D. (2023). Spatial analysis of Chikungunya fever incidence and the associated socioeconomic, demographic, and vector infestation factors in municipalities of Pernambuco, Brazil, 2015-2021. *Brazilian Journal of Epidemiology, 26*, e230018. https://doi.org/10.1590/1980-549720230018

An, Q., Lv, Y., Li, Y., Sun, Z, Gao, X., & Wang, H. (2025). Global foot-and-mouth disease risk assessment based on multiple spatial analysis and ecological niche model. *Veterinary Quarterly*, *45*(1), 1–11. https://doi.org/10.1080/01652176.2025.245448245.

Alexandropoulou, I., Parasidis, T., Konstantinidis, T., Panopoulou, M., & Constantinidis, T.C. (2019). A Proactive Environmental Approach for Preventing Legionellosis in Infants: Water Sampling and Antibiotic Resistance Monitoring, a 3-Years Survey Program. *Healthcare 7*(1), 39. https://doi/10.3390/healthcare7010039.

Alvarez Valdés A.M, Díaz Pantoja C, García Melian M, *et al.* (2007). Sistema integrado de vigilancia para la prevención de dengue. *Revista cubana de medicina tropical, 59*(3), 193-201.

Arias, F., Alegria, M., Kind, A. J., Jones, R.N, Travison, T.G, Marcantonio, E.R., Schmitt, E.M, Fong, T.G, & Inouye, S.K. (2022). A framework of social determinants of health for delirium tailored to older adults. *Journal of the American Geriatrics Society,* 70(1), 235–242. https://doi.org/10.1111/jgs.17465 .

Ast, H.K., Hammer, M., Zhang, S., Bruton, A., *et al.* (2025). Gut microbiome changes with micronutrient supplementation in children with attention-deficit/hyperactivity disorder: the MADDY study. *Gut Microbes, 17(1),* 2463570. doi: 10.1080/19490976.2025.2463570.

Ball, D.F, Barber, M., & Vossen, P.G. (1973). The use of spark source mass spectroscopy for the determination of mercury in fish in environmental surveillance. *Sci Total Environ 2*(1):101-110. doi: 10.1016/0048-9697(73)90010-7.

Ballash, G.A., Mathys, D.A., Feicht, S.M, Mollenkopf, D.F, Albers, A.L, Adams, R.J, & Wittum T.E. (2023). Antimicrobial-Resistant *Enterobacterales* Recovered from the Environment of Two Zoological Institutions Include Enterobacter cloacae Complex ST171 Producing KPC-4 Carbapenemase. *Applied and Environmental Microbiology*, *89*(5), e0025723. https://doi: 10.1128/aem.00257-23.

Baratta, E.J., Parks, D.C, Moeller, D.W, & Rosenstein, M. (1964). An Environmental Surveillance Laboratory for Radionuclide Analyses. *Environ Health Series, Rh Radiol Health*, *20*:1-37.

Barcellos, C., & Quitério, L.A. (2006). Vigilância ambiental em saúde e sua implantação no Sistema Unico de Saúde [Environmental surveillance in health in Brazil's Unified Health System]. *Rev Saude Publica*,*40*(1):170-177. htttps://doi: 10.1590/s0034-89102006000100025.

Barst, R.J., Prince, A.S, & Neu, H.C. (1981). Aspergillus endocarditis in children: case report and review of the literature. *Pediatrics, 68*(1):73-78. https://doi.org/10.1016/j.diagmicrobio.2008.08.007

Bellini, R., Calzolari, M., Mattivi, A., Tamba, M., Angelini, P., *et al.* (2014). The experience of West Nile virus integrated surveillance system in the Emilia-Romagna region: five years of implementation, Italy, 2009 to 2013. *Euro Surveill,19*(44), 20953. https://doi: 10.2807/1560-7917.es2014.19.44.20953.

Bezerra, A.C.V., & Bitoun, J. (2017). Participatory methodology as an instrument for the territorialization of Environmental Surveillance actions. *Cien Saude Colet, 22*(10), 3259-3268. https://doi: 10.1590/1413-812320172210.17722017.

Bischer, A.P, Baran, T.M, & Wojtovich, A. P. (2023). Reactive oxygen species drive foraging decisions in Caenorhabditis elegans. *Redox Biol.*, *67*, 102934. https://doi: 10.1016/j.redox.2023.102934.

Bonnefille, B., Karlsson, O., Rian, M.B, Raqib, R., *et al.* (2023). Nontarget Analysis of Polluted Surface Waters in Bangladesh Using Open Science Workflows. *Environmental Science and Technology, 57*(17):6808-6824. https://doi: 10.1021/acs.est.2c08200.

Brasil, 2025a https://www.gov.br/pt-br/servicos-estaduais/vigilancia-ambiental-prevencao-e-controle-dos-fatores-de-risco-ambientais-relacionados-as-doencas-ou-a-outros-agravos-a-saude-1 4/2/2025

Brasil 2025b https://www.gov.br/saude/pt-br/composicao/svsa/saude-ambiental

Brazil 2025c https://sissgeo.lncc.br/apresentacao.xhtml

Brown, E., Ehizibolo, D., Dogonyaro, B.B, Wungak, Y., *et al.* (2024). Environmental sampling for the detection of capripox viruses and peste des petits ruminants virus in households and livestock markets in Plateau State, Nigeria. *Access Microbiol*, *6*(10):000872.v3. https://doi: 10.1099/acmi.0.000872.v3.

Brown, E., Nelson, N., Gubbins, S., & Colenutt, C. (2021). Environmental and air sampling are efficient methods for the detection and quantification of foot-and-mouth disease virus. *Journal of Virological Methods*, *287*, 113988. https://doi: 10.1016/j.jviromet.2020.113988.

Buckingham, W.R., Ryan Powell, W., Keller, S.A., Hansmann, K.J., & Kind, A.J. (2024). Bigger isn't better: Why small area geographies are best for actionable index development. *Papers in Applied Geography*, *10*(2), 89–95. https: doi: 10.1080/23754931.2024.2312192.

Buffler, P. A., & Aase, J. M. (1982). Genetic risks and environmental surveillance: epidemiological aspects of monitoring industrial populations for environmental mutagens. *Journal of occupational medicine*, *24*(4), 305–314.

Carnevale Miino, M., Macsek, T., Halešová, T., Chorazy, T., & Hlavínek, P. (2023). Pharmaceutical and narcotics monitoring in Brno wastewater system and estimation of seasonal effect on the abuse of illicit drugs by a wastewater-based epidemiology approach. *The Science of the total environment*, *891*, 164386. https://doi.org/10.1016/j.scitotenv.2023.164386

Carvalho, L. V. B., Rocha, F., & Finamore, R. (2021). Vigilância popular ambiental e siderurgia: as experiências de Piquiá de Baixo (MA) e Santa Cruz (RJ), Brasil. *Ciencia & saude coletiva*, *26*(suppl 2), 3635–3645. https://doi.org/10.1590/1413-81232021269.2.20722019

Cawston F. G. (1946). Schistosomiasis in southern Africa in its relation to the pollution of river-pools. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde*, *20*, 240.

Chakraborty, S., Sarkar, K., Chakraborty, S., Ojha, A., Banik, A., Chatterjee, A., Ghosh, S., & Das, M. (2021). Assessment of the surface water quality improvement during pandemic lockdown in ecologically stressed Hooghly River(Ganges) Estuary, West Bengal, India. *Marine pollution bulletin*, *171*, 112711. https://doi.org/10.1016/j.marpolbul.2021.112711

Chame, M., Barbosa, H.J.C, Gadelha, L.M.R Jr, *et al.* (2019). SISS-Geo: Leveraging Citizen Science to Monitor Wildlife Health Risks in Brazil. *Journal of Healthcare Informatics Research, 3*(4),414-440. https://doi: 10.1007/s41666-019-00055-2.

Chaves, E.C.R., Quaresma, J.A.S., Rodrigues, M.H.C. *et al.* (2024). Altered leukocyte pattern and inflammatory markers in unvaccinated long covid patients: a cross-sectional study. *Sci Rep* 14, 28617. https://doi.org/10.1038/s41598-024-75920-1

Cheng, V. C. C., Wong, S. C., Chen, J. H. K., *et.al.* (2020). Escalating infection control response to the rapidly evolving epidemiology of the coronavirus disease 2019 (COVID-19) due to SARS-CoV-2 in Hong Kong. *Infection control and hospital epidemiology*, *41*(5), 493–498. https://doi.org/10.1017/ice.2020.58

Cheng, X., Li, Q., Zhou, Z., Luo, Z., Liu, M., & Liu, L. (2018). Research on a Seepage Monitoring Model of a High Core Rockfill Dam Based on Machine Learning. *Sensors*, *18*(9), 2749. https://doi.org/10.3390/s18092749

Coops, N. C., Stone, C., Culvenor, D. S., & Chisholm, L. (2004). Assessment of crown condition in eucalypt vegetation by remotely sensed optical indices. *Journal of environmental quality*, *33*(3), 956–964. https://doi.org/10.2134/jeq2004.0956

Correia, V. R., Carvalho, M. S., Sabroza, P. C., & Vasconcelos, C. H. (2004). Remote sensing as a tool to survey endemic diseases in Brazil. *Cadernos de saude publica*, *20*(4), 891–904. https://doi.org/10.1590/s0102-311x2004000400003

Corvalán, C., Nurminen, M., & Pastides, H. (1997). *Linkage methods for environmental health analysis: technical guidelines*. World Health Organization; 1997. https://iris.who.int/bitstream/handle/10665/63490/WHO_EHG_97.11.pdf?sequence=1&isAllowed=y

Cozen, W., Avol, E., Diaz-Sanchez, D., McConnell, R., Gauderman, W. J., Cockburn, M. G., Zadnick, J., Jyrala, M., & Mack, T. M. (2008). Use of an electrostatic dust cloth for self-administered home allergen collection. *Twin research and human genetics : the official journal of the International Society for Twin Studies*, *11*(2), 150–155. .

Crabb, H. K., Allen, J. L., Devlin, J. M., Wilks, C. R., & Gilkerson, J. R. (2019). Spatial Distribution of Salmonella enterica in Poultry Shed Environments Observed by Intensive Longitudinal

Environmental Sampling. *Applied and environmental microbiology*, *85*(14), e00333-19. https://doi.org/10.1128/AEM.00333-19

da Costa, C. F., da Silva, A. V., do Nascimento, V. A., de Souza, V. C., Monteiro, D. C. D. S., Terrazas, W. C. M., Dos Passos, R. A., Nascimento, S., Lima, J. B. P., & Naveca, F. G. (2018). Evidence of vertical transmission of Zika virus in field-collected eggs of Aedes aegypti in the Brazilian Amazon. *PLoS neglected tropical diseases*, *12*(7), e0006594. https://doi.org/10.1371/journal.pntd.0006594

Deguen, S., Amuzu, M., Simoncic, V., & Kihal-Talantikite, W. (2022). Exposome and Social Vulnerability: An Overview of the Literature Review. *International journal of environmental research and public health*, *19*(6), 3534. https://doi.org/10.3390/ijerph19063534

de Jonge, E. F., Peterse, C. M., Koelewijn, J. M., van der Drift, A. R., van der Beek, R. F. H. J., Nagelkerke, E., & Lodder, W. J. (2022). The detection of monkeypox virus DNA in wastewater samples in the Netherlands. *The Science of the total environment*, *852*, 158265. https://doi.org/10.1016/j.scitotenv.2022.158265

Dixit, S., Arora, N. K., Rahman, A., *et al.* (2018). Establishing a Demographic, Development and Environmental Geospatial Surveillance Platform in India: Planning and Implementation. *JMIR public health and surveillance*, *4*(4), e66. https://doi.org/10.2196/publichealth.9749

D'Mello-Guyett, L., Cumming, O., Bonneville, S. *et al.* (2021). Effectiveness of hygiene kit distribution to reduce cholera transmission in Kasaï-Oriental, Democratic Republic of Congo, 2018: a prospective cohort study. *BMJ open*, *11*(10), e050943. https://doi.org/10.1136/bmjopen-2021-050943

Dolk H. (1999). The role of the assessment of spatial variation and clustering in environmental surveillance of birth defects. *European journal of epidemiology*, *15*(9), 839–845. https://doi.org/10.1023/a:1007569831029

Dos Santos, E. O., Klain, V. F., B Manrique, S., *et al.* (2023). Influence of landscape structure on previous exposure to Leptospira spp. and Brucella abortus in free-living neotropical primates from southern Brazil. *American journal of primatology*, *85*(4), e23472. https://doi.org/10.1002/ajp.23472

Duong, T. N., Le, T. V., Tran, K. H., *et al.* (2021). Azole-resistant Aspergillus fumigatus is highly prevalent in the environment of Vietnam, with marked variability by land use type. *Environmental microbiology*, *23*(12), 7632–7642. https://doi.org/10.1111/1462-2920.15660

Eriksson, M., Sundberg, L. R., Santosa, A., Lindgren, H., Ng, N., & Lindvall, K. (2025). Health behavioural change - the influence of social-ecological factors and health identity. *International journal of qualitative studies on health and well-being*, *20*(1), 2458309. https://doi.org/10.1080/17482631.2025.2458309

Espinoza, C., Alink, L., Laplante, D. P., Elzinga, B., & van der Veek, S. (2025). COVID-19 hardship and mental health in Chilean parents: the role of disaster exposure and family resilience. *European journal of psychotraumatology*, *16*(1), 2465001. https://doi.org/10.1080/20008066.2025.2465001

Eudes Filho, J., Santos, I. B. D., Reis, C. M. S., *et al.* (2020). A novel *Sporothrix brasiliensis* genomic variant in Midwestern Brazil: evidence for an older and wider sporotrichosis epidemic. *Emerging microbes & infections*, *9*(1), 2515–2525. https://doi.org/10.1080/22221751.2020.1847001

Fielding-Miller, R., Karthikeyan, S., Gaines, T., *et al*. (2023). Safer at school early alert: an observational study of wastewater and surface monitoring to detect COVID-19 in elementary schools. *Lancet regional health. Americas*, *19*, 100449. https://doi.org/10.1016/j.lana.2023.100449Freemon

FR. Reciprocal environmental surveillance model of sleep. J Theor Biol. 1970 May;27(2):339-40. doi: 10.1016/0022-5193(70)90144-x. PMID: 4318082..

Fritz, C. L., Bronson, L. R., Smith, C. R., Crawford-Miksza, L., Yeh, E., & Schnurr, D. (2005). Clinical, epidemiologic, and environmental surveillance for ehrlichiosis and anaplasmosis in an endemic area of northern California. *Journal of vector ecology : journal of the Society for Vector Ecology*, *30*(1), 4–10.

Fumagalli, A., Castells-Nobau, A., Trivedi, D., *et al*. (2025). Archaea methanogens are associated with cognitive performance through the shaping of gut microbiota, butyrate and histidine metabolism. *Gut microbes*, *17*(1), 2455506. https://doi.org/10.1080/19490976.2025.2455506

Gallegos, A. F., & Wenzel, W. J. (1989). HUMTRN and EFFECTS: age and sex specific dosimetric and physiological human population dynamics models for dose assessment. *Health physics*, *57 Suppl 1*, 443–453. https://doi.org/10.1097/00004032-198907001-00061

Goel, V., Ding, J., Hatuwal, B., Giri, E., *et al.* (2025). Ecological drivers of evolution of swine influenza in the United States: a review. *Emerging microbes & infections*, *14*(1), 2455598. https://doi.org/10.1080/22221751.2025.2455598.

Gudi-Mindermann, H., White, M., Roczen, J., Riedel, N., Dreger, S., & Bolte, G. (2023). Integrating the social environment with an equity perspective into the exposome paradigm: A new conceptual framework of the Social Exposome. *Environmental research*, *233*, 116485. https://doi.org/10.1016/j.envres.2023.116485 .

Guimarães, R. M., Cruz, O. G., Parreira, V. G., Mazoto, M. L., Vieira, J. D., & Asmus, C. I. (2014). Análise temporal da relação entre leptospirose e ocorrência de inundações por chuvas no município do Rio de Janeiro, Brasil, 2007-2012 [Temporal analysis of the relationship between leptospirosis and the occurrence of flooding due to rainfall in the city of Rio de Janeiro, Brazil, 2007-2012]. *Ciencia & saude coletiva*, *19*(9), 3683–3692. https://doi.org/10.1590/1413-81232014199.06432014

Hagedorn, B., Zhou, N. A., Fagnant-Sperati, C. S., Shirai, J. H., Gauld, J., Wang, Y., Boyle, D. S., & Meschke, J. S. (2023). Estimates of the cost to build a stand-alone environmental surveillance system for typhoid in low- and middle-income countries. *PLOS global public health*, *3*(1), e0001074. https://doi.org/10.1371/journal.pgph.0001074

Hanf, R. W., Schreckhise, R. G., Patton, G. W., Poston, T. M., & Jaquish, R. E. (1997). Public participation in radiological surveillance. *Health physics*, *73*(4), 700–705. https://doi.org/10.1097/00004032-199710000-00019

Hao, X., Song, H., Su, X., *et al.* (2025). Prophylactic effects of nutrition, dietary strategies, exercise, lifestyle and environment on nonalcoholic fatty liver disease. *Annals of medicine*, *57*(1), 2464223. https://doi.org/10.1080/07853890.2025.2464223

Hazuka, B. T., Dajani, A. S., Talbot, K., & Keen, B. M. (1977). Two outbreaks of Flavobacterium meningosepticum type E in a neonatal intensive care unit. *Journal of clinical microbiology*, *6*(5), 450–455. https://doi.org/10.1128/jcm.6.5.450-455.1977

Heljanko, V., Karama, M., Kymäläinen, A., *et al*. (2024). Wastewater and environmental sampling holds potential for antimicrobial resistance surveillance in food-producing animals - a pilot study in South African abattoirs. *Frontiers in veterinary science*, *11*, 1444957. https://doi.org/10.3389/fvets.2024.1444957

Henning, J., Hesterberg, U. W., Zenal, F., Schoonman, L., Brum, E., & McGrane, J. (2019). Risk factors for H5 avian influenza virus prevalence on urban live bird markets in Jakarta, Indonesia-Evaluation of long-term environmental surveillance data. *PloS one*, *14*(5), e0216984. https://doi.org/10.1371/journal.pone.0216984

Hill, D., Dunham, C., Larsen, D. A., & Collins, M. (2023). Operationalizing an open-source dashboard for communicating results of wastewater-based surveillance. *MethodsX*, *11*, 102299. https://doi.org/10.1016/j.mex.2023.102299

Hodge, R. A., & Longo, J. M. (2002). International monitoring for environmental health surveillance. *Canadian journal of public health = Revue canadienne de sante publique*, *93 Suppl 1*(Suppl 1), S16–S23. https://doi.org/10.1007/BF03405113

Howard, N. J., Dixit, S., Naqvi, H. R., Rahman, A., Paquet, C., Daniel, M., & Arora, N. K. (2018). Evaluation of data accuracies within a comprehensive geospatial-health data surveillance platform: SOMAARTH Demographic Development and Environmental Surveillance Site, Palwal, Haryana, India. *Global health, epidemiology and genomics*, *3*, e19. https://doi.org/10.1017/gheg.2018.17

Hunter, K. W., Jr, & Lenz, D. E. (1982). Detection and quantification of the organophosphate insecticide paraoxon by competitive inhibition enzyme immunoassay. *Life sciences*, *30*(4), 355–361. https://doi.org/10.1016/0024-3205(82)90572-0

Irrgang, C., Eckmanns, T., V Kleist, M., Antão, E. M., Ladewig, K., Wieler, L. H., & Körber, N. (2023). Anwendungsbereiche von künstlicher Intelligenz im Kontext von One Health mit Fokus auf antimikrobielle Resistenzen [Application areas of artificial intelligence in the context of One Health with a focus on antimicrobial resistance]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, *66*(6), 652–659. https://doi.org/10.1007/s00103-023-03707-2

Ito, K., Weinberger, K. R., Robinson, G. S., *et al*. (2015). The associations between daily spring pollen counts, over-the-counter allergy medication sales, and asthma syndrome emergency department visits in New York City, 2002-2012. *Environmental health : a global access science source*, *14*, 71. https://doi.org/10.1186/s12940-015-0057-0

Jackson, J. W., & Arah, O. A. (2020). Invited Commentary: Making Causal Inference More Social and (Social) Epidemiology More Causal. *American journal of epidemiology*, *189*(3), 179–182. https://doi.org/10.1093/aje/kwz199.

ang, D. G., Kind, A. J., Patterson, A., Pedde, M., Powell, W. R., Feldman, E. L., & Goutman, S. A. (2025). Impact of the Adverse Social Exposome on Survival in Individuals With Amyotrophic Lateral Sclerosis. *Neurology*, *104*(4), e213362. https://doi.org/10.1212/WNL.0000000000213362.

Jeong, A., Lovison, G., Bussalleu, A., *et a*l. (2025). Lung function-associated exposome profile in the era of climate change: Pooled analysis of 8 population-based European cohorts within the EXPANSE project. *Environment international*, *196*, 109269. https://doi.org/10.1016/j.envint.2025.109269.

Jones D. P. (2016). Sequencing the exposome: A call to action. *Toxicology reports*, *3*, 29–45. https://doi.org/10.1016/j.toxrep.2015.11.009.

Jutla, A., Huq, A., & Colwell, R. R. (2015). Diagnostic approach for monitoring hydroclimatic conditions related to emergence of west nile virus in west virginia. *Frontiers in public health*, *3*, 10. https://doi.org/10.3389/fpubh.2015.00010.

Kamei, R., & Okabe, S. (2023). In vivo imaging of the phagocytic dynamics underlying efficient clearance of adult-born hippocampal granule cells by ramified microglia. *Glia*, *71*(8), 2005–2023. https://doi.org/10.1002/glia.24379.

Katz, J. B., & Middle, L. A. (1990). Evaluation of thymidine kinase and neomycin phosphotransferase II positive selection systems for recovery of genetically atypical and recombinant DNA vaccine viruses. *Biologicals : journal of the International Association of Biological Standardization*, *18*(4), 301–304. https://doi.org/10.1016/1045-1056(90)90033-v.

Katz J. B. (1990). A dual dominant selection, dual marker gene amplification model for environmental surveillance of recombinant viral vaccines. *Research in virology*, *141*(6), 591–596. https://doi.org/10.1016/0923-2516(90)90032-e.

Khan, M. S., Wurzbacher, C., Uchaikina, A., Pleshkov, B., Mirshina, O., & Drewes, J. E. (2025). A Perspective on Wastewater and Environmental Surveillance as a Public Health Tool for Low- and Middle-Income Countries. *Microorganisms*, *13*(2), 238. https://doi.org/10.3390/microorganisms13020238.

Keitt G. W. (1926). Some Relations of Environment to the Epidemiology and Control of Apple Scab. *Proceedings of the National Academy of Sciences of the United States of America*, *12*(2), 68–74. https://doi.org/10.1073/pnas.12.2.68.

Korvick, J. A., Yu, V. L., & Fang, G. D. (1987). Legionella species as hospital-acquired respiratory pathogens. *Seminars in respiratory infections*, *2*(1), 34–47.

Kounnavong, T., Sato, M., Turner, C., *et al.* (2025). Drivers of food acquisition practices among adolescents in suburban food environments of Lao People's Democratic Republic. *Global health action*, *18*(1), 2451475. https://doi.org/10.1080/16549716.2025.2451475 .

Larsen, D. A., Green, H., Collins, M. B., & Kmush, B. L. (2021). Wastewater monitoring, surveillance and epidemiology: a review of terminology for a common understanding. *FEMS microbes*, *2*, xtab011. https://doi.org/10.1093/femsmc/xtab011.

Lau, S. Y., Chen, E., Wang, M., *et al*. (2019). Association between meteorological factors, spatiotemporal effects, and prevalence of influenza A subtype H7 in environmental samples in Zhejiang province, China. *The Science of the total environment*, *663*, 793–803. https://doi.org/10.1016/j.scitotenv.2019.01.403.

Leifels, M., Khalilur Rahman, O., Sam, I. C., *et al.* (2022). The one health perspective to improve environmental surveillance of zoonotic viruses: lessons from COVID-19 and outlook beyond. *ISME communications*, *2*(1), 107. https://doi.org/10.1038/s43705-022-00191-8.

Lin, C., Yousefi, S., Kahoro, E., Karisani, P., Liang, D., Sarnat, J., & Agichtein, E. (2022). Detecting Elevated Air Pollution Levels by Monitoring Web Search Queries: Algorithm Development and Validation. *JMIR formative research*, *6*(12), e23422. https://doi.org/10.2196/23422

Iivanainen, A., Raitanen, J., & Auvinen, A. (2024). Incidence of vestibular schwannoma in Finland, 1990-2017. *Acta oncologica (Stockholm, Sweden)*, *63*, 111–117. https://doi.org/10.2340/1651-226X.2024.20352.

Ma, Y., Mora Pinzon, M. C., Buckingham, W. R., *et al.* (2025). Comparison of sample characteristics of Wisconsin Alzheimer's Disease Research Center participants with the Wisconsin state population-An evaluation of the recruitment effort. *Alzheimer's & dementia (New York, N. Y.)*, *11*(1), e70036. https://doi.org/10.1002/trc2.70036.

Machado, I. B., Bitencourth, K., Cardoso, K. M., Oliveira, S. V., Santalucia, M., Marques, S. F. F., Amorim, M., & GazêTa, G. S. (2018). Diversity of rickettsiae and potential vectors of spotted fever in an area of epidemiological interest in the Cerrado biome, midwestern Brazil. *Medical and veterinary entomology*, *32*(4), 481–489. https://doi.org/10.1111/mve.12315 .

Maciel E. L. N. (2023). 20 years of the Health and Environmental Surveillance Secretariat: an analysis of two decades and perspectives. *Epidemiologia e servicos de saude : revista do Sistema Unico de Saude do Brasil*, *32*(4), e2023373. https://doi.org/10.1590/S2237-96222023000400016.EN

March, D., & Susser, E. (2006). The eco- in eco-epidemiology. *International journal of epidemiology*, *35*(6), 1379–1383. https://doi.org/10.1093/ije/dyl249

Maree, G., Els, F., Naidoo, Y., *et al*. (2025). Wastewater surveillance overcomes socio-economic limitations of laboratory-based surveillance when monitoring disease transmission: The South African experience during the COVID-19 pandemic. *PloS one*, *20*(2), e0311332. https://doi.org/10.1371/journal.pone.0311332.

Marques, E., Da Silva, E. E., Dos Santos, V. M., Kew, O. M., & Martins, M. T. (1993). Application of the polymerase chain reaction (PCR) to poliomyelitis surveillance through the analyses of sewage samples. *World journal of microbiology & biotechnology*, *9*(5), 566–569. https://doi.org/10.1007/BF00386295

Maynard, J., van Hooidonk, R., Harvell, C. D., *et al*. (2016). Improving marine disease surveillance through sea temperature monitoring, outlooks and projections. *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, *371*(1689), 20150208. https://doi.org/10.1098/rstb.2015.0208

Medina, C. Y., Kadonsky, K. F., Roman, F. A., *et al. (2022). The need of an environmental justice approach for wastewater based epidemiology* for rural and disadvantaged communities: A review in California. *Current opinion in environmental science & health*, *27*, 100348. https://doi.org/10.1016/j.coesh.2022.100348 .

Melcher, E. M., Vilen, L., Pfaff, A., *et al*. (2024). Deriving life-course residential histories in brain bank cohorts: A feasibility study. *Alzheimer's & dementia : the journal of the Alzheimer's Association*, *20*(5), 3219–3227. https://doi.org/10.1002/alz.13773

Menezes, C. T., & Heller, L. (2008). A method for prioritization of areas for pesticides surveillance on surface waters: a study in Minas Gerais, Brazil. *Water science and technology : a journal of the International Association on Water Pollution Research*, *57*(11), 1693–1698. https://doi.org/10.2166/wst.2008.277

Miller, G. W., & Jones, D. P. (2014). The nature of nurture: refining the definition of the exposome. *Toxicological sciences : an official journal of the Society of Toxicology*, *137*(1), 1–2. https://doi.org/10.1093/toxsci/kft251

Molejon, N. A., Lapada, C. M., Skouridou, V., Rollon, A. P., El-Shahawi, M. S., Bashammakh, A. S., & O'Sullivan, C. K. (2023). Selection of G-rich ssDNA aptamers for the detection of enterotoxins of the cholera toxin family. *Analytical biochemistry*, *669*, 115118. https://doi.org/10.1016/j.ab.2023.115118 .

Monge-Corella, S., García-Pérez, J., Aragonés, N., Pollán, M., Pérez-Gómez, B., & López-Abente, G. (2008). Lung cancer mortality in towns near paper, pulp and board industries in Spain: a point source pollution study. *BMC public health*, *8*, 288. https://doi.org/10.1186/1471-2458-8-288 .

Naughton, C. C., Holm, R. H., Lin, N. J., James, B. P., & Smith, T. (2023). Online dashboards for SARS-CoV-2 wastewater data need standard best practices: An environmental health communication agenda. *Journal of water and health*, *21*(5), 615–624. https://doi.org/10.2166/wh.2023.312.

Neefus J. D. (1975). Cotton dust sampling: I. Short termed sampling. *American Industrial Hygiene Association journal*, *36*(6), 470–476. https://doi.org/10.1080/0002889758507273.

Ngwira, L. G., Sharma, B., Shrestha, K. B., *et al*. (2022). Cost of wastewater-based environmental surveillance for SARS-CoV-2: Evidence from pilot sites in Blantyre, Malawi and Kathmandu, Nepal. *PLOS global public health*, *2*(12), e0001377. https://doi.org/10.1371/journal.pgph.0001377

Nielsen, L., Marsland, A. L., Hamlat, E. J., & Epel, E. S. (2024). New Directions in Geroscience: Integrating Social and Behavioral Drivers of Biological Aging. *Psychosomatic medicine*, *86*(5), 360–365. https://doi.org/10.1097/PSY.0000000000001320 .

Nwanaji-Enwerem, J. C., Jackson, C. L., Ottinger, M. A. *et al*. (2021). Adopting a "Compound" Exposome Approach in Environmental Aging Biomarker Research: A Call to Action for Advancing Racial Health Equity. *Environmental health perspectives*, *129*(4), 45001. https://doi.org/10.1289/EHP8392.

Okezie, O. A., Kgomotso, K. K., & Letswiti, M. M. (2010). Mopane worm allergy in a 36-year-old woman: a case report. *Journal of medical case reports*, *4*, 42. https://doi.org/10.1186/1752-1947-4-42

Oliveira, C. M., & Casanova, A. O. (2009). Vigilância da saúde no espaço de práticas da atenção básica [Implementing health surveillance at the primary care level]. *Ciencia & saude coletiva*, *14*(3), 929–936. https://doi.org/10.1590/s1413-81232009000300029.

Oltean, H. N., Lipton, B., Black, A., *et al*. (2025). Developing a one health data integration framework focused on real-time pathogen surveillance and applied genomic epidemiology. *One health outlook*, *7*(1), 9. https://doi.org/10.1186/s42522-024-00133-5 .

Ortega-García, J. A., López-Hernández, F. A., Cárceles-Álvarez, A., Santiago-Rodríguez, E. J., Sánchez, A. C., Bermúdez-Cortes, M., & Fuster-Soler, J. L. (2016). Análisis en áreas pequeñas del cáncer pediátrico en el municipio de Murcia [Analysis of small areas of pediatric cancer in the municipality of Murcia (Spain)]. *Anales de pediatria (Barcelona, Spain : 2003)*, *84*(3), 154–162. https://doi.org/10.1016/j.anpedi.2015.04.021Parrish II RG, McDonnell SM. Sources of Heath.Related Information. In Principles and Practice of Public Health Surveillance Teutsch SM & Churchill RE (Eds), Oxford University Press Inc New York 2000 2nd edition Cpt 3 30-75

Patnaik, J. L., Juliusson, L., & Vogt, R. L. (2007). Environmental predictors of human West Nile virus infections, Colorado. *Emerging infectious diseases*, *13*(11), 1788–1790. https://doi.org/10.3201/eid1311.070506.

Pavlovsky, E. N. (1966). *Natural Nidality Of Transmissible Diseases*. Urbana. University of Illinois Press;

Peters, A., Hoek, G., & Katsouyanni, K. (2012). Understanding the link between environmental exposures and health: does the exposome promise too much?. *Journal of epidemiology and community health*, *66*(2), 103–105. https://doi.org/10.1136/jech-2011-200643.

Powell, W. R., Vilen, L., Zuelsdorff, M., *et al*. (2024). Association between military service and Alzheimer's disease neuropathology at autopsy. *Alzheimer's & dementia : the journal of the Alzheimer's Association*, *20*(2), 1468–1474. https://doi.org/10.1002/alz.13520 .

Prospero, E., Barbadoro, P., Filippetti, F., Appignanesi, R., Ciavattini, A., & Carle, F. (2008). Occurrence of neural tube defects in pregnancy: an excess of cases in a 2773-km2 area in Central Italy. *Journal of toxicology and environmental health. Part A*, *71*(15), 981–983. https://doi.org/10.1080/15287390701838531 .

Raby M. (2015). Ark and Archive: Making a Place for Long-Term Research on Barro Colorado Island, Panama. *Isis; an international review devoted to the history of science and its cultural influences*, *106*(4), 798–824. https://doi.org/10.1086/684610 .

Ribble, C., Hunter, B., Larivière, N., *et al.* (1997). Ecosystem health as a clinical rotation for senior students in Canadian veterinary schools. *The Canadian veterinary journal = La revue veterinaire canadienne*, *38*(8), 485–490.

Robert, C. F., Bouvier, S., & Rougemont, A. (1989). Epidemiology, anthropology and health education. *World health forum*, *10*(3-4), 355–364..

Robison, R. D., Butz, N., Gustafson, S., *et al*. (2024). Ready for Discharge, but Are They Ready to Go Home? Examining Neighborhood-Level Disadvantage as a Marker of the Social Exposome and the Swallowing Care Process in a Retrospective Cohort of Inpatients With Dementia. *American journal of speech-language pathology*, *33*(3), 1536–1547. https://doi.org/10.1044/2024_AJSLP-23-00332.

Rocha, D. C., Santos Louro, L., Ewald Oliveira, H., Cancian de Araujo, B., Ryu, S., & Vicente, C. R. (2025). Use of ProMED as a Surveillance System for Emerging and Re-Emerging Infectious Diseases in Brazil from 2015 to 2020. *Viruses*, *17*(1), 93. https://doi.org/10.3390/v17010093.

Rosenbaum, S. (1945). Manifestations of rickets among children in Palestine. *Harefuah. Foreign ed*, *52*, 23–26.
Sallstrom, T. (1945). Seasonal variations in morbidity in cases of gastric ulcer and duodenal ulcer. *Acta medica Scandinavica*, *121*, 369–381.
Salomon, O.D. (2019) Instructions on how to make an Outbreak of American Cutaneous Leishmaniasis. *Journal of Tropical Medicine and Health, 3(2)*. 146. https://doi. 10.29011/2688- 6383.000146
Salomon, O.D., & Quintana, M.G. (2022). Eco-epidemiological studies to develop integrated vector surveillance of leishmaniasis vectors in the Americas. *One Health & Implementation Research*, *2*, 45-55.. https://doi.10.20517/ohir.2022.09
Sanjak, J. S., McAuley, E. M., Raybern, J., *et al*. (2024). Wastewater Surveillance Pilot at US Military Installations: Cost Model Analysis. *JMIR public health and surveillance*, *10*, e54750. https://doi.org/10.2196/54750 .
Sammarro, M., Rowlingson, B., Cocker, D., *et al*. (2023). Risk Factors, Temporal Dependence, and Seasonality of Human Extended-Spectrum β-Lactamases-Producing Escherichia coli and Klebsiella pneumoniae Colonization in Malawi: A Longitudinal Model-Based Approach. *Clinical infectious diseases: an official publication of the Infectious Diseases Society of America*, *77*(1), 1–8. https://doi.org/10.1093/cid/ciad117.
Santini, M. S., Utgés, M. E., Berrozpe, P., Manteca Acosta, M., Casas, N., Heuer, P., & Salomón, O. D. (2015). Lutzomyia longipalpis Presence and Abundance Distribution at Different Micro-spatial Scales in an Urban Scenario. *PLoS neglected tropical diseases*, *9*(8), e0003951. https://doi.org/10.1371/journal.pntd.0003951 .
Schiller, H., Schönfeld, W., Krasemann, H. L., & Schiller, K. (2007). Novelty detection--recognition and evaluation of exceptional water reflectance spectra. *Environmental monitoring and assessment*, *132*(1-3), 339–350. https://doi.org/10.1007/s10661-006-9538-5.
Sharma, N., Palo, S. K., Bhimarasetty, D. M., *et al*. (2023). Community Dynamics and Engagement Strategies in Establishing Demographic Development and Environmental Surveillance Systems: A Multi-Site Report from India. *Healthcare (Basel, Switzerland)*, *11*(3), 411. https://doi.org/10.3390/healthcare11030411
Shiff, H. M., Arias, F., Dufour, A. B., *et al.* (2022). Paternal Occupation and Delirium Risk in Older Adults: A Potential Marker of Early-Life Exposures. *Innovation in aging*, *6*(5), igac050. https://doi.org/10.1093/geroni/igac050.
Shmool, J. L., Bobb, J. F., Ito, K., *et al*. (2015). Area-level socioeconomic deprivation, nitrogen dioxide exposure, and term birth weight in New York City. *Environmental research*, *142*, 624–632. https://doi.org/10.1016/j.envres.2015.08.019
Silva, E. R. D. F. S., Castro, V., Mineiro, A. L. B. B., Prianti, M. D. G., Martins, G. H. C., Santana, M. D. V., Brito, L. M., & Silva, S. M. M. S. (2018). Sociodemographic and environmental analysis for the occurrence of anti-Leptospira antibodies in dogs of Teresina, Piauí, Brazil. Análise sociodemográfica e ambiental para ocorrência de anticorpos antiLeptospira em cães de Teresina, Piauí, Brasil. *Ciencia & saude coletiva*, *23*(5), 1403–1414. https://doi.org/10.1590/1413-81232018235.19532016 .
Straight, B., Hilton, C. E., Owuor Olungah, C., *et al*. (2025). Drought-compounded stress and immune function in Kenyan pastoralist boys and girls occupying contrasting climate zones. *Annals of human biology*, *52*(1), 2455698. https://doi.org/10.1080/03014460.2025.2455698
Susser, M., & Susser, E. (1996). Choosing a future for epidemiology: II. From black box to Chinese boxes and eco-epidemiology. *American journal of public health*, *86*(5), 674–677. https://doi.org/10.2105/ajph.86.5.674 .
Takane, M., Yabe, S., Tateshita, Y., Kobayashi, Y., Hino, A., Isono, K., Okayasu, H., Diop, O. M., & Tadono, T. (2016). Satellite imagery technology in public health: analysis of site catchment

areas for assessment of poliovirus circulation in Nigeria and Niger. *Geospatial health*, *11*(3), 462. https://doi.org/10.4081/gh.2016.462 .

Tchuem Tchuenté, L. A., Ombede, D. R. E., Noumedem, C. D., *et al*. (2018). Prospects for the elimination of schistosomiasis and soil-transmitted helminthiasis: exploring disease trends through time at the Barombi crater lakes, South-West Cameroon. *Parasitology*, *145*(13), 1700–1714. https://doi.org/10.1017/S0031182018001531 .

Teigen, L. M., Hoeg, A., Zehra, H., Shah, P., Johnson, R., Hutchison, K., Kocher, M., Lin, A. W., Johnson, A. J., & Vaughn, B. P. (2025). Nutritional optimization of fecal microbiota transplantation in humans: a scoping review. *Gut microbes*, *17*(1), 2446378. https://doi.org/10.1080/19490976.2024.2446378 .

Tsai, K. H., Yen, T. Y., Tung, H. H., *et al*. (2024). Surveillance of Emerging Rodent-Borne Pathogens in Wastewater in Taiwan: A One Health Approach. *Tropical medicine and infectious disease*, *9*(11), 282. https://doi.org/10.3390/tropicalmed9110282.

Ugai, S., Liu, L., Kosumi, K., *et al*. (2025). Long-term yogurt intake and colorectal cancer incidence subclassified by *Bifidobacterium* abundance in tumor. *Gut microbes*, *17*(1), 2452237. https://doi.org/10.1080/19490976.2025.2452237

Uppal, K., Walker, D. I., Liu, K., Li, S., Go, Y. M., & Jones, D. P. (2016). Computational Metabolomics: A Framework for the Million Metabolome. *Chemical research in toxicology*, *29*(12), 1956–1975. https://doi.org/10.1021/acs.chemrestox.6b00179.

Uzzell, C. B., Abraham, D., Rigby, J., *et al*. (2024). Environmental Surveillance for Salmonella Typhi and its Association With Typhoid Fever Incidence in India and Malawi. *The Journal of infectious diseases*, *229*(4), 979–987. https://doi.org/10.1093/infdis/jiad427

Veiga Gonçalves, N., Miranda, C. D. S. C., Costa, R. J. F. D., *et al.* (2019). Cutaneous leishmaniasis: Spatial distribution and environmental risk factors in the state of Pará, Brazilian Eastern Amazon. *Journal of infection in developing countries*, *13*(10), 939–944. https://doi.org/10.3855/jidc.11573 .

Vézina, M., & Saint-Arnaud, L. (1994). De la médecine du travail à la santé communautaire en Afrique francophone [From occupational medicine to community health in French-speaking Africa]. *Sante (Montrouge, France)*, *4*(2), 111–114.

Viegas, C., Dias, M., & Viegas, S. (2022). Electrostatic Dust Cloth: A Useful Passive Sampling Method When Assessing Exposure to Fungi Demonstrated in Studies Developed in Portugal (2018-2021). *Pathogens (Basel, Switzerland)*, *11*(3), 345. https://doi.org/10.3390/pathogens11030345.

Wang, Z., Drouard, G., Whipp, A. M., Heinonen-Guzejev, M., Bolte, G., & Kaprio, J. (2024). Association between trajectories of the neighborhood social exposome and mental health in late adolescence: A FinnTwin12 cohort study. *Journal of affective disorders*, *358*, 70–78. https://doi.org/10.1016/j.jad.2024.04.096.

WHO Scientific Working Group (1980). Cholera and other vibrio-associated diarrhoeas. *Bulletin of the World Health Organization*, *58*(3), 353–374.

Wild C. P. (2005). Complementing the genome with an "exposome": the outstanding challenge of environmental exposure measurement in molecular epidemiology. *Cancer epidemiology, biomarkers & prevention : a publication of the American Association for Cancer Research, cosponsored by the American Society of Preventive Oncology*, *14*(8), 1847–1850. https://doi.org/10.1158/1055-9965.EPI-05-0456

Wild C. P. (2012). The exposome: from concept to utility. *International journal of epidemiology*, *41*(1), 24–32. https://doi.org/10.1093/ije/dyr236

Wilke, A. B. B., Farina, P., Ajelli, M., Canale, A., Dantas-Torres, F., Otranto, D., & Benelli, G. (2025). Human migrations, anthropogenic changes, and insect-borne diseases in Latin America. *Parasites & vectors*, *18*(1), 4. https://doi.org/10.1186/s13071-024-06598-7

Xu, M., Cao, C., Li, Q., Jia, P., & Zhao, J. (2016). Ecological Niche Modeling of Risk Factors for H7N9 Human Infection in China. *International journal of environmental research and public health*, *13*(6), 600. https://doi.org/10.3390/ijerph13060600.

Yassi, A., Cheang, M., Tenenbein, M., Bawden, G., Spiegel, J., & Redekop, T. (1991). An analysis of occupational blood lead trends in Manitoba, 1979 through 1987. *American journal of public health*, *81*(6), 736–740. https://doi.org/10.2105/ajph.81.6.736.

Yetim, O., Tamam, L., Küçükdağ, R. M., & Sebea Alleil, İ. (2025). "The wind does not go the way the ship wants!": stress and social support in Syrian migrant adolescents. *International journal of qualitative studies on health and well-being*, *20*(1), 2467514. https://doi.org/10.1080/17482631.2025.2467514.

You, H., Yang, B., Liu, e*t al*. (2025). Unravelling distinct patterns of metagenomic surveillance and respiratory microbiota between two P1 genotypes of *Mycoplasma pneumoniae*. *Emerging microbes & infections*, *14*(1), 2449087. https://doi.org/10.1080/22221751.2024.2449087

Yuan, A., Spira-Cohen, A., Olson, C., & Lane, K. (2024). Immediate Injury Deaths Related to the Remnants From Hurricane Ida in New York City, September 1-2, 2021. *Disaster medicine and public health preparedness*, *18*, e55. https://doi.org/10.1017/dmp.2024.49

Zeichner, B. C., & Adams, S. D. (2010). Using geographic information systems to maximize environmental surveillance efforts and impact. *U.S. Army Medical Department journal*, 29–35.

Zhu, C., Zhang, Y., Pan, Y., Zhang, Z., Liu, Y., Lin, X., Cai, J., Xiong, Z., Pan, Y., & Nie, H. (2025). Clinical correlation between intestinal flora profiles and the incidence of postmenopausal osteoporosis. *Gynecological endocrinology : the official journal of the International Society of Gynecological Endocrinology*, *41*(1), 2465587.

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