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A framework for One Health research

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ABSTRACT

The need for multidisciplinary research to address today's complex health and environmental challenges has never been greater. The One Health (OH) approach to research ensures that human, animal, and environmental health questions are evaluated in an integrated and holistic manner to provide a more comprehensive understanding of the problem and potential solutions than would be possible with siloed approaches. However, the OH approach is complex, and there is limited guidance available for investigators regarding the practical design and implementation of OH research. In this paper we provide a framework to guide researchers through conceptualizing and planning an OH study. We discuss key steps in designing an OH study, including conceptualization of hypotheses and study aims, identification of collaborators for a multi-disciplinary research team, study design options, data sources and collection methods, and analytical methods. We illustrate these concepts through the presentation of a case study of health impacts associated with land application of biosolids. Finally, we discuss opportunities for applying an OH approach to identify solutions to current global health issues, and the need for cross-disciplinary funding sources to foster an OH approach to research.

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1. Introduction

The need for multidisciplinary research to solve today's complex health and environmental challenges has never been greater. The One Health (OH) approach to research addresses questions at the intersections of human, animal, and environmental health by utilizing the expert knowledge of researchers, including public health practitioners and clinicians, from multiple disciplines and at local, national, and global levels. While the need for multidisciplinary research is not new, the concept of OH has gained momentum as researchers from human medicine, public health, veterinary medicine, urban planning, and environmental science increasingly focus on holistic, integrated approaches to complex questions that address human health in conjunction with animal and environmental health [1].

The OH approach to research provides an opportunity for enhanced understanding of a range of health impacts and solutions. By looking at multiple dimensions of the problem through the lens of environmental, animal, and human health, researchers may discover influencing factors that they would not have otherwise seen, which can facilitate more informed intervention design. In 2015, the World Health Organization designated 11 diseases as high risk for severe outbreak, ten of which have a zoonotic reservoir or transmission vector [2]. An OH approach to studying these diseases may be able to provide more complete information about opportunities for outbreak prevention than a traditional one-dimensional approach. For example, a Lassa fever prevention intervention which targets the environmental (e.g. improved household sanitation) and animal (e.g. rodent removal) domains may show promise, but omission of the human domain (e.g. education of nurses on disposal of contaminated material in hospitals) may result in a missed opportunity to achieve optimum results. At worst, siloed approaches may lead to unforeseen detrimental effects. In the Lassa fever example, removal of rodent populations may result in increased malnutrition among humans if rodents were a significant direct or indirect (i.e. prey for larger food source animals) source of protein for families living in affected communities. The ultimate goal of OH research is to identify opportunities for health improvement and optimize risk mitigation simultaneously across all three domains [3].

Though many publications describe the benefits and individual applications of an OH approach [1,4–7], additional guidance for operationalizing the OH approach during the early phase of study design is needed. We address this need by providing a framework for the OH approach to conducting research, with a focus on conceptualization and planning. We illustrate this framework with a case study of the health impacts associated with land application of biosolids.

2. Framework

2.1. Conceptualization phase

To successfully develop a research project using an OH approach, investigators must consider incorporating elements from human, animal, and environmental health and the multiple intersections between each of these (Fig. 1).

2.1.1. Hypothesis and study aims

First, researchers must determine the precise questions they aim to answer and what relationships are known or theoretically exist between various exposure sources and outcomes. In this phase, it may be helpful to draw upon the expertise of research collaborators and relevant literature to inform the development of a diagram or chart of these relationships. For example, a Directed Acyclic Graph could be used to visualize exposure-outcome pathways and identify important covariables and confounders [8]. Or, a logic model or similar multi-pathway visualization matrix may also be helpful for deciding where in the pathway to intervene and for brainstorming the potential impacts of the intervention on animal, human, and environmental health. For example, a graphing exercise may help the research team anticipate downstream factors of a vector control program that should be measured to both determine the program's effectiveness (e.g. reduced number of vector-borne illnesses) and to evaluate any adverse outcomes associated with the intervention (e.g. impact of mosquito fumigation on local flora and fauna or human respiratory illness associated with exposure to fumigation). Hypotheses and study aims can be based on the findings of this graphing process.

2.1.2. Collaborators and stakeholders

Building a multi-disciplinary team is crucial to the development of research projects which aim to use an OH approach. Researchers may look inside their own institutions or externally for relevant expertise. In the team-building phase, it is important to present the research question to a wide and varied audience to uncover perspectives far outside one's own field that may be unexpectedly relevant to the question at hand. Given the diversity of topics covered in the OH approach, study teams may benefit from involvement of, for example, epidemiologists, veterinarians, ecologists, urban planners, structural and environmental engineers, geologists, hydrologists, climatologists, geospatial scientists, botanists, parasitologists, and microbiologists, among others. Early involvement of specialists from each domain will encourage broader thinking in the planning process and will facilitate the aggregation of resources available in each domain, such as funding, staff, and data. Researchers may also consider involvement of community members who have on-the-ground experience with the issue in question, such as farmers, fisherman, park rangers, scuba divers, wildfire firefighters, plant workers, and community members who live near potential exposure sites. Involvement of community members is likely to enhance the research team's ability to collect new data and to understand the context of the data.

2.2. Planning phase

Having considered which topics from each domain to include in a study using an OH approach, the next steps are to determine the appropriate study design, and identify data sources, analytical methods, and data components required to adequately evaluate the research question(s).

2.2.1. Study design

Determining the study design informs the selection of data collection and data analysis methods. The OH approach may draw from a range of study designs which are utilized in multiple disciplines, including, for example, prospective and retrospective cohort, case-control, genome-wide association, randomized control trial, case series, natural experiments, twin studies, risk assessment or risk analyses, experimental studies, and ecological studies. Due to the complexity of the OH research approach, the overall study design may be a combination of these. For example, a retrospective ecological evaluation of arboviral disease incidence in relation to deforestation patterns could be combined with a prospective natural experiment to assess changes in