

Title: Breaking Down Barriers: Identifying and Overcoming Statistical Gaps in One Health Integrated Data Analysis

Abstract:

The field of One Health recognizes the interconnections between human, animal, and environmental health, emphasizing the need for integrated approaches to address complex health challenges. As data availability and technological advancements enable the integration of diverse datasets from multiple disciplines, statistical analysis plays a crucial role in extracting meaningful insights. However, numerous statistical gaps and challenges hinder the effective utilization of integrated One Health data. This research project aims to identify and overcome these barriers by developing novel statistical methods and frameworks, facilitating more robust and comprehensive analysis to inform evidence-based decision-making in the realm of One Health.

Introduction:

The convergence of human, animal, and environmental health under the One Health framework has highlighted the importance of analyzing integrated datasets to gain a comprehensive understanding of complex health issues. Integrated One Health data analysis enables the identification of shared risk factors, pathways of disease transmission, and the development of effective interventions. However, several statistical challenges arise due to the heterogeneity, dimensionality, and complex dependencies present in these integrated datasets. Indeed, in the case of emerging and re-emerging diseases, data often exhibit systematic errors and/or missed characteristics.

This research project aims to address these statistical gaps and provide solutions for robust One Health data analysis.

Objectives:

- 1) Identify statistical gaps in One Health integrated data analysis, from data collection to the analysis.
- 2) Develop novel statistical methods to overcome challenges in data integration, heterogeneity, and dependencies.
- 3) Validate and evaluate the performance of the proposed methods using both real-world and simulated One Health datasets.
- 4) Assess the impact of the proposed statistical approaches on evidence-based decision-making and policy development in the One Health field.

Methodology:

Literature Review: Conduct a comprehensive review of existing statistical approaches used in One Health integrated data analysis. Identify the gaps and challenges faced in current methodologies from data collection to the analysis step.

Method Development: identifying limitations in specific epidemiological indicators (e.g., incidence, prevalence, population-level severity, vaccine/treatment effectiveness) which involves considering factors such as probabilistic non-representativeness of the sample and heterogeneous collection of missing, incomplete, misclassified, or otherwise unreliable data. A special attention will be given to identifying unmeasured confounding factors when comparing different groups based on exposure factors, along with the limitations of study design planning phase. To this end novel statistical methods and frameworks to address the identified gaps will be developed. This may include techniques belonging to several fields: from

the design of the experiment to data integration, record linkage and dimensionality reduction. A special focus will be placed on the development of both covariate-adaptive (CA) and covariate-adjusted response adaptive (CARA) designs (Rosenberger and Lachin 2016) suitable for One Health integrated data analysis along with a properly defined bootstrap-based inference procedure.

Method Validation: Utilize both real-world and simulated One Health datasets to validate and evaluate the performance of the developed statistical methods. Compare the proposed methods with existing approaches and assess their effectiveness in capturing the interconnections between human, animal, and environmental factors.

Impact Assessment: Assess the impact of the proposed statistical approaches on evidence-based decision-making and policy development in the One Health field. Evaluate how the integration of statistical analysis improves the understanding and management of complex health challenges.

Conclusion:

This research project aims to address the statistical gaps and challenges faced in One Health integrated data analysis. By developing novel statistical methods and frameworks, this project seeks to enable more comprehensive and robust analysis of integrated datasets, thereby improving our understanding of complex health issues. The outcomes of this research have the potential to facilitate evidence-based decision-making and policy development in the One Health field, ultimately contributing to the mitigation of health risks and the promotion of global health security.

Activity Plan

The grant holder will carry out training activities at the Department of Statistical Sciences of the University of Bologna. In the first semester, the grantee will be engaged in a literature review that will allow them to understand the nature of both the theoretical and practical problems that motivate the research project and deepen their knowledge of One Health integrated data analysis.

During the second semester, the focus will shift to the study and the development of both CA and CARA procedures for clinical/epidemiological experiments. The aim will be to learn the state-of-the-art of adaptive designs and develop new inferential methodologies suitable for studying One Health data.

Reference

Rosenberger WF, Lachin JM. Randomization in Clinical Trials: Theory and Practice. John Wiley & Sons. 2016