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# Establishment of an indicator framework for Global One Health Intrinsic Drivers index based on the Grounded Theory

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## Abstract

**Background:** One Health has become a global consensus to deal with complex health problems. However, the development process of One Health practice in various countries is still relatively slow, and there is a lack of systematic evaluation index. The purpose of this study was to establish an indicator framework for global One Health Intrinsic Drivers index (GOH-IDI) to evaluate human, animal and environmental health development process globally.

**Method:** First, 82 studies were deeply analyzed by a grounded theory (GT) method, including open coding, axial coding, and selective coding, to establish a three-level indicator framework, which was composed of three first-level indicators, 19 second-level indicators, and 79 third-level indicators. Then, through semi-structured interviews with 28 health-related experts, the indicators were further integrated and simplified according to the inclusion criteria of the indicators. Finally, a fuzzy analytical hierarchy process (FAHP) was used to assign weights to the indicators, thus, forming the evaluation indicator framework of human, animal and environmental health development process.

**Results:** An indicator framework for GOH-IDI was formed consisting of three first-level indicators, 15 second-level indicators and 61 third-level indicators. There were six second-level indicators for “Human Health”, of which “Reproductive, Maternal, New-born, and Child Health” had the highest weight (20.63%) and “Health Risk” had the lowest weight (13.01%). There were four second-level indicators for “Animal Health”, of which “Animal Epidemic Disease” had the highest weight (31.87%) and “Animal Nutritional Status” had the lowest weight (17.36%). Five second-level indicators were set under “Environmental Health”, among which, “Air Quality and Climate Change” had the highest weight (23.82%) and “Hazardous Chemicals” had the lowest weight (17.52%).

**Conclusions:** An indicator framework for GOH-IDI was established in this study. The indicators were universal, balanced, and scientific, and established a tool for scientifically measuring the development level of human, animal and environmental health in different regions globally.

**Keywords:** Global One Health; Intrinsic Drivers index; Indicators; Grounded theory; Fuzzy analytical hierarchy process

## 1. Background

With the deepening of global integration, under the influence of factors such as increased population mobility and intensified environmental change, global public health emergencies are occurring more frequently[1-3]. Human health is closely linked to animals and the ecological environment, sixty percent of known human infectious diseases are zoonotic[4-7], and about 70% of new zoonotic diseases originate in wild animals[8]. Thus, some scholars put forward the concept of One Health, which integrates human, animal, and environmental health to carry out health promotion work[9, 10], the American Veterinary Medical Association first established the One Health Action group in 2007. Based on One Health concept, in 2010, the World Health Organization (WHO), the World Organization for Animal Health (OIE), and The Food and Agriculture Organization of the United Nations (FAO) co-signed an agreement to "sharing responsibilities and coordinating global activities to address health risks at the animal-human-ecosystems interface"[11]. In 2021, the FAO, OIE, WHO, and the United Nations Environment Programme (UNEP)'s One Health High Level Expert Panel (OHHLEP) officially defined One Health as "an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems"[12].

Studies have shown that GOHI consists of external drivers index, intrinsic drivers index and core drivers index, to regard the coordinated development of human, animal and environmental health as the target interface, the coordinated development of One Health practice process need external drivers factors such as society, economy, culture, also need core drivers factors such as the zoonotic disease prevention and control process, the food chain and food safety, prevention and control of microbial resistance and adaptation to climate change[13, 14]. However, there is no unified evaluation standard for One Health Intrinsic Drivers factors in all countries around the world, especially, One Health governance, including human, animal and environmental health development process, is not enough in developing countries[15, 16]. At present, there is little studies on health-related evaluation systems around the world, the sustainable development report (SDR) released by the United Nations, the Institute for Health Metrics and Evaluation the global burden of diseases database (IHME-GBD) established by Washington University, and the environmental performance index (EPI) proposed by Yale University study health-related evaluation systems from the aspects of economic development, disease burden, and ecological environment. However, those studies are limited to specific scientific fields of One Health. Recently, the global One Health index (GOHI), a potential assessment tool for One Health performance, was released by the expert group form Shanghai Jiaotong Univercity firstly in the world[13, 17]. As one of important component, the establishment of indicator framework for global One Health Intrinsic Drivers index (GOH-IDI) has not been reported. Therefore, the establishment of indicator framework for GOH-IDI deserves a more detailed explanation.

Grounded Theory (GT) is a qualitative research method proposed by the American scholars, Anselm Strauss and Barney Glaser in 1967[18]. Its core idea is that researchers do not have theoretical assumptions before the beginning research, but organize, summarize, and analyze the original data through standardized and systematic operations, finally establishing a theoretical model from the bottom up. The method has a clear process, strong operability, scientific and normative characteristics. A fuzzy analytical hierarchy process (FAHP) introduces the idea of fuzzy mathematics based on the analytical hierarchy process (AHP), which can effectively reduce interference from the subjectivity of decision makers' judgments and preferences. For example, Rajabi *et al.*[19] applied FAHP to reasonably assign weight to occupational stress factors of nurses and pre-hospital emergency staff. Wang *et al.*[20] ranked the importance of fire risk factors in high-rise buildings by FAHP. Therefore, in this study, GT and a FAHP was used to construct the evaluation indicator framework for GOH-IDI, including human, animal and environmental health coordinated development process, so as to further improve One Health governance process.

## 2. Methods

### 2.1 The selection of indicators

The evaluation indicator framework of GOH-IDI was constructed using GT and expert interviews. In the GT method, data were collected and analyzed simultaneously. The research data were mainly collected from the literature. Twenty-eight experts in human medicine, animal medicine, environmental science, policy making and public administration, sociology, and psychology were interviewed. These interviewed experts come from all continents of the world, all have a master's degree or higher level of education, and most of them have a vice-senior or senior level of profession. Half of the interviewed experts work at colleges and universities, one-third of the interviewed experts work in medical institutions, the rest work in governments, and all have more than 5 years of work experience in their respective fields.

The accuracy and reliability of the qualitative research phase depend on the research process. Therefore, two researchers coded and interviewed experts to assess the coding results and ensure the accuracy of the data. When no new concepts appeared after reading new literature, the research was deemed to have reached a state of theoretical saturation, which ensured the reliability of the data. **Figure 1** shows the process of the qualitative research phase of this study.

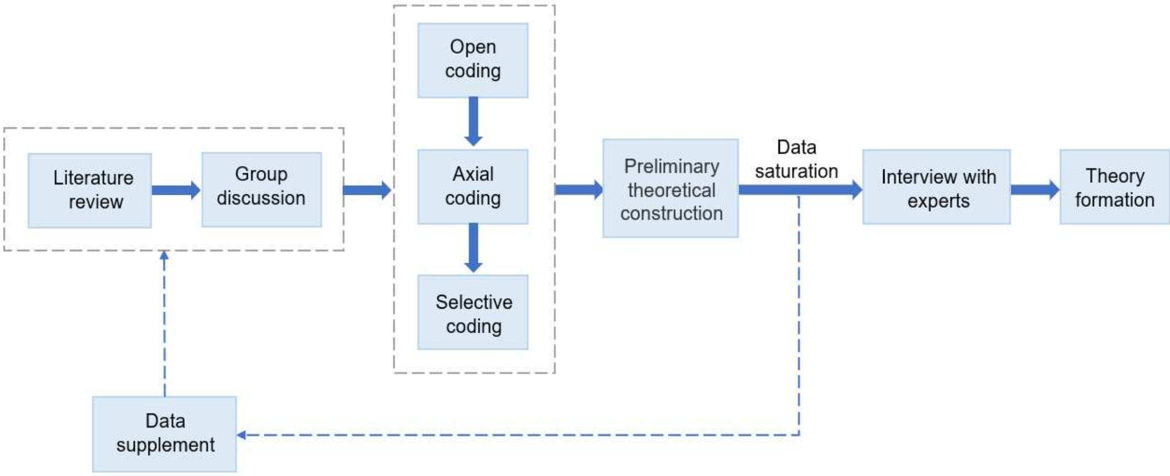


**Figure 1.** Process of the qualitative research stage.

### 2.1.1 The basis of GT

At the first stage of this study, the authors searched the PubMed and ISI Web of science databases using “One Health and indicator”, “One Health and index”, “One Health and metrics”, and “One Health and evaluation” as the keywords. The authors initially selected 103 articles related to the One Health assessment indicators by reviewing article abstracts and references to extract additional relevant articles. Subsequently, the authors consulted 12 global authoritative databases, such as the Sustainable Development Goal (SDG) database, the IHME-GBD, and the EPI. Then, the authors developed five indicator inclusion criteria for the GOH-IDI: First, indicators can accurately and truthfully measure or reflect the health status of a particular field. Second, the data used for indicators can be obtained from authoritative institutions. Third, the data used for indicators can cover most countries in the world. Fourth, the data used for indicators can be updated on time. Fifth, the data used for indicators should be measured in a uniform way to facilitate comparisons between countries. Based on the above inclusion criteria for the indicators, a total of 82 studies were included.

### 2.1.2 GT

At the second stage of the study, GT was used to construct the evaluation indicator framework of GOH-IDI based on the 82 studies identified in the first stage. For the GT, data collection and analysis were carried out at the same time. Thus, data analysis began from reading the first document, and reading the second document was based on the analysis of the previous document. Subsequently, reading following documents was based on the analysis of all prior documents. No new concepts or categories were found in the data analysis after the 69th article. However, to ensure theoretical saturation, the researchers read the remaining 13 articles and analyzed the relevant data. The coding in the GT included three steps: open coding, axial coding, and selective coding[21]. Each step is described in more detail below.

#### 2.1.2.1 Open Coding

The first coding step in the GT was open coding. The authors identified and coded indicators related to human, animal and environmental health from the literature. Each document was analyzed and coded before moving to the next document. New literature was constantly compared to existing literature to identify new indicators (**Table 1**). Throughout the entire open coding process, we not only identified indicators in the data, but also tried to generate categories of extracted indicators, and indicators with similar meanings were divided into the same category. Such classification helped identify associations hidden among the indicators and guided us in coding the remaining studies.

**Table 1** Examples of indicators extracted from the literature

| Source | Indicators | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Emerging rival diseases | Neonatal health | Cardiovascular disease | Tuberculosis | Neoplasms | Controlled Solid Waste | Overexploited or Collapsed Fish Stocks | Air quality and climate change | Tree Cover Loss | Wastewater Treatment | Trawling or Dredging Fish |
| SDG[22] | | √ | √ | √ | √ | | | √ | | √ | |
| IHME-GBD[23] | | √ | √ | √ | √ | | | | | | |
| EPI[24] | | | | | | √ | √ | √ | √ | √ | √ |
| Marie C.E. Hanin et al.[25] | √ | | | √ | | | | | | | |
| Nichola R. Naylor et al.[26] | | | | | | | | √ | | | |
| Tadeusz Dutkiewicz et al.[27] | | √ | √ | | √ | | | | | √ | |

#### 2.1.2.2 Axial Coding

The second coding step was axial coding. In open coding, data were shredded to better identify the indicators. In axial coding, the indicators were reorganized in a new format by associating the categories and indicators with each other. Therefore, we associated categories with indicators and treated all interrelated categories as more abstract second-level indicators. Therefore, following the axial coding, second-level indicators were identified to evaluate the main ideas of human, animal and environmental health.

#### 2.1.2.3 Selective Coding

The third coding step was selective coding. Selective coding is the process of linking core categories with second-level and third-level indicators, and forming the overall framework. In this step, all second-level and third-level indicators were integrated and organized around the core category (first-level indicator) to form a complete evaluation indicator framework of GOH-IDI. The indicators generated was reviewed, revised, and improved successively. If blank areas were found, theoretical sampling, i.e., literature review, was used to fill them.

### 2.1.3 Expert interviews

In the third stage, semi-structured interviews were conducted with 28 experts in human medicine, animal medicine, environmental science, policy making and public administration, sociology, and psychology, among other fields, based on the evaluation indicator framework of GOH-IDI initially formed by the GT in the second stage. According to the inclusion criteria of the indicators in the first stage, the indicator was further integrated and streamlined to determine the final evaluation indicator framework of GOH-IDI.

## 2.2 Setting of indicator weights

In this section, we used a FAHP for quantitative assessments. The FAHP is a decision-making method based on the traditional AHP, which takes into account the fuzziness of people's judgment of complex things and introduces the fuzzy consistent matrix[28, 29]. We used a FAHP to determine the weight of the second-level indicators, and set the first-level and third-level indicators with equal weights. Based on the established evaluation indicator framework of GOH-IDI, a questionnaire was developed to assess the importance of indicators according to the comparisons of the relative importance of second-level indicators to first-level indicators. The questions involved in the questionnaire compared every two indicators of all second-level indicators (For example, there is such a question in the questionnaire: "Which do you think is more important in human health assessment, 'Reproductive, Maternal, New-born, and Child Health' or 'Infectious Diseases'?"). The questionnaire for judging the importance of indicators was distributed to 42 experts in the fields of health-related, and we analyzed their opinions on the relative importance of indicators.

First, R 3.6.1 software was used to generate a judgment matrix $R_{a\times a}^{b}$ according to the opinions of different experts, as shown in Formula (1). *a* indicates that there are *a* indicators, and *b* indicates that there are *b* experts. $r_{ie}$ represents the importance of indicator *i,* relative to indicator *e*. Then, using Formula (2) to calculate weight vector. Finally, normalizing the weight vector to calculate weights of the second-level indicators, as shown in Formula (3).

$$\boldsymbol{R}_{a\times a}^{b} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1a} \\ r_{21} & r_{22} & \cdots & r_{2a} \\ \vdots & \vdots & \cdots & \vdots \\ r_{a1} & r_{a2} & \cdots & r_{aa} \end{bmatrix} = (r_{ie}) \tag{1}$$

$$\boldsymbol{\omega}_i = \frac{\left(\prod_{j=1}^{a} r_{ie}\right)^{\frac{1}{a}}}{\sum_{k=1}^{a} \left(\prod_{j=1}^{a} r_{ke}\right)^{\frac{1}{a}}} \tag{2}$$

$$\boldsymbol{W}_i = \frac{\boldsymbol{\omega}_i}{\sum_{e=1}^{a} \boldsymbol{\omega}_e} \tag{3}$$

## 3. Results

### 3.1 Evaluation indicator framework of GOH-IDI

Based on the GT, we used a literature review and group discussions to preliminarily develop a three-level evaluation indicator framework of GOH-IDI, which consisted of three first-level indicators, 19 second-level indicators, and 79 third-level indicators. Subsequently, through expert interviews, the indicators were further integrated and streamlined according to the inclusion criteria. The final evaluation indicator framework of GOH-IDI was constructed using three first-level indicators, 15 second-level indicators, and 61 third-level indicators. The 61 concepts, including "Maternal Health", "Neonatal Health", "Child Health", and "Adolescent Fertility" were based on open codes (third-level indicators) extracted from the literature and group discussions. The 15 categories, including "Reproductive, Maternal, New-born and Child Health", "Infectious Diseases", "Non-communicable Diseases", and "Mental Health" were based on axial codes (second-level indicators) extracted from the open codes. "Human Health", "Animal Health", and "Environmental Health" were the core categories (first-level indicators) of the evaluation indicator framework of GOH-IDI, based on axial code induction (**Table 2**).

**Table 2** Evaluation indicator framework of GOH-IDI based on GT and FAHP

| First-level indicators | Weight | Second-level indicators | Weight | Third-level indicators | Weight |
|---|---|---|---|---|---|
| 1.Human Health | 33.33% | 1.1 Reproductive, Maternal, New-born, and Child Health | 20.63% | 1.1.1 Maternal Health | 25% |
| | | | | 1.1.2 Neonatal Health | 25% |
| | | | | 1.1.3 Child Health | 25% |
| | | | | 1.1.4 Adolescent Fertility | 25% |
| | | 1.2 Infectious Diseases | 19.53% | 1.2.1 Tuberculosis | 20% |
| | | | | 1.2.2 HIV | 20% |
| | | | | 1.2.3 Malaria | 20% |
| | | | | 1.2.4 Neglected Tropical Diseases | 20% |
| | | | | 1.2.5 COVID-19 | 20% |
| | | 1.3 Non-communicable Diseases and Mental Health | 15.88% | 1.3.1 Cardiovascular Disease | 20% |
| | | | | 1.3.2 Neoplasms | 20% |
| | | | | 1.3.3 Diabetes Mellitus | 20% |
| | | | | 1.3.4 Chronic Respiratory Disease | 20% |
| | | | | 1.3.5 Suicide | 20% |
| | | 1.4 Injuries and Violence | 13.49% | 1.4.1 Road Traffic | 33.33% |
| | | | | 1.4.2 Unintentional Poisoning | 33.33% |
| | | | | 1.4.3 Homicide | 33.33% |
| | | 1.5 Universal Health Coverage and Health Systems | 17.47% | 1.5.1 Health Coverage | 25% |
| | | | | 1.5.2 Research and Development Expenditures on Health Issues | 25% |
| | | | | 1.5.3 Domestic Health Expenditures | 25% |
| | | | | 1.5.4 Infant Vaccination | 25% |
| | | 1.6 Health Risk | 13.01% | 1.6.1 Unsafe or Unimproved Water, Sanitation and Hygiene | 33.33% |
| | | | | 1.6.2 Household Air Pollution | 33.33% |
| | | | | 1.6.3 Occupational Risks | 33.33% |

| First-level indicators | Weight | Second-level indicators | Weight | Third-level indicators | Weight |
|---|---|---|---|---|---|
| 2.Animal Health | 33.33% | 2.1 Animal Epidemic Disease | 31.87% | 2.1.1 Diseases of Domestic Animals | 50% |
| | | | | 2.1.2 Diseases of Wild Animals | 50% |
| | | 2.2 Animal Welfare, Relevant Regulations, and Policy Support | 24.66% | 2.2.1 Overexploited or Collapsed Stocks Fish | 50% |
| | | | | 2.2.2 Trawling or Dredging Fish | 50% |
| | | 2.3 Animal Nutritional Status | 17.36% | 2.3.1 Chicken Meat Production Efficiency | 25% |
| | | | | 2.3.2 Pig Meat Production Efficiency | 25% |
| | | | | 2.3.3 Cattle Production Efficiency | 25% |
| | | | | 2.3.4 Cattle Milk Production Efficiency | 25% |
| | | 2.4 Animal Biodiversity | 26.11% | 2.4.1 Endemic Mammal Species | 16.67% |
| | | | | 2.4.2 Endemic Bird Species | 16.67% |
| | | | | 2.4.3 Endemic Amphibian Species | 16.67% |
| | | | | 2.4.4 Endemic Reef-forming Coral Species | 16.67% |
| | | | | 2.4.5 Endemic Freshwater Crab Species | 16.67% |
| | | | | 2.4.6 Endemic Shark and Ray Species | 16.67% |
| 3.Environmental Health | 33.33% | 3.1 Air Quality and Climate Change | 23.82% | 3.1.1 Ambient Particulate Matter Pollution | 20% |
| | | | | 3.1.2 Household Solid Fuels | 20% |
| | | | | 3.1.3 Ambient Ozone Pollution | 20% |
| | | | | 3.1.4 Climate Risk | 20% |
| | | | | 3.1.5 Greenhouse Gas | 20% |
| | | 3.2 Land Resources | 19.55% | 3.2.1 Area at Risk Elevation | 20% |
| | | | | 3.2.2 Tree Cover Loss | 20% |
| | | | | 3.2.3 Grassland Loss | 20% |
| | | | | 3.2.4 Wetland Loss | 20% |
| | | | | 3.2.5 Mineral Depletion | 20% |
| | | 3.3 Sanitation and Water Resources | 20.68% | 3.3.1 Freshwater | 33.33% |
| | | | | 3.3.2 Clean Drinking Water | 33.33% |
| | | | | 3.3.3 Renewable Internal Freshwater Resources | 33.33% |
| | | 3.4 Hazardous Chemicals | 17.52% | 3.4.1 Fertilizer Consumption | 14.28% |
| | | | | 3.4.2 Controlled Solid Waste | 14.28% |
| | | | | 3.4.3 $SO_2$ Growth | 14.28% |
| | | | | 3.4.4 $NO_X$ Growth | 14.28% |
| | | | | 3.4.5 Wastewater Treatment | 14.28% |
| | | | | 3.4.6 Electronic Waste | 14.28% |
| | | | | 3.4.7 Non-recycled Municipal Solid Waste | 14.28% |
| | | 3.5 Environmental Biodiversity | 18.42% | 3.5.1 Protected Areas Representativeness | 33.33% |
| | | | | 3.5.2 Species Habitat | 33.33% |
| | | | | 3.5.3 Biodiversity Habitat | 33.33% |

There were six second-level indicators for “Human Health”, which were “Reproductive, Maternal, New-born, and Child Health”, “Infectious Diseases”, “Non-communicable Diseases and Mental Health”, “Injuries and Violence”, “Universal Health Coverage and Health Systems”, and “Health Risk”. Human Health focused on health throughout the complete life cycle of the entire population, the health risks brought by animals and the external environment, and the role of the health system in ensuring Human Health.

There were four second-level indicators for “Animal Health”, which were “Animal Epidemic Disease”, “Animal Welfare, Relevant Regulations, and Policy Support”, “Animal Nutritional Status”, and “Animal Biodiversity”. Animal Epidemic Disease affected Animal Nutritional status, and Animal Nutritional Status reacted to Animal Epidemic Disease. Animal Biodiversity was affected by Animal Welfare, but was more related to macro ecological environments.

There were five second-level indicators for “Environmental Health”, which were “Air Quality and Climate Change”, “Land Resources”, “Sanitation and Water Resources”, “Hazardous Chemicals”, and “Environmental Biodiversity”. The discharge of hazardous chemicals had an impact on all aspects of Environmental Health. Climate change, loss of land resources, ecological construction and water resources are concrete manifestations of Environmental Health.

## 3.2 Indicator weights

In this study, the first-level and third-level indicators were set with equal weights, and the weight of second-level indicators were determined by a FAHP. Thus, the weights of the first-level indicators of the evaluation indicator framework of GOH-IDI, “human health”, “animal health”, and “environmental health” were 33.33%. Among the second-level indicators of “Human Health”, “Reproductive, Maternal, Newborn, and Child Health” had the highest weight (20.63%), while the weights of the other indicators from highest to lowest were “Infectious Diseases” (19.53%), “Universal Health Coverage and Health Systems” (17.47%), “Non-communicable Diseases and Mental Health” (15.88%), “Injuries and Violence” (13.49%), and “Health Risk” (13.01%). Among the second-level indicators of “Animal Health”, “Animal Epidemic Disease” (31.87%) and

"Animal Biodiversity" (26.11%) had higher weights, while "Animal Welfare, Relevant Regulations, and Policy Support" (24.66%) and "Animal Nutritional Status" (17.36%) had lower weights. Among the second-level indicators of "Environmental Health", "Air Quality and Climate Change" had the highest weight (23.82%), while the weights of the other indicators from highest to lowest were "Sanitation and Water Resources" (20.68%), "Land Resources" (19.55%), "Environmental Biodiversity" (18.42%), and "Hazardous Chemicals" (17.52%).

### 3.3 Indicator pathways

According to the concept of One Health, human health, animal health and environmental health restricted and promoted each other to form an organic and unified One Health system (**Figure 2**). According to the "structure-process-result" model, the constructed One Health indicators were divided into structural indicators, process indicators, and outcome indicators. "Structure" refers to infrastructure, "process" refers to intervention measures, and "outcome" refers to post-intervention performance.

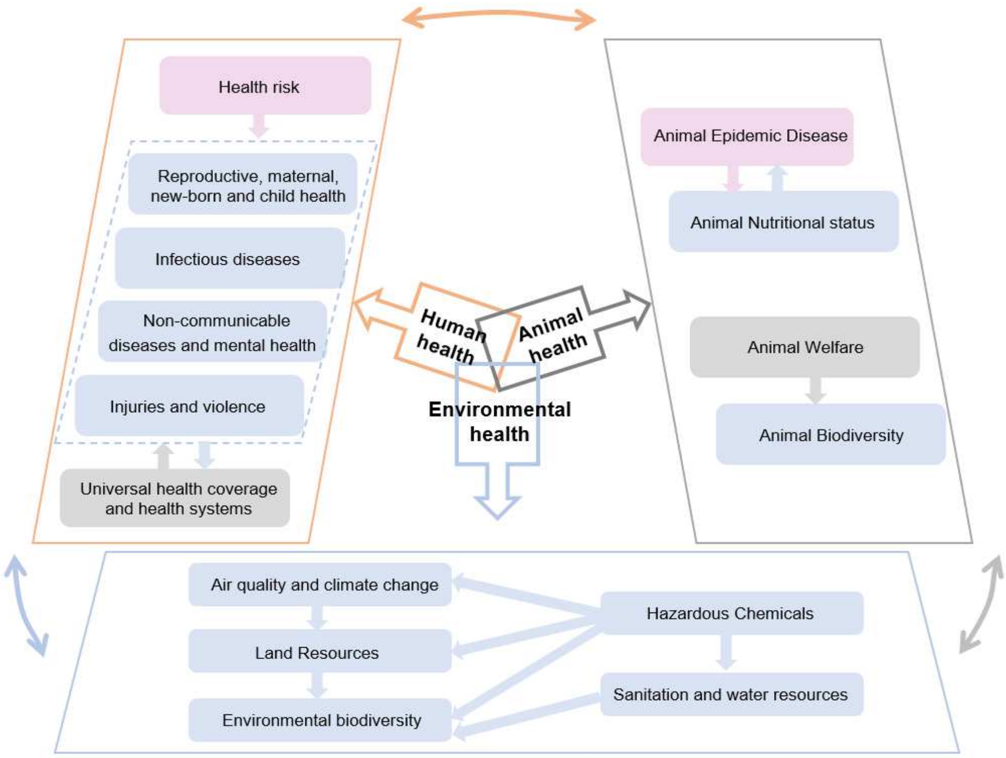


**Figure 2.** Relationships for the evaluation indicators of GOH-IDI

**Figure Legend:** According to the "structure-process-result" model, the second-level indicators of the indicator framework of GOH-IDI were divided into different categories: gray represents structural indicators, pink represents process indicators, and blue represents outcome indicators.

In Human Health, the four second-level indicators, “Reproductive, Maternal, New-born, and Child Health”, “Infectious Diseases”, “Non-communicable Diseases and Mental Health”, and “Injuries and Violence”, were outcome indicators, which reflected the whole population life cycle health, and were the core indicators of Human Health. “Universal Health Coverage and Health Systems” was a structural indicator, which reflected the guarantee of health system on human health. “Health Risk” was a process indicator that was composed of indicators of the impact of the external environment on human health. “Health Risk” can affect the core indicators, and “Universal Health Coverage and Health Systems” was affected by the core indicators, and can react to the core indicators.

In Animal Health, “Animal Epidemic Disease” was a process indicator, and the most important part of animal health. “Animal Welfare, Relevant Regulations, and Policy Support” were structural indicators reflecting policies and regulations related to animal welfare. “Animal Nutrition Status” and “Animal Biodiversity” were outcome indicators that directly reflected animal health. Animal nutrition status and animal epidemic disease affected each other. A decline in animal nutrition status can lead to a decline in animal immunity and an increase in the number of reported animal epidemic diseases. Animal epidemic disease could also affect the intake of nutrients in food. Although “Animal Biodiversity” was affected by animal welfare, it is more related to the macro ecological environment.

In Environmental Health, “Air Quality and Climate Change”, “Land Resources”, “Sanitation and Water Resources”, “Hazardous Chemicals”, and “Environmental Biodiversity” were all outcome indicators that directly reflected the health of the environment. The discharge of hazardous chemicals can affect all steps and should be should be controlled emphatically. Air quality and climate change, loss of land resources, ecological environment construction and water resources, and environmental biodiversity were all concrete manifestations of environmental health. Damage to air quality could lead to extreme weather, which in turn affected land resources. The destruction of land resources will lead to habitat loss for animals and plants, and affect environmental biodiversity. Ultimately, all environmental pressures will be transferred to animal and human health.

## 4. Discussion

Previous studies have proposed GOHI, which provides an evaluation method for One Health governance process in various countries around the world, and illustrates the determinants and contributing factors of the achievements of One Health governance. The intrinsic drivers index, which emphasize the synergistic development of human, animal and environmental health, are an important part of GOHI. In-depth analysis of intrinsic drivers index can highlight the governance elements and key issues of human, animal and environmental health, and help to optimize the allocation of health resources and promote the process of sustainable development.

GT is a bottom-up inductive research method that aims to establish theories based on empirical data. GT is performed by iterating data collection and analysis by performing continuous comparisons, extracting concepts reflecting research results in the process of continuous comparison, developing categories and the correlations between categories, and combining all such data into theories[30]. Theoretical sampling continues until the data are saturated and the theory is complete. The results from the method were not only based on practical experience, but also better than practice. When the results are applied in practice, its advantages will be more prominent. A FAHP can avoid the influence of human subjectivity and objectively determine the weights of indicators. It introduces the idea of fuzzy mathematics based on the AHP, which can divide the complicated factors of the evaluated object into an orderly hierarchical structure according to the interaction, influence, and subordinate relationship to obtain the weights of the indicators. It can also effectively reduce interference from the subjectivity of decision makers' judgments, preferences, and understanding of the problem being solved[31]. Therefore, to make the evaluation indicator framework of GOH-IDI not only reflect the connotation of One Health and minimize the one-sidedness of indicator weights due to human subjectivity, the GT and FAHP was used to establish the evaluation indicator framework and render it more scientific and objective.

Based on the GT and FAHP, this study constructed a three-level evaluation indicator framework of GOH-IDI, which was composed of three first-level indicators, 15 second-level indicators, and 61 third-level indicators using literature searches, group discussions, and expert interviews. There were six second-level indicators and 24 third-level indicators in Human Health, among which, “Reproductive, Maternal, Newborn, and Child Health” had the highest weight (20.63%). There were four second-level indicators and 14 third-level indicators in Animal Health, among which, “Animal Epidemic Disease” had the highest weight (31.87%). There were five second-level indicators and 23 third-level indicators in Environmental Health, among which, “Air Quality and Climate Change” had the highest weight (23.82%). Existing health-related evaluation systems around the world, such as the Sustainable Development Report released by the United Nations, summarize the current development trends of 17 Sustainable Development Goals in each country from three aspects: economic development, social progress, and environmental protection[32]. The Global Health Security Index (GHS Index), jointly developed by the Nuclear Threat Initiative (NTI) and the Johns Hopkins Center for Health Security, focuses on the ability of countries to prevent and control pandemics from six aspects: prevention, detection and reporting, rapid response, health systems, compliance with international norms, and risk environment[33]. It can be seen that these existing health-related evaluation systems only focus on specific scientific fields of One Health, and thus, the research on One Health is fragmented and limited. This study explored the evaluation indicator framework of GOH-IDI from the aspects of human health, animal health and environmental health, most of the selected indicators are outcome indicators, which can directly reflect the practice process of human, animal and environmental health, and the indicators are universal, balanced and scientific. This study reported the establishment process for indicator framework of GOH-IDI, and established a tool for scientifically measuring the development level of human, animal and environmental health in different regions to evaluate the progress and development of One Health capacity building throughout the world.

Through literature review and expert interviews, Hanin *et al*.[34] showed that collaborative development between multiple disciplines is crucial in One Health governance, and its weight accounts for 70% of One Health governance. Hanin *et al*. proposed that currently, collaboration between human health and animal health teams is gradually increasing, but collaboration with other disciplines is not enough. Therefore, different countries, disciplines and institutions should be combined to enhance the capacity of One Health building in an integrated manner. Bordier *et al*.[35] constructed an evaluation matrix to measure the cross-sector collaboration of One Health in order to evaluate the quality of One Health cross-sector collaboration. It was found in this study that the literature related to human health indicators was the most abundant followed by that related to environmental health and the literature related to animal health indicators were least abundant, which was consistent with the research results of Vreeland *et al*.[36] Moreover, Vreeland *et al.* also proposed that in health-related journals, only 6.8% of journals included articles related to human, animal and environmental health at the same time. Therefore, we gave equal weights to Human Health, Animal Health, and Environmental Health in the GOH-IDI (i.e., 33% each), reflecting the importance of multidisciplinary collaborative development in the concept of One Health.

There were some deficiencies in this study. The evaluation indicator framework of GOH-IDI proposed in this study was based on preliminary research and exploration, which needs to be further improved by combining evaluation indicator framework of GOH-IDI with the progress of One Health governance in each country. In addition, due to the poor compatibility of the research team with multiple languages, the studies retrieved for this indicator framework were only in English, which did not allow for a comprehensive assessment of studies in other languages, such as French, German, and Russian, among others.

## 5. Conclusions

One Health governance has become a global complex health problem and a universal consensus. This study constructed an evaluation indicator framework of GOH-IDI, which is scientific and feasible. The evaluation indicator framework of GOH-IDI provides an overall framework for “what to implement” and “how to improve” in the One Health governance, and can also be used as a guide for planning the governance of human, animal and environmental health throughout the world. The results of this study suggested that the information from the global official database (for example, SDG and IHME-GBD) could be used to quantitatively evaluate the human, animal and environmental health of all countries throughout the world, which can scientifically grasp the effectiveness and shortcomings of the capacity building for One Health, in order to formulate the goals and paths of One Health practice in line with local reality.

**Abbreviation**

GOHI: global One Health index; GOH-IDI: global One Health Intrinsic Drivers index; WHO: World Health Organization; OIE: World Organization for Animal Health; FAO: Food and Agriculture Organization of the United Nations; UNEP: United Nations Environment Programme; OHHLEP: One Health High Level Expert Panel; SDR: sustainable development report; GBD: global burden of diseases; EPI: environmental performance index; GT: Grounded Theory; SDG: Sustainable Development Goal; WHO-GHO: World Health Organization-Global Health Observatory; IHME-GBD: Institute for Health Metrics and Evaluation the global burden of diseases; FAHP: fuzzy analytical hierarchy process; AHP: analytical hierarchy process; GHS Index: Global Health Security Index; NTI: Nuclear Threat Initiative.

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**Authors’ contributions**

JF, ZG, JC, and SL conceived and designed the manuscript. JF, ZG, and LA collected the references, did the interviews, and wrote the manuscript. JL, XZ, CC, JX, SX, and XZ revised the paper. JF, ZG, JC and SL finalized the manuscript. All authors read and approved the final manuscript.

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**Availability of data and materials**

The data used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declaration

**Ethics approval and consent to participate**

Not applicable.

**Consent for publication**

Not applicable.

**Competing interests**

Xiaonong Zhou is an Editor-in-Chief of infectious Diseases of Poverty. Jin Chen is an editor of Infectious Diseases of Poverty. The authors have no other competing interests to disclose.

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