

# Leveraging Data and Technology to Enhance Interdisciplinary Collaboration and Health Outcomes

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## Summary

**Objective:** To give an overview of recent research and propose a selection of best papers published in 2022 in Informatics for One Health.

**Methods:** An extensive search using PubMed and Web of Science was conducted to identify peer-reviewed articles published between December 2021 and December 2022, in order to find relevant publications in the 'Informatics for One Health' field. The selection process comprised three steps: (i) eight candidate best papers were first selected by the two section editors; (ii) external reviewers from internationally renowned research teams reviewed each candidate best paper; and (iii) the editorial committee of the Yearbook conducted the final best paper selection.

**Results:** The candidate best papers represent studies that characterized significant challenges facing Informatics for One Health. Other trends of interest related to the deployment of medical artificial intelligence tools and the implementation of the FAIR principles within the One Health broad scenario. In general, papers identified in the search fell into one of the following categories: 1) Health improvement via digital technology; 2) Climate change / Environment / Biodiversity; and 3) Maturity of healthcare services.

**Conclusion:** The topic turns extremely important in the next future for what concerns the need to understand complex interactions in order to safeguard the health of populations and ecosystems.

## Keywords

One health; digital health; one digital health; health outcomes; healthcare services

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## 1 Introduction

Health Informatics, originally intended to enhance the management of health data and information made available through health information technology and related to patient care [1, 2], has undergone profound changes mainly related to the advancements of digital technologies applied to the spheres of (individual) living, societies, and ecosystems. Accordingly, the thriving field of Digital Health is called to provide answers about, e.g., efficient healthcare delivery, p-health, and health promotion and well-being, thus entailing a wide range of expertise [3, 4]. New strands of research – such as public health informatics, digital epidemiology, or infodemiology, among others – are therefore dealing with new kinds of issues related to the delivery of healthcare in a syndemic scenario, the digital transformation of Human & Animal Health Data (including Animal Welfare), and the digital nature conservation, which require an even more comprehensive range of expertise [5–7]. The most recent efforts are now addressing the instances concerning the integration with One Health's transdisciplinary approach, which recognizes the connection between people's health, animal health, and the surrounding environment [8].

Future health ecosystems demand the timely deployment of new digital tools to explore complex biological systems and networks at different scales [9]. This means, in turn, focusing on centering on (and strengthening) educational needs for the healthcare workforce, computer scientists, and decision-makers to acquire Biomedical

and Health Informatics (BMHI) knowledge and skills at various levels [10]. This focus on education can make it possible to leverage the power of data, technology, and information systems to: (i) promote collaboration between stakeholders, (ii) enhance decision-making to gather, integrate, analyze, and share health-related data based on the interconnectedness between human, animal, and environmental domains, and (iii) set up and deploy the righteous interventions [11].

Based on such premises, the International Medical Informatics Association (IMIA) Yearbook Selection Committee identified "Informatics for One Health" as this year's theme. The special section of the Yearbook focuses on calling out recent, high-quality publications that examine and advance our understanding in terms of building complex health interactions and fostering collaborative efforts to safeguard the health of populations and ecosystems.

## 2 Methods

We conducted an extensive literature research on PubMed and Web of Science (WoS) during December 2022. We used the following query: *((one health) OR (global health)) AND ((digital health) OR (medical informatics))*.

Given the breadth of the topic underlying the "Informatics for One Health" section, it was purposely decided to design a "high-level" query to avoid incurring excessive constraints. All the terms, except "digital health", belong to the MeSH thesau-

rus. On the one hand, the relation between “medical informatics” and “digital health” has been pinpointed in the previous section; on the other hand, the choice of using “global health” instead of, e.g., “public health informatics” reflects the well-known connection between the former and “one health” as to their shared goal of promoting holistic approaches to health, recognizing the linkages between human, animal, and environmental health, and addressing global health challenges through collaborative efforts [12–14].

Only manuscripts in English published between December 1, 2021 and December 31, 2022 were included. The PRISMA methodology was then adopted to conduct the literature review [15] and articulated as follows:

- **Identification:** Information retrieval yielded 377 articles from PubMed and 35 from WoS. Search results were merged, and 20 duplicates were removed. No additional records were identified through other sources;
- **Screening:** Out of the 392 records undergoing an initial screening, 340 were excluded whose titles or abstracts did not adequately relate to the terms used in the query;
- **Eligibility:** both editors reviewed the remaining 52 articles and categorized them into three groups (accept, discuss, and discard) based on their innovativeness, scientific and practical impact, and methodological quality. One inclusion criterion mainly related to the overall number of citations and the journal’s relevance in the Medical Informatics community (SCImago H-Index). In particular, journal quartiles were assessed for the categories: “Health Informatics”, “Computer Science”, and “Medicine (others).” This last term was meant to keep out papers that focused on specific medical disciplines. Exclusion criteria focused on ignoring papers explicitly dealing with “mental health”, “apps development”, “blockchain”, “regional-wise experiences”, and “trials involving specific subjects’ ages (e.g., young adults, older adults). Papers published in previous editions of the IMIA Yearbook, as well as unavailable articles, were excluded too. It was eventually decided to postpone the decision

concerning review papers and conference proceedings,

- **Final candidate list:** The final candidate best papers selection was done based on a full-text review and ended with a list of six candidate best papers. Among these, it was decided to keep also a paper authored by the two section editors since, despite the manifest conflict of interest, it provided a remarkable addition to the field. Eventually, two more papers – a regional-wise study and a review paper – were included after an additional manual screening.

Following the IMIA Yearbook selection process, the eight candidate best papers were further evaluated by the two section editors, two chief editors, and additional external reviewers (at least two reviewers per paper) with expertise in medical or public health informatics.

The IMIA Yearbook Editorial Committee selection meeting was held in a blended form on May 5, 2023. In this meeting, the paper entitled “Operationalizing “One Health” as “One Digital Health” through a global framework that emphasizes fair and equitable sharing of benefits from the use of artificial intelligence and related digital technologies” authored by Ho [16] was finally selected as the best paper for the Yearbook special section. Besides that, although “Climate change, human health, and health informatics: a new view of connected and sustainable digital health” by Gray [17] was not selected as best paper as well – being it technically a mini review – it was agreed to highlight it as a necessary “honorable mention”, so a total of two papers are distinguished (Table 1).

## 3 Findings and Trends

A broad overview of the research field of the “Informatics for One Health” section was achieved during the selection of the best papers. A more formal text-mining approach was also applied to overcome possible biases and to avoid selective perception [18]. Authors’ keywords (#TOT≈2,000; n≈700 different keywords, 501 of which were only used once) were extracted from all articles. The most frequent keywords retrieved were “Health / Healthcare” (n=392), “Digital” (n=181), “Review” (n=106), and “One” (n=75).

A brief discussion is provided below of the most important themes discovered while evaluating the candidate best papers. These themes highlight some critical areas of research in this field, which are expected to see continued growth in the coming years.

### 3.1 Health Improvement via Digital Technology

Many authors emphasize the importance of high-quality data and digital technologies, including artificial intelligence, in monitoring healthcare from various perspectives: a more specific reference to their capacity to address One Health-related complex challenges can be found in Ho [16], who explores the potential of digital tools via the collection and processing of real-time data, in various domains such as agriculture and conservation biology, towards, e.g., early detection of infections. A similar point of view is also tackled by the survey paper of the special section, authored by Scott *et al.*,

**Table 1** Top papers chosen for the special section of the IMIA Yearbook Informatics for One Health. Papers are listed in alphabetical order by the last name of the first author. The (\*) denotes an honorable mention.

| Section                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Informatics for One Health                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <ul style="list-style-type: none"> <li>▪ (*) Gray K. Climate change, human health, and health informatics: a new view of connected and sustainable digital health. <i>Front Digit Health</i> 2022;4:869721.</li> <li>▪ Ho CWL. Operationalizing “One Health” as “One Digital Health” through a global framework that emphasizes fair and equitable sharing of benefits from the use of artificial intelligence and related digital technologies. <i>Front Public Health</i> 2022;10:768977.</li> </ul> |

in describing the role of digital technologies in surveillance systems as a pre-requisite for a “new wave” of public education (the so-called citizen science: see, e.g., [19]) to ensure societal preparedness for necessary tracing in future pandemics [20]. The improvement of health and healthcare through the use of information technology applications [17] is also analyzed in terms of correct access to health-related information. The development of digital health literacy is vital in harnessing the benefits of digital media for health, countering misinformation, and addressing health inequalities [21, 22]. In this regard, a specific focus is on Smart (Healthy) Cities, wherein the pervasive use of digital technologies is filtered through policies of digital (health) literacy to foster a mature and aware citizen engagement towards all the three One Health domains (human, animal, surrounding environment) [11].

### 3.2 Climate Change / Environment / Biodiversity

Nowadays, the need is rising to transform health systems to be more sustainable and resilient to the impacts of climate change. According to Gray [17], health informatics connects climate and health. It calls for decarbonizing the healthcare sector and using data to gain insights into the health impacts of climate change. It also highlights the importance of making healthcare services more resilient and enabling public health functions to minimize preventable health harms from climate change. The impact of climate change on biodiversity can also be discerned in the increase in zoonotic diseases and their connection to environmental changes – e.g., Nipah virus infection and COVID-19 [23]. An effective response to this global-size issues also comes through the deployment of data-driven science in generating massive datasets for biodiversity and environmental indicators. Initiatives such as the Biodiversity Observation Network and the Global Biodiversity Information Outlook have identified variables and goals to monitor and evaluate biodiversity changes. However, data collection and integration challenges remain, including information gaps, limited granular data,

and biases. This translates, at a higher level, into a lack of a unifying framework for data in One Health [16], which leads to several single projects that only enable environmental monitoring and data sharing on a small scale. It is the case of the OP-ERA project, as reported by Tamburis & Benis [24], whose goal is to determine the optimal evacuation route for animals in case of fire in the “Mount Vesuvius’ red zone” in South Italy [25]. In this regard, several initiatives are being pursued to connect One Health and other frameworks, such as the UN Sustainable Development Goals and Gaia theory. The survey paper suggests adopting a “*Learning One Health Systems*” framework that dynamically integrates data, information, and knowledge from humans, animals, and the environment [20].

### 3.3 Maturity of Healthcare Services

Planning (and justifying) significant investments in digital health solutions are also critical, given the development of affordable and sustainable healthcare systems. In this context, building digital health literacy is essential to creating demand for digital health services within the modern and evolving public health sector and addressing the habit of seeking analog services to improve self-care and reduce critical events [11, 21]. Woods *et al.* [26] report the experience from Queensland, Australia, where research was conducted to evaluate the concept of digital maturity and the use of digital maturity models (MMs) to assess the level of capability in various dimensions of digital health. The Healthcare Information and Management Systems Society’s (HIMSS) Digital Health Indicator (DHI) was introduced as a self-assessment tool to measure the digital capability of healthcare services across four key dimensions: interoperability, person-enabled health, predictive analytics, and governance and workforce. The concept of online Community of Practice (CoP), in the words of Fruchtmann *et al.* [27], relates instead to the efforts of global health partnerships towards the facilitation of collective learning and engagement around the use of systems thinking for district health systems from

low- and middle-income countries. In both cases, the need emerges for effective collaborations among different actors to develop affordable and sustainable digital-enabled healthcare systems. The benefits of technology in improving health outcomes also emphasize the need to ensure the authenticity and accessibility of information [22].

## 4 Conclusions and Outlook

Along with those reported in the previous section, we could observe other major trends being further continued. They mainly relate to: (i) the assessment of transparency and trustworthiness of medical artificial intelligence tools to deal with issues originated within a broad and comprehensive digital landscape [28, 29], and (ii) the importance of data collection, management, and analysis in the One (Digital) Health domain, and its integration with the FAIR (Findable, Accessible, Interoperable, and Reusable) principles to create an innovative framework [6, 16, 24, 30]. These aspects leave a broad room for further investigations.

Evaluating the importance of Informatics for One Health means dealing in the next future with crucial aspects such as data integration, disease surveillance, and early warning systems, risk assessment and modeling, policy development and resource allocation, and education and capacity building. To this purpose, the One Digital Health framework provides the fabric of interconnections through its five dimensions (*i.e.*, citizens’ engagement, education, environment, human and veterinary health care, and Healthcare Industry 4.0) [6] to enhance our interdisciplinary understanding of complex health interactions, strengthen early warning systems, and foster collaborative efforts to safeguard health outcomes for populations and ecosystems.

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## Appendix: Content Summary of Selected Best Paper Published in 2022 for the IMIA Yearbook, Section Informatics for One Health

Ho CWL

**Operationalizing “One Health” as “One Digital Health” Through a Global Framework That Emphasizes Fair and Equitable Sharing of Benefits From the Use of Artificial Intelligence and Related Digital Technologies**

**Front Public Health 2022 May 3;10:768977. doi: 10.3389/fpubh.2022.768977**

In this paper, the author focuses on the ur-

gent need for significant changes in human activities to combat climate change and its impact on biodiversity, human and animal health, and geopolitics. The potential of digital tools in various domains such as healthcare, agriculture, and conservation biology is discussed, emphasizing the centrality of data in the One Health approach. The current challenges in data access, curation, and sharing and the need for fairness and equity in data governance are addressed. Therefore, the lack of a unifying framework for data in the One Health approach is a contributing factor to data gaps. The importance of sharing disease surveillance data and information for disease detection and response is emphasized, suggesting that data federation could be a viable approach. In this regard, the importance of high-quality data and digital technologies, including artificial intelligence, in monitoring health and

environmental concerns is discussed, and their role is explored for what concerns the operationalization of the One Digital Health framework, along with the rising challenges in data integration and the uptake of digital technologies. Furthermore, the article explores the role of data-driven science in generating massive datasets for biodiversity and environmental indicators. It emphasizes the need for ethical considerations and suggests implementing the FAIR principles for data management. The author eventually proposes the idea of a global framework on “Open Data” for Health to address data accessibility, fairness, and equity concerns, along with the challenges of data sharing in the context of the so-called Access and Benefit Sharing (ABS) framework, which integrates biodiversity and health data while addressing ethical and legal concerns.