

## REVIEW ARTICLE

# Understanding One Health and Zoonosis: A Systematic Review with a Bibliometric Analysis of Turkish Research and Global Perspectives (1974-2023)

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## Abstract

A bibliometric analysis explored the understanding of the “One Health” and “zoonosis” concepts among Turkish researchers and identified existing gaps. The analysis examined trends in research on “One Health,” “zoonosis,” and “zoonoses,” focusing on publications from Türkiye and globally. Data from Scopus were analyzed using VOSviewer and RStudio software. The results showed that research interest in these concepts has grown in Türkiye since the 2000s. However, the number of articles from Türkiye remains low compared to developed countries. The interdisciplinary nature of “One Health” and “zoonosis” research in Türkiye reflects contributions from various academic fields. Medical sciences lead in research, followed by immunology and veterinary sciences. In Türkiye, “One Health” is predominantly associated with animals, especially felines, and zoonotic pathogens such as *Toxoplasma*, *Anthrax*, and *Echinococcus*. It also relates to epidemiology, infectious diseases, and antibiotic resistance. Globally, “One Health” has a broader perspective, encompassing environmental health, education, veterinary medicine, and food safety. Regarding “zoonosis,” Türkiye focuses on pathogens such as *Anthrax*, *Echinococcus*, *Brucella*, *Leishmania*, and Hantavirus. Globally, additional pathogens such as *Rickettsia*, *Taenia solium*, and *Giardia* are included. “Zoonosis” is also linked to climate change, animal welfare, and vector- and food-borne diseases. Despite increased interest, Türkiye’s scientific production remains limited. Emphasis on interdisciplinary collaboration and broader conceptual frameworks could enhance understanding and research impact.

**Keywords:** Bibliometric analysis, One Health, Pathogens, Türkiye, Zoonosis

## INTRODUCTION

Pathogens (viruses, bacteria, fungi, parasites, and prions) in the environment pose challenges for humans, animals, and plants. Disease transmission between animals and humans is a concern because human-animal health and the ecosystem are closely linked <sup>[1]</sup>. This tight link has given birth to many concepts, such as “One Health” and “zoonosis”. Although the concept of “One Health” was formally introduced by the WHO in the early 2000s <sup>[2]</sup>, some may argue that its principles existed since the earliest days of life on Earth. The One Health High-Level Expert Panel (OHHLEP) defined One Health as “...an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent. The approach mobilizes multiple sectors, disciplines, and communities at various levels of society to work together to foster well-being and tackle threats to health and

ecosystems while addressing the collective need for clean water, energy, and air, safe and nutritious food, taking action on climate change, and contributing to sustainable development” <sup>[3]</sup>.

The zoonosis concept refers to a disease that spreads between vertebrate animals and humans, a definition established in 1951 by the World Health Organization’s Expert Committee on Zoonoses. The term “zoonosis” (plural: zoonoses) is composed of two words originating from Greek, “zoon” meaning animal and “noson” meaning disease. Rudolph Virchow invented this term in the late 19<sup>th</sup> century to define illnesses in humans caused by animals <sup>[4]</sup>. One of the earliest documented outbreaks of a zoonotic disease is the plague in Athens in 430 BC. This outbreak led to the death of nearly 100.000 people. Subsequent pandemics, such as the Justinian plague in 541 AD and the “Black Death” in 1345, were also caused by *Yersinia pestis*. Another notable zoonotic epidemic termed the “American Plague” occurred from 1793 to 1798, claiming the lives of approximately 25.000 individuals <sup>[5]</sup>.



Since the onset of the 20<sup>th</sup> century, numerous zoonotic diseases have emerged, posing significant challenges to public health worldwide. For the past two decades, there has been a renewed acknowledgment of the necessity for a holistic approach to this health concern [6]. This led to a tripartite FAO-OIE-WHO collaboration in 2010 [7]. Since then, the amount of research on “One Health” topics has grown worldwide.

Within this scenario, Türkiye’s singular geographic and ecological diversity brings forth an appropriate illustration of the call for a One Health approach. Türkiye serves as a natural bridge between Asia, Africa, and Europe, with a subtropical climate. This positioning gives Türkiye a global importance and role in the transmission of emerging and re-emerging diseases including zoonotic diseases. In addition to its geography, which allows it to benefit from diverse climatic conditions with different flora and fauna, there are many marshes and sanctuaries for immigrant birds in Türkiye, such as the “Sultan Marshes” in the Kayseri region in Central Anatolia, the “Manyas Bird Paradise” in the Marmara region, the “Kizilirmak Delta” or the “Çerneke Ringing Station” in Bafra near Samsun in the Black Sea region, the “Hevsel Bird Paradise” in Diyarbakir in the southeast, and the “Aras Bird Paradise” in the northeast. This diversity provides habitats for various arthropod vectors throughout the year, giving these sites significant epidemiological importance. Türkiye is also a touristic country welcoming millions of tourists from all over the world each year, and it experiences waves of migrants from different countries, who find Türkiye a country of passage to Europe. From an epidemiological point of view, this migratory flow constitutes one of the pathways for the introduction and dissemination of zoonotic diseases.

Indeed, interest in the “One Health” concept has improved in Türkiye, reaching a significant milestone with the country’s first One Health congress in 2015. However, despite this growing interest, studies evaluating scientific knowledge and research output in this field have revealed room for improvement [8-10].

We aim to assess the understanding of the concepts One Health and zoonosis among professionals in the health sector, scientists, and policymakers. Through a bibliometric investigation, we compare Türkiye’s expertise with global knowledge, identifying both research gaps and emerging challenges. The goal is to help researchers identify emerging challenges and potential research directions in the field of One Health on a global scale.

## MATERIAL AND METHODS

Bibliometric analysis enables a quantitative analysis of documentary sources in a specific field. A bibliometric analysis can highlight key themes, notable developments, emerging trends, and gaps in a study, an approach also

referred to as “scientific mapping.” Thus, performance analysis and scientific mapping constitute the two fundamental pillars of bibliometric methodology.

We used the bibliometric approach to analyze the research trends for “One Health,” “zoonosis,” and “zoonoses” by the number of publications. We used only the bibliographic database Scopus for several key reasons. Firstly, it gives one of the most comprehensive collections of articles covering a wide range of disciplines relevant to the One Health and zoonosis framework, including medicine, veterinary science, environmental science, and social sciences. Secondly, only data collected from Scopus allowed us to do the analyses on RStudio and VOSviewer. Data collected from other databases were not compatible with the software package. Thus, Scopus was chosen for its comprehensive citation metrics, multidisciplinary scope, and broad coverage across a wide range of academic fields. Additionally, it is the preferred platform for bibliometric analyses, as most scientific documents and citation data used in such studies are indexed in Scopus.

The search formula in Scopus was set as: (TITLE-ABS-KEY (“One Health”) OR TITLE-ABS-KEY (“one-health”) OR TITLE-ABS-KEY (“one health”) OR TITLE-ABS-KEY (“One health”) OR TITLE-ABS-KEY (“zoono\*”) OR TITLE-ABS-KEY (“Zoono\*”)) AND (LIMIT-TO (DOCTYPE, “re”) OR LIMIT-TO (DOCTYPE, “ar”)) AND (LIMIT-TO (AFFILCOUNTRY, “Turkey”)) for Türkiye and (TITLE-ABS-KEY (“One Health”) OR TITLE-ABS-KEY (“one-health”) OR TITLE-ABS-KEY (“one health”) OR TITLE-ABS-KEY (“One health”) OR TITLE-ABS-KEY (“zoono\*”) OR TITLE-ABS-KEY (“Zoono\*”)) AND (LIMIT-TO (DOCTYPE, “re”) OR LIMIT-TO (DOCTYPE, “ar”)) AND (EXCLUDE (AFFILCOUNTRY, “Turkey”)) for “Worldwide” situation. For the global situation, only Türkiye was excluded, and a total of 67.455 research and review articles were found. The research was limited to articles published up to 2023. Scopus limits the export of the bibliometric data to a maximum of 20.000.

We used the software VOSviewer [11] for author keyword maps and R version 4.3.1 (2023-06-16) with the packages bibliometrix. The R software was used to generate a collaboration map, and Excel tables automatically used the function “biblioshiny()” [12] and exported data in Excel format. With VOSviewer, a co-occurrence analysis was performed with authors’ keywords, with a minimum occurrence of five. At this phase, a modification occurred in the dataset where “zoonoses” was substituted with “zoonosis”.

## RESULTS

### Number of Publications

A comparison was made by using the combination of three concept words: “zoonosis”, “zoonoses”, and “One Health”

for Türkiye and the world. The number of published articles is important because it shows the level of interest. A total of 1300 articles have been found, and among them, only 123 were review articles; the rest were research articles (*Table 1*). The oldest article on this topic was published in 1974, long before WHO officially recognized the importance of the “One Health” concept. Meanwhile, the rise of interest among Turkish scientists started in the 2000s (*Fig. 1*), with an increase in the number of publications and the number of citations. The number of publications dropped in 2014 and 2018 and began to rise again in 2019. In other parts of the world, scientists have been interested in the “One Health” concept since World War II and that interest continues to grow today (*Fig. 1*). An analysis of the number of published documents per country shows that most of the publications have been from developed countries such as the USA, UK, China, Brazil, Germany, France, Italy, Australia, India, Canada, Spain, Iran, Japan, Netherlands, Switzerland, and Belgium. Even though the developed countries’ scientific production is far greater than Turkish scientific production, many countries have not produced as much as Turkish scientists (*Fig. 4*; countries depicted in red signify those with fewer documents relative to Türkiye).

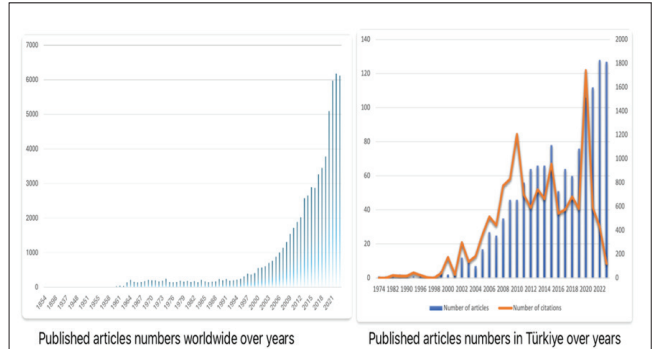
The aforementioned concepts have been referenced across diverse academic domains. In Türkiye, they are used 50% of the time in medicine while globally the figure is 34%. In microbiology and immunology, the concepts have been given more importance in the rest of the world, with 21% of the publications in this field versus 18% in Türkiye. Nevertheless, the concepts are mostly used in medicine, immunology, microbiology, veterinary medicine, agriculture, and biological science (*Fig. 2*). In *Fig. 3*, the presentation highlights the preeminent ten authors who have demonstrated significant contributions to the field. Among the notable contributors to the field, with the most publications, are Inci A, Simsek S, Ahmed H, Kilic S, Celebi B, Yildirim A, Duzlu O, Pekmezci GZ, Ozkul A, and Ertabaklar H (*Fig. 3*).

### Authors’ Keywords Analysis

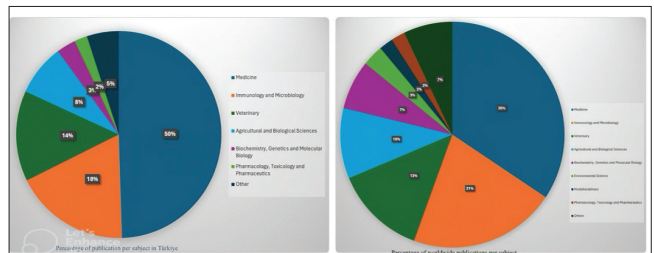
A comparative examination of the “One Health” paradigm reveals disparities in its conceptualization in Turkey in juxtaposition with the global perspective (*Fig. 5*). The associations in Türkiye underscore the confluence of the term “One Health” with animals, emphasizing feline species and diverse pathogens such as *Toxoplasma*, *Borrelia*, coronavirus, and various viruses. *Fig. 5* suggests that in Türkiye the “One Health” theme focuses on zoonotic diseases, epidemiology, infectious diseases, and antibiotic resistance. An inconsistency becomes apparent when examining the worldwide discussion of the “One Health” concept. Notable divergences include environmental health, education, veterinary medicine,

**Table 1.** Numbers and types of documents published in Türkiye

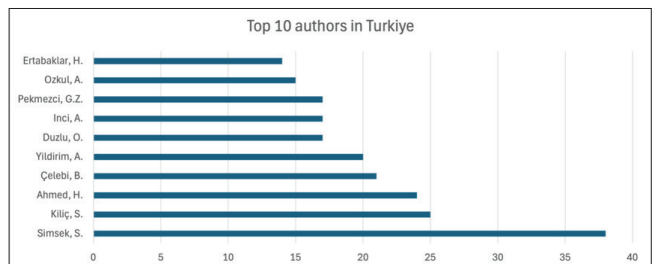
Type of Document	Numbers
Article	1177
Review	123
<b>Total</b>	<b>1300</b>



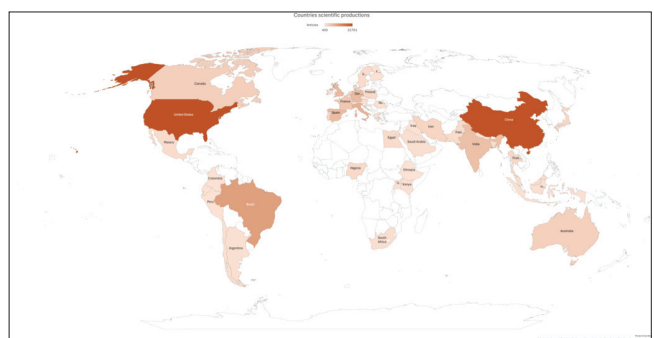
**Fig 1.** Number of publications per year worldwide vs in Türkiye. The figure shows how scientific production on “One Health” and “zoonotic” topics has evolved over the years



**Fig 2.** Percentage of publications per subject in Türkiye and worldwide. The figure illustrates how scientific production is distributed across different subjects



**Fig 3.** Top 10 authors in Türkiye



**Fig 4.** Scientific production per country. Scientific production was classified according to country, which shows the place that Türkiye holds



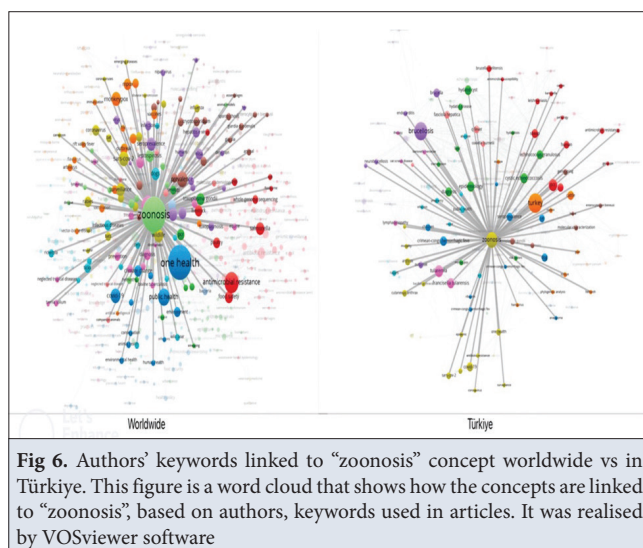
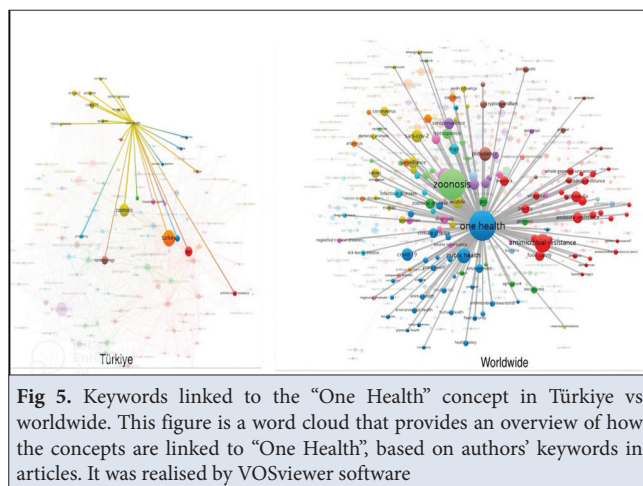
food safety, health policy, and climate change. This suggests a broader, interdisciplinary orientation on an international scale. The pathogenic associations in the global context span a wider spectrum, incorporating entities such as *Cryptosporidium*, *Blastocystis*, *Salmonella*, arboviruses, and bacteria. The Turkish approach prioritizes mammalian species, underscoring a focus on them within the framework of the “One Health” paradigm. Fig. 6 provides an in-depth exploration of the interrelations inherent in conceptualizing “zoonosis.” Within the Turkish context, this conceptual framework is notably entwined with various pathogens, including *Toxoplasma*, *Anthrax*, *Fasciola hepatica*, *Echinococcus*, *Brucella*, *Leishmania*, and Hantavirus. Additionally, there is an associative linkage to other pathogens, such as *Francisella*, *Bartonella*, *Coxiella*, Crimean Congo virus, and helminths. A global perspective unveils parallel associations between the “zoonosis” concept and analogous pathogens in Türkiye, albeit with nuanced distinctions. These distinctions include “hepatitis virus” and pathogens such as *Taenia solium*, *Rickettsia*, *Salmonella*, and *Giardia*, which are conspicuously

absent in the author-associated keywords from Türkiye. Noteworthy is the linkage of the “zoonosis” concept to specific animal categories, including rodents, cats, dogs, humans, and cattle. Ticks emerge as principal vectors associated with zoonotic occurrences. The significance of wildlife and pets is underscored, emphasizing their substantial roles within the global zoonotic landscape. Moreover, the conceptual tapestry of zoonosis extends to tightly interconnected themes, including animal welfare, climate change, vector-borne and food-borne illnesses, and food safety.

## DISCUSSION

We analyzed the concepts of “One Health,” “zoonosis,” and “zoonoses” to show the status of research conducted in the field by Turkish scientists and a comparative analysis with worldwide data by using bibliometric data. The quantity of publications serves as a crucial bibliometric indicator, providing insight into the level of attention a research field commands and its growth trajectory over time. The inaugural mentions of One Health in academic literature emerged predominantly from institutions and organizations in the United States, with subsequent contributions originating in Europe. Globally, nearly half of all scholarly publications on One Health are attributed to research conducted at North American institutions, with European institutions contributing approximately one-third of the total publications [8]. In Türkiye, academicians have been interested in this topic in the 2000s, and that interest continues to grow [9,10]. Globally, the One Health field has witnessed a consistent increase in publications in the last two decades, with a surge commencing around the 2000s. In terms of scientific production, Türkiye surpasses many countries by a significant margin. Most African nations, such as Egypt, Nigeria, and Kenya, and some European countries such as Romania and Ireland have demonstrated less production.

Academicians from various universities have conducted most of the research in Türkiye. The burgeoning global acceptance of the One Health framework underscores the indispensable role of academia in shaping and structuring future professionals. The cultivation of a proficient global workforce proficient in bridging interdisciplinary gaps and fostering collaboration across diverse sectors is paramount for the improvement of health outcomes [13]. The conceptual understanding and implementation processes of the One Health approach in Türkiye are progressing more slowly compared to the United States and European countries. To ensure parallel progress in these processes, it is essential to embrace the One Health approach, make prompt political decisions, and allocate sufficient financial resources. In Türkiye, a “One Health” institute does not yet exist, nor is a curriculum dedicated



exclusively to it. Its creation could have a significant impact on the academic environment. Türkiye's strategic geographic position, the wide diversity of ecosystems, and the movement of human and animal populations lead to a high prevalence of human-animal interactions, thus increasing the risks associated with zoonotic diseases. The establishment of a One Health institute would serve as a multidisciplinary research hub, support the development of public policies in human, animal, and environmental health, and foster intersectoral coordination. Disease surveillance is a fundamental pillar of this approach; such an institute could significantly strengthen national capacities to detect and respond to priority diseases. An equally essential role would be to ensure the continuing training of health professionals and students to ensure a competent workforce aware of global health issues. The number of national and international multidisciplinary research networks focused on zoonotic diseases and the One Health paradigm is on the rise [8]. A global map delineates academic institutions, organizations, groups, and laboratories actively dedicated to advancing the concept of One Health. However, the low representation of Türkiye on this map raises attention [14]. It would be important for Türkiye to join the Global Early Warning System (GLEWS), which has national partners to assist in primary warning [15].

The bibliometric analysis highlighted a growing interest in One Health, showcasing its potential. However, it also brought to light a lack of involvement with the environmental sector in Türkiye. Findings suggest a necessity for more practical strategies to enhance collaboration across sectors and promote knowledge sharing. Effective strategies must be supported with funding [16]. To achieve a more holistic perspective, it is crucial to involve researchers with diverse expertise and disciplinary backgrounds. This interdisciplinary approach will enable a comprehensive examination of One Health, considering the human-animal-environment interface as an interconnected and unified entity rather than distinct and separate components [17].

Authors' keyword maps revealed various terms associated with zoonosis and One Health. Zoonosis consistently refers to specific diseases in Türkiye. Despite the World Health Organization cataloguing over one hundred zoonotic diseases, the significance attributed to these diseases varies among countries. In the Mediterranean region, zoonoses such as brucellosis, anthrax, and rabies are endemic. In Türkiye, the general directorate of public health focused on the following diseases: Ebola virus disease, tularaemia, brucellosis, anthrax, echinococcosis, West Nile disease, hantavirus disease, Crimean Congo haemorrhagic fever, rabies, and leishmaniasis [18]. However, research has revealed the presence of over thirty zoonotic

diseases in the country, encompassing viral, bacterial, helminthic, protozoan, and fungal categories [15,19]. Some are vector-borne zoonotic diseases [17-21], and others are food-borne zoonotic diseases [15,22-23]. The prioritization of research and surveillance for zoonotic diseases differs among countries, depending on their epidemiological, economic, and health contexts. Certain nations prioritize the surveillance and control of specific zoonotic diseases, while others emphasize different ones, reflecting diverse public health priorities and contexts. In 2022, the European Union (EU) reported *Salmonella*, *Campylobacter*, and *Yersinia* as the top three zoonotic pathogens along with Shiga toxin-producing *Escherichia coli* and *Listeria monocytogenes* infections. Among vector-borne zoonoses, West Nile disease ranked at the top in Europe [24]. Research in the Horn of Africa has centered on diseases including hepatitis E, leptospirosis, brucellosis, Q fever, Rift Valley fever, trypanosomiasis, tuberculosis, toxoplasmosis, anthrax, echinococcosis, rabies, and leishmaniasis [25]. In South Africa, the top four zoonotic diseases prioritized are tuberculosis, brucellosis, Rift Valley fever, and cysticercosis [26]. Research in other parts of the continent has concentrated on a wider range of diseases, including anthrax, astrovirus, bartonellosis, borreliosis, brucellosis, cysticercosis, *Escherichia coli* infections, Ebola virus, echinococcosis, enterocytozoonosis, Human T-lymphotropic virus (HTLV), influenza A, Lassa virus, leishmaniasis, leptospirosis, Marburg virus, Middle East Respiratory Syndrome Coronavirus (MERS-CoV), monkeypox, pentastomiasis, Q fever, rabies, rickettsiosis, Rift Valley fever, Simian Immunodeficiency Virus (SIV), toxoplasmosis, and tuberculosis [27].

Among the concepts associated with "zoonosis" is "animal welfare". For millennia, human-animal relations have played a crucial role in veterinary medicine and overall health and welfare. Better animal welfare is linked to less diseases [28]. In Türkiye, no studies associating "animal welfare" with zoonosis or the concept of One Health have been identified thus far, likely due to the recent introduction of this concept in veterinary curricula [29]. Climate change is also intertwined with the concept of zoonosis, as evidenced by the significant role played by ecological niche modelling (ENM) in determining the distribution of potential vectors responsible for diseases. ENM enables scientists to estimate the geographical areas where specific vectors are likely to be found. In Türkiye, a limited number of studies have explored the correlation between "climate change" and zoonotic diseases [28-33]. One of the most important concepts linked to "zoonosis" and "One Health", whether for Turkish or worldwide, is "Antimicrobial Resistance (AMR)". Indeed, the effectiveness of any therapeutic agent can be hindered by the possibility of tolerance or resistance developing

over time. Its negative implications extend across social, economic, and health domains, impacting individuals, animals, and the environment. Thus, AMR became a worldwide health concern integrated into the One Health approach [34]. Globally, the misuse of antimicrobials in veterinary and human medicine has led to a high level of AMR. In Türkiye, AMR is a huge concern due to its high level [35]. For this reason, the Ministry of Health (MoH) has instituted two key antimicrobial stewardship programs. The first program is tailored for hospitals, while the second program is designed to address antimicrobial stewardship in the community [36]. Researchers have been involved in this field and have focused more on public health pathogens such as *Campylobacter* [35-37], *Salmonella* [38-41], *Staphylococcus* [42-46], *Pseudomonas* [47], and *E. coli* [48]. AMR is one of the most obvious challenges that demands a One Health approach. In Türkiye, although research on antibiotic resistance has so far focused primarily on pathogens of public health interest, it is relevant to broaden investigations to domesticated animals, wildlife reservoirs, and environmental sources to obtain a more integrated and comprehensive view.

Bridging this gap requires strong advocacy at the administrative level. Additionally, there is a need to foster a multidisciplinary and interdisciplinary working culture across institutions at the central, regional, and local levels that aligns with the One Health approach. In this context, establishing a One Health institute at universities would be a crucial step in implementing the One Health approach and cultivating a One Health culture.

## CONCLUSION

In conclusion, a bibliometric analysis of “One Health” and “zoonosis” research in Türkiye and globally revealed progress in these areas. While the interest and involvement of Turkish scientists in One Health research, particularly in addressing zoonotic diseases, is increasing, there are notable gaps, particularly in environmental aspects and interdisciplinary cooperation. The identification of various zoonotic diseases underlines the complexity of the issue and the need for comprehensive approaches. The interweaving of concepts such as animal welfare, climate change, and antimicrobial resistance with One Health highlights the interdependence of human, animal, and environmental health. This aspect deserves attention by researchers, decision-makers, politicians, and others. In parallel with worldwide developments, Türkiye needs to reduce the gaps in the fields of “One Health” and “zoonoses” and to carry out management coordination in accordance with the One Health approach. It is necessary to encourage interdisciplinary collaboration in the context of GLEWS, establish One Health institutes, expand research focus areas, implement antimicrobial resistance management,

strengthen environmental and climate change efforts, investigate the epidemiology of other zoonotic diseases, demonstrate required political decisions, and create funding. The paradigmatic relationship between the One Health concept and the Sustainable Development Goals (SDGs) should be acknowledged and integrated into the academic framework of universities in Türkiye.

## DECLARATIONS

**Availability of Data and Materials:** The datasets generated and analyzed during the study are available from the corresponding author (S. D. Diop) upon request.

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**Competing Interests:** The authors declare that there is no conflict of interest.

**Declaration of Generative Artificial Intelligence (AI):** The authors declare that no content (text, tables, figures, or conclusions) in this manuscript was generated by artificial intelligence (AI) or AI-assisted technologies. AI tools were used solely for improving readability, grammar, and language editing after the authors had written the complete manuscript. The authors take full responsibility for the integrity and originality of the work presented.

**Authors Contributions:** SDD developed the core ideas and designed the study framework. SDD, AI, ADK and ÖD devised and coordinated the methodology. SDD drafted the initial manuscript. AI, ADK, and ÖD contributed significantly to the writing and revision of the manuscript. All authors read and approved the final manuscript.

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