Control and Preventive Measures to Tackle Zoonotic Diseases from the Fish

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ABSTRACT

Zoonotic diseases (ZD) exert a profound global impact on public health, presenting a formidable threat to human populations worldwide. Although mammals and birds are widely acknowledged as primary sources of zoonotic pathogens, the role of fish as potential carriers and transmitters of these diseases should not be underestimated. Both wild-caught and farmed fish can harbor and transmit diverse zoonotic pathogens to humans through consumption, handling, or exposure to contaminated water. Fish act as hosts for a wide spectrum of ZD i.e., by salmonellosis, a disease caused by Salmonella bacteria, frequently linked to the consumption of inadequately cooked or raw fish products. Another notable concern associated with fish consumption is Vibrio infections, prominently caused by Vibrio vulnificus and Vibrio parahaemolyticus. Moreover, parasitic infections such as anisakiasis, attributed to nematode worms, can be transmitted to humans through ingestion of raw or undercooked fish. These diseases manifest a spectrum of symptoms ranging from gastrointestinal distress to severe infections, provoking potentially dire repercussions for human health. Fish-associated ZD results from diverse risk factors: inadequate handling, consumption of raw fish-derived food, exposure to contaminated environments, and interactions with infected fish. A comprehensive approach is indispensable including proper techniques, food safety regulations, surveillance, and public education. Collaboration among fisheries, health authorities, and the public is also crucial. Therefore, the current chapter will primarily emphasize the strategies essential for the control and prevention of zoonotic disease from fish.

Keywords: Zoonotic disease, Prevention, Control, Techniques, Organization

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1. INTRODUCTION

Zoonoses, refer to diseases transmitted from animals to humans, pose a significant threat to human health and their direct impact could potentially be fatal (Bonilla-Aldana and Rodriguez-Morales 2022). The thirteen most prevalent ZD have had a detrimental effect on human health worldwide, resulting in 2.4 billion cases of illness and 2.7 million human fatalities each year. This risk is particularly predominant among low and middle-income nations, where the disease burden is borne heavily by impoverished livestock workers. Addressing the issue of ZD holds immense importance as it exerts a potential role in protecting the overall well-being of the global population and minimizing the devastating impact these diseases impose on human lives. By prioritizing efforts to tackle ZD, we can effectively safeguard global public health and significantly reduce the burden they impact on individuals and communities worldwide (Grace et al. 2012). The genesis and transmission of different infectious diseases are greatly affected by human beings, animals as well as the environment (Thompson and Kutz 2019). The majority of contagious diseases that seriously threaten human health are spread by animals. According to the "Asia Pacific Strategy for Emerging Infectious Diseases," more than 70% of these pathogens originated from animal species, and they are responsible for causing over 60% of novel infections in humans (WHO 2014).

According to Tumbarski et al. 2020), fish-borne trematodes have been identified as a significant cause of infection among approximately half of the world's population. Moreover, Slingenbergh 2013) asserted that the majority of newly discovered human diseases were associated with animals and, in particular, with the consumption of animal-derived food products. The Food and Agriculture Organization's (FAO) 2019 report identifies aquaculture as the fastest-growing sector in food production, highlighting the significance of fish in the global economy as a source of food. Historically, the risk of fish-borne ZD was thought to be limited to anglers and fish keepers (processing plants). However, with the widespread expansion of fish farming and aquarium hobbies, there has been a marked increase in the documented incidence of fish-borne zoonoses since the late 1950s. The 1980s in particular saw a high number of such incidents (Lehane and Rawlin 2000).

Food-borne zoonotic pathogens can infect both humans and animals, causing a range of potentially fatal diseases (Alvi et al. 2021). The growth of globalization and mechanization has led to changes in domestic and international markets. In the past, food-borne zoonoses were typically found in underdeveloped nations due to poor hygiene and handling practices. However, the aquaculture industry has emerged as the fastest-growing sector in food production, and it is important to ensure high standards of hygiene and food safety to prevent the spread of these diseases.

Fish have been identified as carriers of various zoonotic microorganisms (Boylan 2011), with bacterial infections being the most common. Although fish that are immune to certain diseases can make people quite sick, such opportunistic infections are rare. These pathogens can be acquired by fish from their natural aquatic environment, which can be contaminated by agricultural practices, animal and human waste, domestic garbage, and wild animals (Antuofermo et al. 2023). Poor hygiene during the exploitation of aquatic species or their products may lead to the transmission of zoonotic infections to humans. Additionally, the consumption of raw or undercooked aquatic foods can result in the spread of food-borne illnesses (Fig. 1) (Boylan 2011).

Helminth parasites transmitted by fish & shellfish products are responsible for prominent health issues caused by food-borne diseases, affecting over half a billion people globally, including those in developed countries (WHO 1995). Certain types of parasites, which can be very dangerous, are transmitted to humans through the consumption of uncooked fish. In recent years, the prevalence of these ichthyozoonoses has significantly escalated due to various factors, including the expansion of the global market for fish & fish products, the rise in consumption of sectoral fish dishes, and the development of advanced diagnostic methods (Robinson and Dalton 2009; McCarthy and Moore 2000; Nawa et al. 2005; Keiser and Utzinger 2005;). To better understand the relationship between parasite zoonoses &

circumstances such as poverty, aquaculture intensification, and waste disposal, the healthcare significance of these zoonoses must be defined (Pal and Ayele 2020).

2. MAJOR ZOONOTIC AGENTS FROM FISH ENGAGED IN INFECTING HUMANS

Infectious diseases including parasitic infestations are important health problems in both animals and humans (Alvi et al. 2022; Alvi and Alsayeqh 2022). Infectious diseases with zoonotic potential may be transmitted to humans through various pathways, involving ingestion, animal bites, vector-borne transmission & contact with animals or their excretions (Gauthier 2015; Rahman et al. 2020). These diseases are caused by a broad range of pathogens, including bacteria, viruses, parasites & fungi, which are typically harbored by animals and may be transmitted directly or indirectly to humans (Fig. 2) (Wolfe et al. 2007).

1.1. PARASITES

The presence and transmission of tapeworms, roundworms, and flukes derived from fish species, such as *Dibothriocephalus latum*, *Anisakis spp*., and *Metagonimus yokogawaii*, to human beings predominantly occur through the ingestion of undercooked fish-based items (Antuofermo et al. 2023). These parasitic organisms pose a significant health risk, leading to various illnesses but generally not resulting in fatality (Cong and Elsheikha 2021). Sufficient knowledge exists regarding the importance of seafood in the worldwide human diet, alongside the escalating problem pertaining to seafood-borne disease and related parasitic infections. Certain fish species, which form a significant part of the human diet, are recognized as hosts for parasitic organisms (Shamsi 2019).

A multitude of these parasitic organisms have the potential to be transmitted to humans, and certain species, such as gnathostomiasis and anisakiasis, can impose significant risks to the health of humans (Herman and Chiodini 2009; Audicana et al. 2002; Daengsvang 1981). Among various disease-causing factors, fish products hold a prominent position (Huss et al., 2000). In addition to their widespread occurrence, parasites are often neglected in discussions concerning the safety of seafood (Shamsi 2020). Consequently, parasites originating from fish frequently evade diagnosis and remain responsible for the emergence of numerous ZD (Dorny et al. 2009; Shamsi 2019).

The methodologies employed for the detection of pathogenic organisms and the standards for food inspection exhibit significant variations across nations, often lacking adequacy and consistency (Williams et al. 2020). Despite this, in industrialized areas of the world, regulations pertaining to food handling & restrictions of import for zoonotic parasites (ZP) infections are occasionally overlooked (Shamsi 2016).

The escalation in the incidence, geographic frequency & distribution of ZD associated with fish consumption can be attributed primarily to global warming and the increasing demand for exotic, undercooked, and raw food (Shamsi and Sheorey 2018). This rise in health issues has been supported by studies conducted by Chai et al. (2005) and Lõhmus and Björklund (2015). Notably, an estimated 680 million individuals are considered to be at risk of being affected by freshwater fish liver flukes, with approximately 45 million people currently affected by these parasites (Saijuntha et al. 2021). Helminthic pathogens, in particular, pose a significant concern among seafood parasites owing to their diverse nature & abundance in tropical aquatic environments, leading to their frequent transmission to fish (Chai et al. 2009; Ogbeibu et al. 2014). For instance, in Vietnam alone, 268 species of helminth have been identified in 213 species of fish (Nguyen et al. 2021).

One of the major contributing factors to the persistence and transmission of parasites is the trophic-oriented life cycle, wherein the parasites rely on the food web to be transmitted to their host (Polley and Thompson 2009). Furthermore, numerous edible fish species particularly teleost are believed to act as intermediate hosts for parasitic infections, thereby increasing the risk of infection in relation to the host's

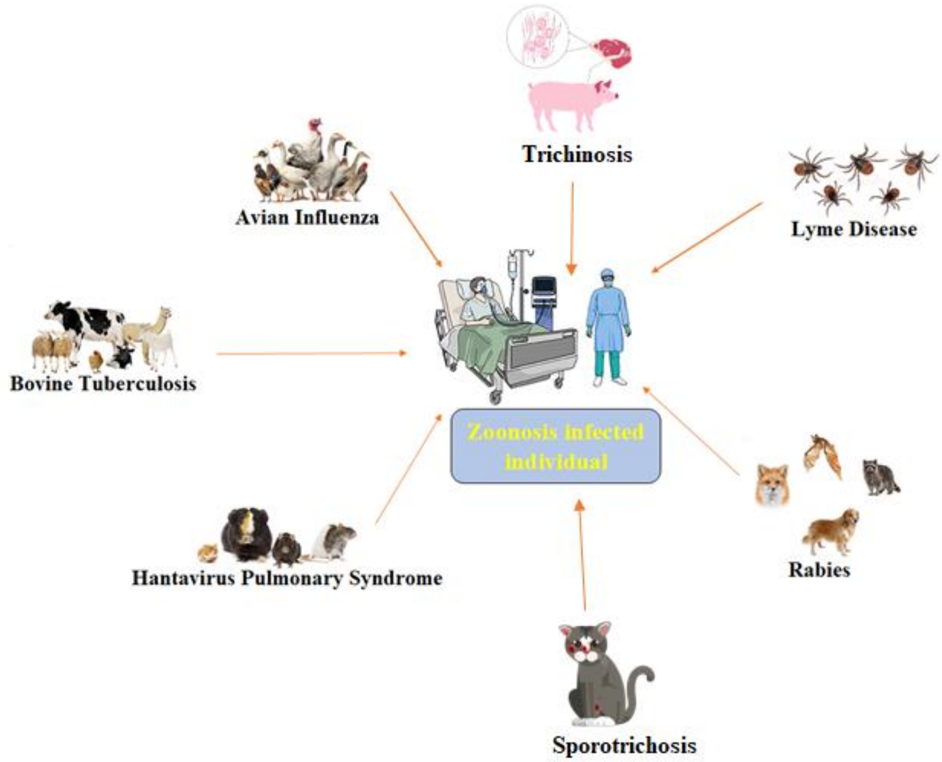

Fig. 1: A global nexus of zoonotic disease, interaction between animals and humans

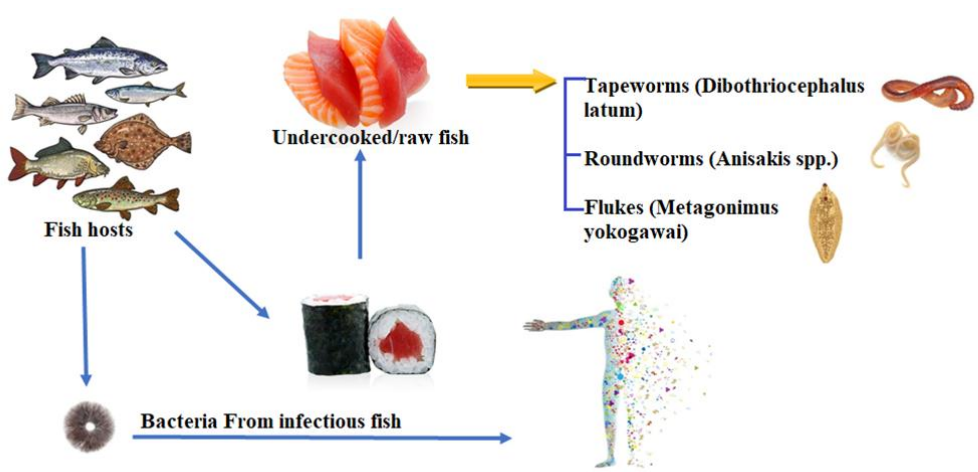

Fig. 2: Bacterial zoonotic pathogen transmission from fish to humans.

size (Marcogliese 2003). In general, the parasite load tends to increase in proportion to the trophic level of the host, with larger fish species harboring a considerable number of parasites. Unfortunately, many ZP may not exhibit visible signs of infection in the infected fish, posing challenges in diagnosis, particularly when the larvae are small and present at low levels (Lowry and Smith 2007; Shamsi and Suthar 2016).

In accordance with Shamsi (2019), there are approximately forty species of fish parasites capable of infecting humans. Whereas some of these parasites may be rarely encountered, others may be

extremely pathogenic & induce significant public health risks (Deardorff 1991). Estimates suggest that helminthic parasites alone may threaten the well-being of more than 500 million individuals (dos Santos & Howgate 2011). Furthermore, this figure is expected to increase due to the effects of global warming (Fiorenza et al. 2020).
Fish-borne helminthic diseases can give rise to severe clinical manifestations, including brain hemorrhage, hemiparesis & even malignancies, in addition to mild to severe allergic reactions and gastrointestinal disorders i.e., stomach pain & diarrhea (Sripa et al. 2011; Germann et al. 2003; Cong and Elsheikha 2021). A study aimed at assessing the prevalence of ZP i.e., *Isoparorchis sp.* in *Bagridae* fish imported into Australia, *Euclinostomum sp.* in *Channidae fish,* and *Eustrongylides sp.* in *Channidae fish* (Williams et al. 2022). Regular investigation is crucial to prevent the introduction of ZP, even if freezing imported edible fish can render the parasites inactive (Williams et al. 2022).

1.2. FUNGAL ZOONOTIC AGENTS

Fungi, a taxonomically diverse assemblage of non-photosynthetic microorganisms, exhibit a broad spectrum of ecological roles, including parasitism of humans, plants, and animals, as well as saprophytic lifestyles in soil as well as decaying organic substrates (Cullings et al. 2023). Among the vast array of fungal pathogens that have been identified, a mere 300 have been certainly demonstrated to exert a threat to the health of humans, as attested by the authoritative Center for Disease Control and Prevention (CDC) in 2017. However, fungal infections caused by ubiquitous environmental fungi remain a persistent public health challenge. Moreover, the zoonotic potential of fungi, which can be transmitted among humans and animals, is a source of growing concern for global health authorities, given the potential for serious negative impacts on public health. Regrettably, despite the pressing need for targeted prevention and control strategies to address zoonotic fungi, inadequate attention has been established to this issue in the context of global public health initiatives (CDC 2017).

1.3. BACTERIA

Bacteria, being the most prevalent fish-born zoonotic pathogens, pose a significant concern for humans (Fig. 2). The transmission of these pathogens commonly occurs through the introduction of infectious fish or contaminated treatment fomites to the skin, particularly through cuts, penetrating wounds, or abrasions (Souza 2011). The proliferation of bacteria is facilitated by the amplified organic load observed in recirculating systems, as it provides an excellent substrate for bacterial growth. In order to minimize the risk of infection, it is imperative for veterinary clinicians to consistently wear personal protective equipment (PPE), such as gloves, since the majority of the microorganisms discussed herein are frequently present even in fish that do not exhibit clinical symptoms. Although certain gram-positive microorganisms hold significance in the field of medicine, the pathogenic microorganisms primarily belong to the gram-negative category (Boylan 2011). The incidence of bacterial zoonotic pathogens in fish exhibits periodic variation, necessitating regular assessment of the occurrence of pathogens in both wild & cultivated fish stocks (Meron et al. 2020; Regev et al. 2020). Furthermore, ornamental fishes can serve as a significant reservoir of bacterial zoonotic pathogens, often exhibiting high levels of antibiotic resistance (Weir et al. 2012).

1.4. VIRUSES

Noroviruses represent a distinct group of viruses responsible for inducing acute gastroenteritis when individuals consume contaminated fish & shellfish products. This illness has become a major concern of global public health, causing not only human suffering but also economic losses (Pavoni et al. 2013; Marsh et al. 2018; Kittigul et al. 2016). These viruses, characterized by their nonenveloped nature and possession of a single-stranded RNA genome, pertaining to the *Caliciviridae* family and are categorized into 7 genogroups, with GI and GII being the most frequently encountered in human infections (Vinje et al. 2000). The symptoms of Norovirus-induced gastroenteritis encompass symptoms such as vomiting, diarrhea, abdominal pain as well and flu-like symptoms, which generally manifest within 12 to 48-hour after consuming contaminated food. While the disease is typically self-limiting, individuals with compromised immune systems may experience prolonged infections (Reeck 2010).

Additionally, hepatitis A virus can cause hepatitis, characterized by liver inflammation, upon consumption of frozen & fresh food products, i.e., bivalves, fish, & water, that are polluted with the virus. Symptoms of hepatitis A encompass nausea, fatigue, diarrhea, vomiting, dark urine, jaundice, abdominal pain, fever, muscle pain & joint pain which can persist for several weeks or even months. However, severe cases can lead to liver failure or prove fatal, particularly among elderly individuals and those with pre-existing chronic liver disease (Roldán et al. 2013).

2. ROUTES OF TRANSMISSION TO HUMANS

Zoonotic bacteria possess the capability to be transmitted to humans through various routes. Among these routes, 64% of transmissions occur via the oral route, primarily through the consumption of untreated food derived from fish species. Additionally, 23% of transmissions occur through skin contact as well as cutaneous ulcers, while 19% are attributed to water contaminated with these bacteria (Raissy 2017). The escalating production and consumption of aquatic animals by humans have contributed to the increase in the risk of developing ZD (Haenen et al. 2013). Consequently, the need for rapid, accurate, and specific methods for the identification of pathogenic bacteria in the aquatic environment has been intensified in recent years, parallel to the increased nutritional reliance on fish. Numerous studies have successfully employed quantitative, rapid as well as accurate techniques to identify these pathogenic bacteria (Novotny et al. 2004) Table 1.

Table 1: Routes of transmission for zoonotic pathogen into the human body

Routes	Percentage	Reference
Oral	64%	
Skin contact	23%	(Raissy 2017).
Water contamination	19%	

3. TECHNIQUES FOR DETECTION OF ZOONOTIC AGENTS

With the growing need for more rapid and accurate detection of zoonotic bacteria, various molecular techniques have been developed (Koo et al. 2023). Among these, the polymerase chain reaction (PCR) has become a widely used method for detecting many types of pathogens due to its sensitivity and specificity (Law et al. 2015). In addition to conventional PCR, other PCR-based techniques have been developed to further improve detection capabilities. Multiplex-PCR allows for the detection of multiple pathogens in a single reaction, while real-time (qRT)-PCR enables the quantitative detection of bacterial DNA in real-time (Park et al. 2014). Droplet digital PCR (ddPCR) is another PCR-based technique that enables precise as well as absolute quantification of DNA molecules, allowing f the detection of levels of zoonotic bacteria (Fykse et al. 2007).

Random amplification of polymorphic DNA (RAPD) and restriction fragment length polymorphism (RFLP) are employed for bacterial differentiation. Isothermal techniques, including recombinase polymerase amplification (RPA), nucleic acid sequence-based amplification (NASBA), Small Molecule Accurate Recognition Technology (SMART), and rolling circle replication (RCA), offer the advantages of identifying bacteria in resource-limited settings without the need for specialized equipment (Farzadnia and Naeemipour 2020).

Advanced techniques in bacterial detection include RT-NASBA and LAMP-on-a-chip, which offer rapid, efficient, as well as cost effective solution. Biosensors, such as electrochemical immunosensors, fiber optic microchannel biosensors, and quartz crystal microbalance (QCM)-based biosensors, provide effective means of identifying zoonotic bacteria. These techniques demonstrate exceptional efficiency, enabling the simultaneous monitoring of multiple pathogens in aquatic environments. Moreover, the microarray technique facilitates the assessment of gene expression under diverse cell growth condition and allows for the simultaneous detection of several bacterial genera, presenting a comprehensive approach to bacterial analysis (Farzadnia and Naeemipour 2020).

Recent developments in biosensors have significantly improved the identification of bacterial species, making them a preferred detection method over molecular techniques. Among these sensors, electrochemical immunosensors, fiber optic microchannel biosensors, and quartz crystal microbalance (QCM)-based biosensors are highly efficient, cost-effective, and can detect zoonotic bacteria in multiple steps. These biosensors have the advantage of being sensitive, specific, and have the potential to be used for real-time monitoring in the aquatic environment (Ulrich 2004).

4. PREVENTION AND CONTROL

Microorganisms present in fish can significantly contribute to public health complications, making it crucial to raise awareness among the people about these microbial agents and the risks associated with consuming raw or undercooked fish (Kobuszewska and Wysok 2023). As a result, regular monitoring and implementation of quality control measures for consumed fish become imperative. Such measures not only facilitate the effectiveness as well as prompt control of diseases but also provide essential information for the treatment and prevention of aquatic zoonotic microorganism, ensuring the safety of individuals and overall public health (Bibi et al. 2015).

The control of zoonotic agents in fish poses a significant challenge as fish farming is predominantly reliant on natural environmental conditions. The degradation of the aquatic environment significantly impacts fish health and is the primary cause of most fish diseases. Thus, a multidisciplinary approach that encompasses knowledge of potential fish pathogens, an understanding of fish biology and comprehensive awareness of environmental factors is necessary to implement suitable measures for the prevention and management of various diseases (Toranzo et al. 2005).

Efficient cleaning sterilization of ponds are essential to disrupt the lifecycle of certain nematode species and reduce the population of intermediate hosts. Failure to clean and sterilize ponds properly can lead to the persistence of a significant number of intermediate hosts even after refilling (Clausen et al. 2012; Hedegaard et al. 2012; Tran et al. 2019). The prevalence of fish derived ZD in populations is influenced by various factors such as geographic location, accessibility to fresh seafood, sanitation practices, fish farming procedures and diets. Additionally, individual and social behaviors also play a crucial role (Deardorff 1991). Unlike many other lethal diseases, fish-derived ZD are not confined to specific regions and can occur globally regardless of income levels (Chai et al. 2005).

The significance of fish-derived diseases has increased remarkably in developed nations worldwide due to factors such as consumer demand, a growing international market, demographic changes and improved transportation systems (Shamsi 2016). To mitigate the risks associated with zoonotic infections throughout the stages of harvesting, processing, storage and post-processing, several measures can be implemented. Government agencies and the seafood sector can effectively address the challenges posed by zoonotic fish-derived Helminthes through the implementation of initiatives such as good manufacturing practices (GMPs) and Hazard Analysis and Critical Control Points (HACCP) systems (Adams et al. 1997).

Antibiotics are often considered a key component in controlling various zoonotic factors, making antibiotic treatment a prominent strategy for managing bacterial zoonotic pathogens (Durborow 1999; Shin and Park 2018). Individuals involved in fish and fish derived food productions must be well-informed about zoonotic pathogens and preventive measures to reduce the risk of these diseases. Given the unavoidable interaction with water and fish in aquaculture systems, prevention remains the most effective strategy to mitigate the risks associated with zoonotic illnesses (Smith 2011). In the cases of food-borne zoonoses, the transmission of multidrug-resistant animal pathogens to humans through contaminated food is a significant concern. Addressing this critical issue necessitates the monitoring of multidrug-resistant microorganisms in both animals and humans, emphasizing the importance of collaborative efforts between veterinarians, physicians and environmental experts (Chowdhury et al. 2021).

It is important to take precautions such as avoiding direct contact with fish mucus and wearing disposable gloves. Consulting a physician is necessary, even if experiencing nonspecific symptoms. Regular handwashing, especially after direct contact with water and fish is the most effective measure. It is also important to refrain from eating or drinking without handwashing. Transmission of ZD-causing agents can occur through indirect or direct contact with insects, vectors, contaminated objects, inhalation and ingestion (Boylan 2011).

Adequate technological facilities and proper methodologies for handling fishing vessels are necessary to prevent fish contamination with various microorganisms, including parasites. Cooking fish at 62°C for approximately 15 seconds is sufficient to kill parasites, but it may not be enough to detoxify certain bacterial toxins present in fish. To eliminate parasites from fish and test for their presence, informing fish sellers to inspect remaining fish and ensuring complete cooking of fish and fish-derived products are viable options (Seafood Health Facts 2020).

Research has shown that heat inactivation or freezing is the most effective method for reducing the risk of ZD (Ahuir-Baraja et al. 2021). Aquaculture systems, ranging from personal aquariums to large ponds, contain nutrient-rich water that promotes bacterial growth. Therefore, various studies have explored the use of chemicals for efficient disinfection of contaminated environments. To effectively prevent fish related zoonoses, it is important to handle chemicals safely, consider contact time, and ensure accurate dosage. Interestingly, drying or desiccation has also been identified as a reliable method for disinfecting zoonotic bacterial diseases (Chen 1995; Murrell 2002). While freezing can deactivate parasites in imported edible fish, not all captured fish undergo freezing conditions (Williams et al. 2022). The preference of consumers for cooked seafood products, including raw fish slices, can contribute to the transmission of zoonotic pathogens (You et al. 2021).

The effectiveness of preventive and control strategies in preventing outbreaks of ZD can be influenced by cultural practices. Consuming ready-to-eat raw fish products such as sushi and sashimi poses a biological hazard, highlighting the importance of strict governmental regulations to ensure the safety and quality of fish used for these purposes (Lehel et al. 2021). Additionally, the significant expansion of the freshwater ornamental fish sector has led to increased human-fish contact, which can contribute to the transmission of zoonotic infections. The presence of Mycobacterium species in freshwater ornamental fish has been observed, underscoring the magnitude of this challenge (Phillips Savage et al. 2022).

Fish handlers and veterinarians should take precautions to protect themselves from potential exposure to waterborne pathogens, particularly if they have abrasions or open wounds. Wearing disposable gloves is highly recommended during various activities involving fish such as handling fish tissues, mucus or waste products. In case where water contact is unavoidable, the use of gels, tissue glue and topical ointment such as triple antibiotic and silver sulfadiazine can provide additional surface wound protection, although gloves remain the preferred option (Grant and Olsen 1999; Boylan 2011).

Deep wounds should be promptly washed with regular or saline water and then disinfected using appropriate substances such as alcohol, hydrogen peroxide, betadine, or chlorhexidine. Serious injuries require immediate medical attention and pose a higher risk. Veterinarians play a crucial role in educating stake holders about ZD, demonstrating proper use of personal protective equipment, and informing patients to provide a comprehensive history if a suspected fish-derived zoonosis is identified. Effective communication between veterinarians, staff, patients, and hospitals is essential for education and management of fish-derived zoonoses (Grant and Olsen 1999; Boylan 2011).

To effectively address the complex issues of One Health related to seafood safety, it is imperative to foster active stakeholder engagement and establish strong interrelationships among them (Shamsi 2019). The World Health Organization (WHO) has documented that globalization and the widespread movement of people and animals have facilitated the worldwide dissemination of ZD. Furthermore, the absence of adequate public health facilities in rural areas, substandard transport systems for specimens and a dearth of proper laboratory facilities for early disease diagnosis have contributed to pathogen transmission. WHO reports have emphasized that the main barriers to controlling zoonotic infections and implementing a One Health System are diagnosis and detection, disease management, organizational challenges as well as halting pathogen transmission. Accordingly, the recommended measures include enhancing early disease and pathogen identification, managing infections, controlling vectors and rodents as well as promoting effective collaboration between animal & human health officials (World Health Organization 2021).

In order to effectively address zoonoses and prevent disease outbreaks, it is crucial to incorporate the "One Health" approach into the training of university students, research institutions, research teams as well as international organizations. The One Health (OH) framework is a comprehensive and interdisciplinary strategy that operates at various levels, aiming to achieve optimal health outcomes by recognizing the interconnectedness between animals, humans, plants as well as their shared environment. Successful implementation of the One Health system requires international collaboration and coordination between healthcare staff and veterinarians. To control fish-derived ZD and potential epidemics, it is imperative to combine regulated fish farming practices with measures such as minimizing water pollution and enhancing disease surveillance systems (Fig. 3) (Marbán-Castro et al. 2019; Aggarwal and Ramachandran 2020).

5. ORGANIZATIONS OVERLOOKING THE SPREAD OF FISH ZOONOSES AND SUCCESS STORIES

Numerous organizations have been established globally to prevent and control fish zoonoses. Although fish zoonoses pose minimal threats to humans, WHO recognizes the importance of addressing the issues (WHO, 2014). The Kenyan ZD Unit (ZDU), is an example of secretariate under the Zoonoses Technical Working Group (ZTWG), established in 2001 through the WHO One Health program. The ZDU is responsible for providing technical advices on fish zoonoses prevention and control in Kenya and is chaired on a rotational basis by the Director of Veterinary Service and the Director of Medical Service of the Government of Kenya. Control programs have been successful in Thailand for fish-borne trematodiases and in Peru for *Taenia solium* cysticercosis using available tools. Scaling up control strategies in endemic areas is essential to control the transmission of fish zoonoses. For instance, the “Lawa project” is working with a transdisciplinary team to control fish-borne trematodiasis in the north-eastern Lawa Lake region of Thailand, which had a high community prevalence of 67% before control activities began. The transmission of fish zoonotic trematodes (FZT) in fish nurseries was found to be high in northern Vietnam which can potentially seed a large number of grow-out farms with ZFTs. The prevalence of FZTs in fish decreases from 70% to 1% over ten years after a successful campaign. Despite the existence of One Health programs and ministries in every country, progress on fish zoonoses remain limited and the focus is primarily on other issues such as antibiotic resistance and parasitic infestations. The low prevalence and threat posed by fish-borne zoonoses contribute to the lack of successful studies in this area (Bardhan 2022) Table 2.

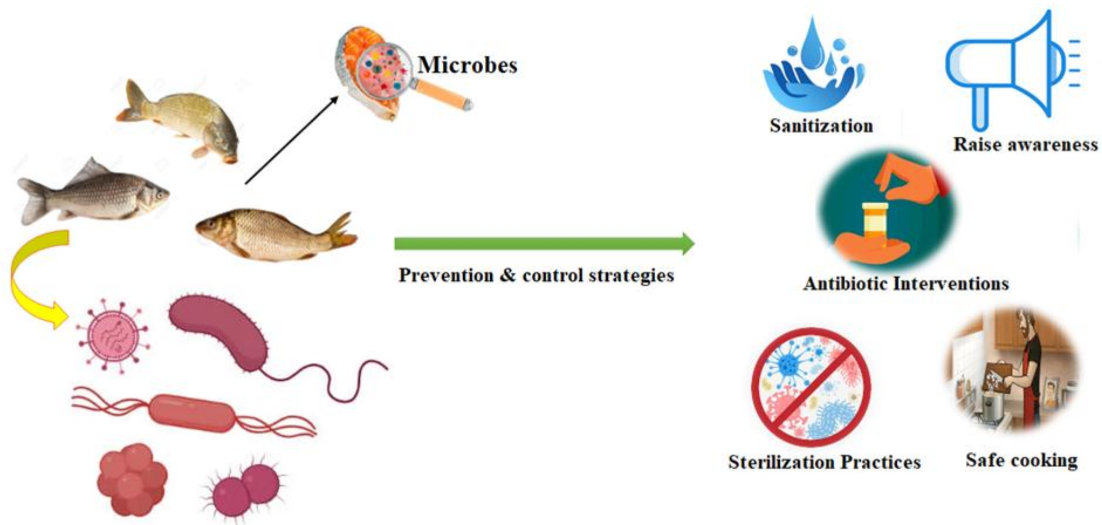

Fig. 3: Overview of prevention and control strategies of zoonotic diseases from fish.

Table 2: International initiatives addressing zoonotic risks associated with fishes

Project/organization	Country	Contribution	Reference
ZDU	Kenya	Prevention of fish-borne trematodiasis	
ZDU	Thailand		
ZDU	Peru	Controlling *Taenia solium cysticercosis*	(Bardhan 2022)
Lawa project	Thailand	Fish-born trematodiasis prevention	

CONCLUSION

In conclusion, the comprehensive strategies elucidated in this chapter underscore the imperative of proactive measures for preventing and controlling zoonotic diseases originating from fishes. By integrating rigorous surveillance, biosecurity protocols and collaborative research efforts, we can effectively mitigate the risks posed by these diseases at a global scale. Furthermore, the diverse range of international organizations dedicated to this cause exemplifies the concerted endeavor towards safeguarding human health.

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