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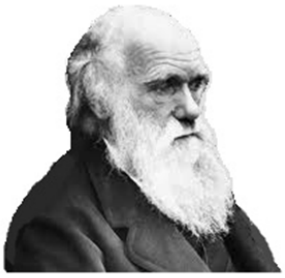

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Addressing Zoonotic Helminths in Nigeria: Bridging Public Health and Veterinary Strategies

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ABSTRACT

Zoonotic helminths are parasitic worms that are transmissible between animals and humans, they represent a significant public health challenge in Nigeria. These infections are sustained by poor sanitation, poverty, close human-animal interactions, and environmental factors, making their control complex and multifaceted. This manuscript highlights the socioeconomic and public health burden of zoonotic helminths in Nigeria, which manifests as chronic morbidity, stunted growth in children, reduced productivity among affected populations, and significant economic losses in the livestock sector. The manuscript calls for an urgent need to address zoonotic helminths through an integrated approach that bridges public health and veterinary strategies. Key strategies are proposed to tackle zoonotic helminths effectively, including strengthening public health infrastructure through the provision of clean water, improved sanitation, and waste management systems. Health education and community engagement are emphasized as critical tools to foster preventive practices, particularly among vulnerable populations. Regular deworming programs for livestock and companion animals and robust zoonotic disease surveillance systems are highlighted as essential veterinary interventions. Furthermore, the manuscript underscores the importance of enforcing regulations on the use of anthelmintic drugs to curb the growing threat of drug resistance. The One Health approach - an integrative framework linking human, animal, and environmental health - is presented as the cornerstone of sustainable zoonotic helminth control. The manuscript concludes with actionable recommendations tailored to the Nigerian context, advocating for community ownership, policy reforms, and sustained international support. By implementing these strategies, Nigeria can significantly reduce the prevalence of zoonotic helminths, improve public health outcomes, and achieve sustainable development goals related to health and well-being.

***Keywords*:** Helminths, zoonoses, Soil-transmitted helminths, sustainable control, Nigeria

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1. INTRODUCTION

Zoonotic helminths, parasitic worms transmissible between animals and humans, pose a significant public health challenge in Nigeria. These helminths include nematodes (e.g., *Ascaris lumbricoides*, *Toxocara canis*, and *Ancylostoma caninum*), cestodes (e.g., *Echinococcus granulosus*), and trematodes (e.g., *Schistosoma* sp. and *Fasciola* sp.). The burden of these infections is amplified by socio-economic factors such as poverty, poor sanitation, limited access to healthcare, and low levels of health education [1, 2]. Rural communities and urban slums are disproportionately affected due to close human-animal interactions and inadequate waste management systems, which create favorable conditions for helminth transmission [3].

Globally, zoonotic helminths contribute significantly to morbidity, particularly among vulnerable populations such as children, women, and immunocompromised individuals. In Nigeria, helminthiasis continues to be a pervasive issue, highlighting systemic deficiencies in public health infrastructure and environmental management. Soil-transmitted helminths, including *Ascaris lumbricoides* and *Trichuris trichiura*, are endemic, with prevalence rates remaining alarmingly high over decades despite global progress in their control [4, 5].

The epidemiology of zoonotic helminths in Nigeria underscores the multifactorial nature of their persistence. Environmental factors, such as the tropical climate, facilitate the survival and transmission of infective helminth stages. Behavioral practices, including open defecation and inadequate deworming of pets, exacerbate the issue [6]. Companion animals, particularly dogs, serve as critical reservoirs for helminths like *Toxocara canis* and *Ancylostoma caninum*, which can cause severe health conditions such as visceral and cutaneous larva migrans in humans [7, 8]. Emerging trends, including rapid urbanization and climate change, are altering the patterns of zoonotic helminth infections. These changes have introduced previously uncommon helminths, such as *Capillaria* spp. and *Oesophagostomum bifurcum*, posing new challenges to public health systems [9]. Additionally, globalization and changing dietary habits have increased the risk of foodborne helminthiasis, such as anisakiasis, linked to raw or undercooked fish [10].

The socio-economic impact of zoonotic helminths is profound. Infected individuals frequently experience reduced productivity due to chronic morbidity, while children suffer from stunted growth and cognitive impairment, perpetuating cycles of poverty [11, 12]. Despite these significant consequences, zoonotic helminths remain neglected within Nigeria's health agenda, overshadowed by more prominent infectious diseases such as malaria and HIV/AIDS.

This narrative review seeks to synthesize current knowledge on the epidemiology, risk factors, and public health implications of zoonotic helminths in Nigeria. It aims to inform strategies for effective control and prevention, emphasizing the need for an integrated, multi-sectoral approach. By combining health education, veterinary public health, and robust policy frameworks, this review advocates for sustainable mitigation measures to address the burden of these neglected infections. The time for action is now, as a coordinated response is essential to safeguard the health and well-being of Nigeria’s population.

2. EPIDEMIOLOGY OF ZOONOTIC HELMINTHS IN NIGERIA

Zoonotic helminths are widely distributed across Nigeria, reflecting the diverse ecological and socio-economic conditions that support their persistence. While soil-transmitted

nematodes such as *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms (e.g., *Ancylostoma duodenale*) are frequently mentioned, it is critical to distinguish these from zoonotic helminths. The latter category includes parasites transmitted between animals and humans, emphasizing a unique public health challenge requiring distinct surveillance and intervention strategies [4, 6]. In Osun State, *Ascaris lumbricoides* was found in 67% of stool samples analyzed in rural communities [13]. Similarly, in Anambra State, prevalence rates for *Trichuris trichiura* exceeded 40% among school-aged children, underscoring the endemicity of these parasites [3]. In Lagos, a study revealed contamination rates of over 90% for playground soils with helminth eggs, including *Ascaris* and *Trichuris* [14].

Companion animals, particularly dogs, play a significant role in the transmission of zoonotic helminths such as *Toxocara canis* and *Ancylostoma caninum*. Surveys in Sokoto State reported that 78% of household dogs harbored zoonotic helminths, posing a direct threat to human health [6]. Similarly, studies conducted in Plateau State showed a 55% prevalence of *Toxocara canis* in dogs, highlighting a significant zoonotic risk [15]. Waterborne trematodes, including *Schistosoma haematobium* and *Schistosoma mansoni*, are also endemic in Nigeria. In Ogun State, *Schistosoma haematobium* infections were recorded in 48% of individuals living near freshwater sources [16]. Trematodes including *Fasciola* sp. were also reported to be prevalent among livestock in Niger State [17], with reported prevalence rates of 60% among school children [18].

Emerging zoonotic helminths, such as *Capillaria* sp. and *Oesophagostomum bifurcum*, have been reported in neighboring West African countries and are increasingly being identified in Nigeria [9]. Recent studies highlight the role of altered environmental landscapes and climate change in facilitating the survival and spread of these parasites [6, 17]. For instance, *Capillaria* species, previously limited to certain regions, are now observed in freshwater systems frequently used by local populations [6].

Similarly, *Oesophagostomum bifurcum*, often linked to primates, is becoming a concern due to its zoonotic potential as human-primate interactions increase in shared habitats [6, 19]. This trend underscores the urgent need for surveillance programs to monitor and mitigate emerging risks effectively. Additionally, foodborne zoonoses such as anisakiasis, caused by consuming raw or undercooked fish, have become more prevalent with the rising popularity of imported culinary practices [19].

2. 1. Soil-Transmitted Helminthic Zoonoses in Humans

The soil is an important route for the transmission of numerous human pathogens, including the five major soil-transmitted helminths (STHs), also known as geo-helminths according to [19], namely: roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), hookworms (*Ancylostoma duodenal* and *Necator americanus*), and threadworm *Strongyloides stercoralis*.

The World Health Organization [11] reported that an estimated one billion people are infected with soil-transmitted helminths (STHs) worldwide, particularly in resource-poor settings. While the overall mortality from STH infections is low, their morbidity significantly impacts growth, nutrition, physical fitness, and cognitive functions among infected individuals, particularly infants, school children, and adults in developing countries [4]. This underscores the need to distinguish STH-related data from zoonotic helminths to maintain focus on the latter's public health implications. In Africa, an estimated 89.9 million children harbor STHs, many of whom are co-infected with two or more STH species [11].

According to Olaniyi et al. [5], prevalence studies of soil-transmitted helminths since the 1970s have indicated that the triad of *Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworm species are common infections in Nigeria. It has been reported that the prevalence of these parasites especially *Ascaris* has not changed in the past 50 years [20], and poly-parasitism with these nematodes is also a common occurrence [21, 22]. A survey of fecal samples collected from playgrounds, markets, motor parks, and residential and recreational areas in Lagos [14] revealed that 96.3% of the samples contained ova of *Ascaris lumbricoides*. These natural playgrounds have been reported as a major source of infection for children [20, 23].

Near to the ground level of education and poor socio-economic status of parents, have been associated with helminthic infection in children [3,16]. In Nigeria, helminthic infections are still a disease of poverty, as there exists a strong correlation between parental socio-economic status and intestinal parasitosis in children. The global public health importance of hookworm disease, Ascariasis, and Trichuriasis has been widely reviewed [2, 24, 25]. The disability-adjusted life-years (DALYs) lost to STHs as described by Chan [11] are enormous in comparison with other infections.

A major reason such high DALY values were attributed to STHs stemmed from the linkage of hookworm to anemia, ascariasis to growth stunting, and trichuriasis to decreased school performance [12]. By treating only school children in high-prevalence communities, it is estimated that 70% of the total burden due to soil-transmitted helminths can be prevented [26].

Helminthic infections, long neglected, are now regaining public health attention due to their profound impact on children's health in endemic countries [27]. While school-based control programs have proven practicable and well-received at the community level, these initiatives primarily address soil-transmitted helminths. Nwaorgu et al. [28] highlighted the community's willingness to contribute to drug purchases and disseminate health awareness, underscoring the importance of community engagement for sustainable programs tailored to Nigeria's specific parasitic disease burden.

3. RISK FACTORS AND CHALLENGES

The persistence and transmission of zoonotic helminths and soil-transmitted helminths (STHs) in Nigeria are influenced by multiple risk factors, including economic, socio-environmental, and zoonotic-specific challenges.

3. 1. Economic Impacts

Poverty is a critical underlying factor driving the high prevalence of zoonotic helminths and STHs. Limited access to clean water, healthcare, and proper sanitation facilities increases the vulnerability of impoverished communities to these infections [2, 3]. Poor households often lack the financial resources to afford preventive measures, such as periodic deworming programs for pets and humans.

Malnutrition, common in impoverished areas, weakens the immune system, making individuals more susceptible to infections. Additionally, educational campaigns on zoonotic helminths and STHs are often inaccessible in these regions, contributing to low awareness and poor preventive practices.

3. 2. Socio-Environmental Factors

3. 2. 1. Poor Sanitation

Open defecation and inadequate waste disposal systems are widespread in many parts of Nigeria, leading to significant soil contamination with helminth eggs. Studies have shown that areas with high levels of environmental contamination, such as playgrounds and marketplaces, are hotspots for soil-transmitted helminths [5, 14]. These unsanitary conditions exacerbate the cycle of infection, particularly among children who play in contaminated environments. Poor drainage and stagnant water further create breeding grounds for vectors of waterborne helminths, such as *Schistosoma* sp. Effective waste management systems and improved sanitation are often lacking, particularly in low-income areas.

3. 2. 2. Environmental Factors

Nigeria's tropical climate, characterized by high humidity and temperatures, creates favorable conditions for the survival and transmission of helminth eggs and larvae. Seasonal flooding and poor drainage systems often exacerbate the spread of waterborne helminths, such as *Schistosoma* sp., in endemic areas [18, 29]. Human activities, such as fishing and farming in contaminated water sources, also increase exposure to helminth infections. Furthermore, deforestation and urbanization are altering ecological balances, leading to increased contact between humans and previously isolated animal reservoirs of helminths.

3. 3. Zoonotic Impacts

3. 3. 1. Human-Animal Interaction

The close interaction between humans and domestic animals, particularly in rural areas, serves as a major risk factor for zoonotic helminth transmission. Dogs, often kept as pets or for security, are significant reservoirs for helminths like *Toxocara canis* and *Ancylostoma caninum*. Studies indicate that direct contact with infected animals or their feces contributes to the high prevalence of zoonotic helminthiasis in children [6, 8]. Improper handling of animal feces or failure to administer regular anthelmintic treatment to pets exacerbates the risk. Additionally, the habit of allowing pets into sleeping areas or children’s play zones heightens exposure to infective helminth stages.

4. PUBLIC HEALTH AND ECONOMIC IMPACTS

Zoonotic helminths contribute to considerable morbidity, especially among children and immunocompromised individuals. Infections with *Ascaris lumbricoides* and *Trichuris trichiura* are linked to malnutrition, stunted growth, and impaired cognitive development in children [11]. A study in Oyo State found that 58% of school-aged children infected with soil-transmitted helminths had anemia and reduced school attendance [30]. Similarly, *Schistosoma haematobium* infections are associated with chronic urinary tract issues and an increased risk of bladder cancer [18]. Helminths like *Toxocara canis* cause ocular larva migrans, leading to visual impairments. In Lagos, 15% of children attending ophthalmic clinics showed evidence of helminth-associated ocular pathology [31]. Additionally, hookworm infections contribute to

iron-deficiency anemia, particularly among pregnant women, leading to adverse pregnancy outcomes such as low birth weight and preterm delivery [4].

4. 1. Economic Impacts

The economic burden of zoonotic helminths is substantial, with reduced productivity due to chronic illness. Agricultural workers and farmers are particularly affected, and infections like fascioliasis impair physical ability and work output. In Kano State, farmers infected with liver flukes lost up to 30% of their annual income due to decreased productivity and increased medical expenses [32]. Healthcare costs for diagnosing and treating helminth infections further strain household and national budgets. T

he cost of treating schistosomiasis alone is estimated at over ₦4 billion annually, mainly due to hospitalizations and medications [18]. Indirect costs, including absenteeism from work and school, exacerbate the economic burden, perpetuating poverty. The stigma surrounding helminth infections, especially visible manifestations like skin lesions or distended abdomens in children, leads to social isolation and mental health challenges. The chronic nature of these infections also reduces life expectancy and hinders economic development at both the community and national levels. Efforts to control zoonotic helminths must address both health and economic impacts, emphasizing integrated strategies that include health education, sanitation improvements, and access to affordable healthcare.

5. EMERGING TRENDS AND CHALLENGES

The epidemiology of zoonotic helminths in Nigeria is shaped by emerging trends and persistent challenges that require adaptive strategies for effective control.

5. 1. Climate Change and Environmental Disruption

Climate change has exacerbated the spread of zoonotic helminths by altering the distribution of intermediate hosts and creating favorable conditions for parasite development. Rising temperatures and increased rainfall in certain regions of Nigeria have expanded the habitats of vectors such as freshwater snails, which are intermediate hosts for *Schistosoma* sp. [29]. Seasonal flooding has also intensified the contamination of water sources, increasing exposure to waterborne helminths.

Additionally, deforestation and urbanization have disrupted ecosystems, bringing humans into closer contact with wildlife reservoirs of helminths. This has contributed to an increase in zoonotic infections in peri-urban areas, where land-use changes facilitate the movement of infected animals into human settlements [30].

5. 2. Urbanization and Changing Lifestyles

Rapid urbanization in Nigeria has led to the proliferation of slums with poor sanitation and inadequate waste management, creating favorable conditions for the transmission of soil-transmitted helminths such as *Ascaris lumbricoides* and *Trichuris trichiura* [4]. Changing dietary habits, including the increased consumption of raw or undercooked meat and fish, have heightened the risk of foodborne zoonoses, such as anisakiasis [10]. These lifestyle changes exacerbate the public health burden posed by zoonotic helminths.

5. 3. Anthelmintic Resistance

The widespread use of anthelmintic drugs in both humans and livestock has raised concerns about the emergence of drug-resistant helminths. Studies in Nigeria have reported reduced efficacy of commonly used deworming agents, particularly in livestock, threatening the effectiveness of control programs [38]. Resistance is compounded by the unregulated use of these drugs, often without veterinary supervision, further complicating efforts to control helminth infections.

5. 4. Lack of Public Awareness and Health Education

A significant challenge in combating zoonotic helminths is the low level of public awareness regarding these infections. Misconceptions about transmission routes and preventive measures are widespread, particularly in rural communities [5]. The absence of comprehensive health education programs undermines efforts to reduce the burden of helminth infections, particularly in vulnerable populations.

5. 5. Insufficient Research and Surveillance

There is a critical gap in the surveillance of zoonotic helminths in Nigeria, with limited data on emerging species and their prevalence. This lack of robust research hinders the development of targeted interventions and policy frameworks. Strengthening research capacity and establishing nationwide surveillance systems are essential to address these challenges effectively and ensure that control programs remain responsive to evolving threats. Addressing these emerging trends and challenges will require a multifaceted approach that incorporates environmental management, public health education, surveillance, and effective regulation of anthelmintic use.

6. CALL TO ACTION

The pervasive burden of zoonotic helminths in Nigeria demands an urgent and coordinated response. The previous sections highlighted the significant public health and economic impacts of these infections, driven by factors such as poor sanitation, poverty, environmental disruptions, and a lack of effective control measures. To address this complex issue, a practical and sustainable strategy tailored to Nigeria's socio-economic, cultural, and ecological context is crucial. This call to action provides actionable steps to mitigate the impact of zoonotic helminths on public health and socio-economic development.

6. 1. Strengthening Public Health Infrastructure

As highlighted, poor sanitation and access to clean water are major contributors to the spread of zoonotic helminths. Strengthening public health infrastructure is fundamental to addressing these infections. Efforts must focus on constructing and maintaining modern sanitation facilities, particularly in urban and rural areas. Safe water sources such as solar-powered boreholes and rainwater harvesting systems are vital to reducing exposure to waterborne helminths. Additionally, proper waste management systems, including waste treatment plants and regulated sewage systems, should be prioritized to prevent environmental contamination and the spread of helminths.

6. 2. Health Education and Community Engagement

Health education is critical in raising awareness about the modes of transmission, symptoms, and preventive measures for zoonotic helminths. Nationwide public health campaigns using traditional media, social media, and community outreach programs can ensure widespread dissemination of information. School-based deworming programs and hygiene education should target children, who are especially vulnerable to helminth infections. Community engagement through health promotion activities involving teachers, parents, and local leaders can help create a sustained, localized effort to reduce infection rates.

6. 3. Veterinary and Animal Health Interventions

As zoonotic helminths are often transmitted through animals; veterinary and animal health interventions are essential. Regular deworming programs for companion animals and livestock must be implemented nationwide. Government subsidies for anthelmintic treatments will ensure accessibility for low-income households, helping to reduce infection reservoirs. Establishing a robust zoonotic disease surveillance system and integrating veterinary and human health data will help monitor trends and guide targeted interventions. Mobile veterinary clinics can further support these efforts, especially in rural and underserved areas.

6. 4. Regulation and Policy Development

Effective regulation of anthelmintic drug use is necessary to prevent the emergence of drug-resistant helminths. Training veterinarians and livestock farmers on proper drug administration practices is crucial. Furthermore, comprehensive national policies on zoonotic helminths, supported by adequate funding and stakeholder involvement, are needed to drive long-term success. Strengthening policy frameworks will ensure that resources are allocated efficiently, and interventions are aligned with public health goals.

6. 5. Research and Capacity Building

Investing in research is vital for understanding the epidemiology of zoonotic helminths in Nigeria. Epidemiological studies mapping the prevalence and distribution of these infections will inform targeted interventions. Capacity building for health professionals, veterinarians, and community health workers is also critical.

Training programs on zoonotic diseases and One Health approaches will ensure that the workforce is equipped to handle the complexities of helminth control. Collaboration with international partners can provide the technical expertise and resources needed to strengthen research and capacity-building efforts.

6. 6. Multisectoral Collaboration and One Health Approach

A multisectoral approach is key to addressing zoonotic helminths in Nigeria. Adopting a One Health framework that integrates public health, veterinary, and environmental sectors will facilitate coordinated control programs. Local governments, non-governmental organizations, and communities should collaborate to develop and implement community-led initiatives.

These can include forming health committees, conducting clean-up campaigns, and establishing local surveillance networks, empowering communities to take ownership of helminth control.

6. 7. International Partnerships

International partnerships with organizations such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and international non-governmental organizations can provide funding, technical support, and capacity-building opportunities. Cross-border surveillance and control programs with neighboring countries are essential to addressing the transboundary nature of zoonotic helminths.

7. CONCLUSIONS

Zoonotic helminths remain a persistent challenge in Nigeria, with significant implications for public health, economic stability, and socio-cultural development. However, their control is not only feasible but necessary through a concerted effort that incorporates actionable, sustainable interventions. The strategies proposed in this manuscript emphasize the importance of a multifaceted approach, ensuring the inclusion of community engagement, policy reforms, and international cooperation.

To achieve tangible results, Nigeria must prioritize investments in public health infrastructure, such as providing access to clean water, modern sanitation facilities, and waste management systems. Sustainable solutions like solar-powered water systems and community-led sanitation initiatives can address the unique challenges posed by both urban and rural settings. Integrating health education into school curricula and leveraging community networks will foster a culture of preventive practices such as handwashing that significantly reduce exposure to helminths.

Veterinary interventions must be scaled up to include regular deworming programs for livestock and companion animals, along with capacity building for veterinarians and livestock farmers. A robust surveillance system is essential to monitor infection trends and effectively guide resource allocation. Stricter regulations on anthelmintic drug use and focused efforts to combat drug resistance will help safeguard the long-term efficacy of control measures. Research should remain a cornerstone of helminth control efforts, with increased funding for epidemiological studies and collaboration with international organizations. Such initiatives will not only provide the necessary evidence base for targeted interventions but also drive innovation in control strategies. A unified One Health approach - linking human, animal, and environmental health - should be the backbone of sustainable control programs. By fostering collaboration across public health, veterinary, and environmental sectors, Nigeria can ensure that zoonotic helminth control efforts are comprehensive and effective. Community participation, supported by local governments and non-governmental organizations, will be critical in ensuring the long-term sustainability of these programs.

Ultimately, controlling zoonotic helminths in Nigeria requires commitment at all levels - from individual communities to international partners. By adopting the recommendations outlined in this review, Nigeria can mitigate the burden of these infections, improve public health outcomes, and contribute to the global fight against neglected tropical diseases.

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