Giardia duodenalis in the Philippines: Its Prevalence, Impact, and Diagnostic Challenges

ABSTRACT

Giardia duodenalis, also referred to as *G. intestinalis* or *G. lamblia*, is a flagellated protozoan parasite responsible for giardiasis, a gastrointestinal illness. The parasite is classified into eight assemblages (A-H), with assemblages A and B primarily affecting humans, though zoonotic transmission has been documented. The clinical presentation of giardiasis ranges from asymptomatic cases to severe gastrointestinal symptoms, including prolonged diarrhea, abdominal pain, bloating, malabsorption, and significant weight loss during acute infections. In endemic areas, chronic giardiasis in children has been linked to developmental stunting and cognitive impairments. Diagnosis commonly involves microscopic and serological techniques, while nitroimidazoles such as metronidazole and tinidazole remain the mainstay treatments. However, emerging drug resistance and occasional treatment failures present significant challenges. Additionally, the lack of an effective vaccine complicates efforts to control the transmission and progression of the disease. High infection rates are frequently observed in regions with inadequate sanitation and poor hygiene, particularly in developing countries like the Philippines. Given the limited research on *G. duodenalis* infections and related parasitological studies in the Philippines, this review emphasizes the critical gaps in knowledge regarding the prevalence, pathology, and treatment of giardiasis in the local context. The development of affordable and practical diagnostic methods is essential for improving the clinical management of giardiasis and addressing its impact on vulnerable communities.

Keywords: *Giardia duodenalis*, Giardiasis, Prevalence, Epidemiology, Philippines

I. INTRODUCTION

Giardia duodenalis, also known as *Giardia intestinalis* or *Giardia lamblia*, is a flagellated protozoan parasite responsible for causing giardiasis, a gastrointestinal illness. It is among the most widespread intestinal parasites worldwide, affecting millions annually, particularly in regions with inadequate sanitation and hygiene [1]. This protozoan poses a significant threat to both human and animal health. Within *Giardia*, eight genetic assemblages (A-H) have been identified, with Assemblages A and B being the primary infective types in humans, although zoonotic transmission has also been documented [2,3].

The clinical manifestation of giardiasis varies from asymptomatic to severe gastrointestinal symptoms. Acute infections may result in extended diarrhea, stomach pain, bloating, malabsorption, and considerable weight loss [1,4]. Particularly in areas where giardiasis is prevalent, chronic infections in children have been associated to developmental stunting and cognitive problems. [5,6]. Asymptomatic carriers greatly contribute to *Giardia* transmission by cyst shedding [1,3].

Giardia duodenalis, one of the most common intestinal parasites, causes gastrointestinal diseases in industrialized and developing nations. Its prevalence ranges from 2–5% in industrialized nations to 20–30% in South Asia and sub-Saharan Africa with poor sanitation. Approximately 200 million people in Asia, Africa, and Latin America experience symptomatic giardiasis annually, highlighting its public health importance [7].

Giardiasis is a major health issue in the Philippines, especially in impoverished areas without clean water and sanitation. A study in a Manila slum found a prevalence rate of 22.05%, highlighting the significant infection rate gap between rural and urban areas [7]. In institutionalized populations, the disease is more common with a prevalence of 17.6% among inmates and 11.6% among children in residential institutions in Metro Manila [8]. Sanitation, healthcare, and public health all have bearing on the frequency of giardiasis, so exposing national disparities.

Giardia is transmitted through the consumption of infective cysts, predominantly through contaminated water or food. Transmission between individuals, especially among children and institutionalized groups, is prevalent [5,7]. Environmental conditions, including inadequate waste disposal and insufficient access to potable water, aggravate the transmission of giardiasis. Inadequate handwashing and the use of untreated water are additional factors that contribute to its endemicity [1,7].

Giardiasis affects Philippine public health and socioeconomic stability, particularly children and those in poor areas. Recurrent infections cause developmental delays, stunted growth, and malnutrition in children. Chronic effects and high treatment costs strain families and the healthcare system [9]. The prevalence of *G. duodenalis* in untreated rural water sources emphasizes the need of improved water quality control and sanitation system. These structural problems have to be resolved if we are to lower the preventable and treatable giardiasis' social and medical loads.

Traditional stool microscopy diagnoses giardiasis by identifying cysts or trophozoites. This method, a gold standard for decades, is cheap and widely available, but intermittent cyst excretion, observer's expertise, and lack of sensitivity, especially in asymptomatic cases, can reduce its accuracy [10]. Ritchie's method or formalin-ether sedimentation are used to reduce false-negative results and increase sensitivity [11]. Microscopy is less sensitive and specific than enzyme-linked immunosorbent assay (ELISA) and immunochromatographic test (ICT). They detect stool *Giardia* antigen. Another sensitive immunological method is Direct Fluorescence Assay (DFA), which uses fluorescently labeled antibodies to identify *Giardia* cysts [12]. The use of these methods is constrained by equipment and reagent requirements [12]. Molecular techniques such as polymerase chain reaction (PCR) and real-time PCR demonstrate superior sensitivity and specificity in the diagnosis of giardiasis, even in cases with low parasite loads in fecal samples. Symptomatic as well as those that are asymptomatic can be detected using real-time PCR [13]. As a result of their high cost and complexity, assays based on fluorescent microspheres and loop-mediated isothermal amplification (LAMP) are not typically utilized in countries with limited resources, such as the Philippines [14].

Innovative diagnostic methods like microRNA-based detection are being investigated. MiR5 and miR6 are promising biomarkers for giardiasis, especially in duodenal biopsy samples. PCR, histopathology, and imprint cytology on duodenal biopsies improve diagnostic accuracy, especially in chronic diarrhea patients [13,15]. Larger Philippine hospitals diagnose with stool microscopy and antigen detection. Giardiasis surveillance and management can be improved by molecular diagnostics, addressing diagnostic challenges and improving public health [7]. This review addresses knowledge gaps and aligns Philippine public health efforts with global water quality and sanitation goals. To reduce the disease's impact, diagnostic capacity, especially molecular methods, must be increased and integrated into public health initiatives.

II. EPIDEMIOLOGY OF GIARDIASIS IN THE PHILIPPINES

Giardia duodenalis is the causative agent of giardiasis, a significant global health concern. According to the World Health Organization [16], an estimated 28.2 million cases of diarrhea are attributed to this disease annually, predominantly affecting children and immunocompromised individuals. The burden of giardiasis is particularly pronounced in developing countries, where inadequate sanitation and contaminated water sources facilitate its transmission [9,17]. The disease primarily spreads via the fecal-oral route through the consumption of contaminated water or food. It is especially prevalent in areas with insufficient water treatment and limited access to safe drinking water [7,18], with the risk further heightened during the wet season when flooding exacerbates water source contamination [17].

In the Philippines, giardiasis is a major public health concern. The prevalence rate was documented at 22.05% in this cross-sectional study among residents of a slum area in Manila, which has been attributed to environmental contamination, poor sanitation, and lack of clean water [7]. A nationwide survey conducted by Natividad et al. [8] showed interregional differences, with Mindanao accounting for the highest prevalence of 3.6%, followed by Luzon and Visayas at 1.9% and 0.9%, respectively. These data imply the vulnerability of populations in areas with suboptimal living conditions [8]. This is a major concern, as the disease often particularly affects children and those living in urban slums or rural settings. Several studies have reported a higher prevalence among children [7] and males [8], though these data were outdated, and recent investigation is needed to validate these findings.

In the Philippines, environmental factors have been identified as significant contributors to the transmission of giardiasis. A study by Vejano et al. [19] conducted in Laguna Lake and its tributaries revealed the presence of *G. duodenalis* in 37.7% of samples collected from tributary rivers and 16.7% from the lake itself. The study found that assemblage A was the predominant genotype, highlighting a clear risk of zoonotic transmission. The assembly on both sides identified the carrier stage of Assembly A as belonging to humans and animals, indicating a high risk of zoonotic transmission [19]. Furthermore, a more thorough analysis of numerous water bodies by Onichandaran et al. [17], including ponds, rivers, and swimming pools, revealed that 45.5% of water samples contained *Giardia* cysts, indicating widespread environmental contamination and highlighting the urgent need for better water sanitation. [17].

These studies primarily rely on traditional diagnostic techniques like microscopy, which have a limited scope and may result in a significant underestimation of the true prevalence of giardiasis in the Philippines. Advanced diagnostic methods, such as polymerase chain reaction (PCR), are recommended for their superior sensitivity in detecting and genotyping *Giardia* [8,18]. Additionally, this waterborne disease often coexists with other pathogens like *Cryptosporidium*, complicating both diagnosis and public health interventions [8,17].

To address these gaps, future epidemiological research should emphasize the use of molecular diagnostic tools and investigate the socioeconomic and environmental factors influencing giardiasis prevalence. Improvements in water sanitation infrastructure and targeted public health campaigns promoting hygienic practices are crucial to reducing the burden of giardiasis, particularly in vulnerable populations at heightened risk of infection.

III. DIAGNOSTIC METHODS FOR GIARDIASIS

Considering its diverse clinical manifestations and significant public health implications in the Philippines, precise diagnosis of giardiasis is essential [10]. A variety of diagnostic techniques are available, including microscopy, molecular methods, antigen detection, and innovative approaches such as microRNA-based detection [10,20] (Table 1). Employing a combination of these methods can improve diagnostic accuracy, especially in cases with low parasite loads or sporadic cyst shedding [10,20].

Traditionally, stool microscopy has been the cornerstone of giardiasis diagnosis in the Philippines. Microscopic identification of *Giardia* spp. in fecal specimens is regarded as the definitive method for diagnosing giardiasis. This technique is employed to identify cysts and trophozoites. To increase diagnostic yield, though, its sensitivity varies from 50% to 70% depending on the parasite load and the observer's expertise; it also usually requires the analysis of several stool samples taken on several days. Notwithstanding these constraints, microscopy is still extensively used in fields with limited resources since it is cheap and can simultaneously detect co-infections with other intestinal parasites, so acting as a valuable tool [10,20].

Molecular diagnostics, particularly polymerase chain reaction (PCR), have emerged as the gold standard for giardiasis diagnosis [11]. With the added benefit of genotyping *Giardia* into Assemblages A and B, which are absolutely vital for knowledge of zoonotic transmission, PCR-based methods including real-time PCR exhibit high sensitivity and specificity [14]. Duodenal biopsy together with PCR or histopathological analysis is utilized in chronic cases where fecal samples do not yield positive results to enhance detection [13]. Although PCR is the recommended approach for giardiasis diagnosis, its great cost causes practical difficulties. Offering PCR diagnostic treatments is difficult, particularly in underdeveloped nations with limited tools and infrastructure [11].

Antigen detection methods, including immunoassay techniques such as enzyme-linked immunosorbent assays (ELISAs) and rapid antigen detection tests (RDTs), like non-enzymatic immunochromatographic assays, are used to identify *G. intestinalis* antigens in human fecal samples [12,14]. These tests, which target specific *Giardia* antigens in stool specimens, offer sensitivity and specificity rates exceeding 90% [12]. While they are highly effective in high-throughput diagnostic environments, their widespread use in the Philippines is hindered by the high cost of test kits and limitations in supply chain logistics [11]. Fluorescence microscopy, which detects cysts stained with fluorochrome-labeled anti-cyst antibodies, is another option but is subjective and relies heavily on the training and expertise of the observer, limiting its accessibility. Emerging technologies, such as fluorescent microsphere-based assays (Luminex) and loop-mediated isothermal amplification (LAMP), show promise as advanced diagnostic tools [14].

Emerging tools including microRNA-based diagnostics and loop-mediated isothermal amplification (LAMP) have great potential to detect giardiasis. LAMP is best for field use in areas with limited resources since it runs at a constant temperature, so removing the need for thermal cycling [14]. *Giardia*-specific microRNAs (e.g., miR5 and miR6) have shown great sensitivity and specificity in recent studies, so providing a non-invasive substitute that might enhance current approaches. Although these technologies are still in experimental phases, in the Philippines they are a vital area for next investment and study [15].

In the Philippines, comparative research has highlighted the shortcomings of relying solely on conventional microscopy for diagnosing giardiasis. A study by Yason and Rivera [7] in a Manila slum area revealed a higher prevalence of *Giardia* infections than previously reported, demonstrating the improved diagnostic sensitivity achieved by combining PCR with microscopy. Their findings showed that both assemblages A and B affect human and animal hosts, suggesting a potential zoonotic risk. This underscores the need to improve diagnostic methods to inform targeted health policies [7].

To address the challenges of diagnosing giardiasis in the Philippines, it is essential to adopt molecular, antigen-based, and emerging diagnostic tools. The goal is to advance research into the latest diagnostic technologies and ensure these tools are both affordable and accessible, facilitating their integration into regional healthcare systems, particularly in developing countries where giardiasis is widespread but resource limitations hinder accurate diagnosis.

A summary table of various diagnostic methods for giardiasis is presented below, highlighting the importance of assessing the strengths, limitations, and suitability of each method based on the available resources and healthcare infrastructure in different areas. This will help guide the selection of the most appropriate diagnostic approach to enhance accuracy and treatment efficacy.

Table 1. A comparative analysis of the currently available diagnostic methods used in studies for detecting giardiasis.

Diagnostic Method	Purpose and Findings	Reference
Enzyme-linked immunosorbent assay (ELISA)	Tests stool samples with great sensitivity (up to 95%) and specificity (100%) for *Giardia*-specific antigens including GSA-65. Especially in low-intensity infections, ELISA detects more cases than microscopy.	[12]
Rapid immunochromatographic tests (RDTs)	Uses visual indicators to detect *Giardia* antigens in stool samples, so generating quick, point-of-care diagnosis. Results are available in 10–15 minutes, making this method suitable for field and resource-limited settings.	[14]
Polymerase Chain Reaction (PCR)	Detects *Giardia* DNA in stool samples with high sensitivity and specificity. Multiplex PCR enables many protozoan parasites be simultaneously detected, while nested PCR increases the detection of low parasite loads.	[14]

Real-time PCR	Amplifies and quantifies *Giardia* DNA in stool samples to provide high sensitivity for low parasite loads moderate or asymptomatic infections detection.	[20]
Duodenal biopsy with PCR/Histopathology	An advanced method used in persistent or chronic cases. Histopathology and imprint cytology can identify trophozoites, while PCR on biopsy samples improves diagnostic yield, detecting cases missed by stool-based methods.	[13]
MicroRNA-based detection	Identifies *Giardia*-specific miRNAs (e.g., miR5, miR6) in duodenal biopsy and stool samples. This emerging method demonstrates high sensitivity and could outperform traditional DNA-based diagnostics for biopsy samples.	[15]
Loop-mediated isothermal amplification (LAMP)	A rapid and cost-effective molecular method that amplifies *Giardia* DNA at a constant temperature without requiring thermal cycling. LAMP is ideal for resource-limited settings due to its simplicity and efficiency.	[14]
Fluorescent microsphere-based assays	Uses tools like Luminex to combine immunological and molecular detection. Large-scale epidemiological investigations can benefit from the simultaneous identification of *Giardia* and other diseases made possible by these high-throughput tests.	[14]

IV. PATHOGENESIS AND TRANSMISSION

Giardia duodenalis causes giardiasis through two life stages: the trophozoite and the cyst. The infection occurs when individuals ingest cysts, which are environmentally resistant, from contaminated food, water, or infected persons [1,4]. The trophozoites use ventral disks to attach to the intestinal epithelium, resulting in mechanical damage to the brush border, shortening of microvilli, and increased intestinal permeability, which leads to nutrient malabsorption [4,7]. The parasite’s proteases further disrupt the intestinal barrier, contributing to diarrhea and malabsorption, particularly during acute infections [4]. In the Philippines, chronic cases of malnutrition, stunted growth, and cognitive impairments present serious public health issues, particularly among children [3,7].

Multiple routes spread giardiasis in the Philippines. The most common route of transmission is waterborne, with *Giardia* cysts found in rivers, recreational pools, and Laguna Lake, the country's largest inland lake. The most common zoonotic genotype in environmental samples is Assemblage A, indicating widespread water contamination [7,19]. In densely populated urban slums and institutional settings such as daycare centers, person-to-person transmission is also prevalent, facilitated by asymptomatic carriers who shed infective cysts [3,7]. Giardiasis persists due to livestock and domestic animal zoonotic transmission, as Assemblages A and B have been found in the Philippines [7,19]. Although understudied, foodborne transmission can occur through cyst contamination during irrigation or food handling [3,6].

Environmental and socioeconomic factors significantly influence the transmission dynamics of giardiasis in the Philippines. The country's growing population, inadequate sanitation infrastructure, and high poverty rates contribute to the persistence of the disease [7,17]. Rural communities reliant on untreated water sources and urban slums with insufficient waste disposal systems are particularly vulnerable to giardiasis [3,7]. Giardiasis is common in rural and urban slums with poor waste disposal and untreated water. A Manila slum study found 22.05% prevalence, mostly associated with Assemblage B. *Giardia* cysts were found in 37.7% of tributary river samples in Laguna Lake, indicating widespread environmental contamination of water sources [19].

Giardiasis affects public health as well as individual health. Children and immunocompromised people are most at risk of malnutrition, stunted growth, and chronic gastrointestinal issues [3,4,7]. Seasonal transmission peaks during the rainy season complicate control [3,19]. Due to the high cost of treatment, it put a strain financially on the community, and loss of productivity also affects the economy. So, to address the issue on giardiasis it is needed to improve water monitoring, health education, and invest more in diagnostic tools. For targeted interventions, molecular epidemiology and environmental surveillance should be given more importance.

V. TREATMENT AND VACCINE

Currently, no commercial vaccine is available to prevent giardiasis, although ongoing global research and experimental animal studies have shown promising potential. The parasite's ability to alter its surface antigens poses significant challenges to vaccine development. To date, no vaccination campaigns specific to the Philippines have been conducted [1,4,21]. Collaborative efforts between local and international research institutions could play a crucial role in advancing vaccine development for giardiasis [21].

Nitroimidazoles, such as metronidazole and tinidazole, are used for treatment, with the latter preferred because of its single-dose regimen and less side effects [1,6]. For circumstances where nitroimidazoles are not effective, other drugs such as albendazole and nitazoxanide are used. Nitroimidazoles are becoming less used; treatment failures in some areas are recorded at 20%. [22–24]. Reduced drug activation pathways in *Giardia*, such as pyruvate ferredoxin oxidoreductase activity or nitroreductase enzyme changes, affect the parasite's susceptibility to nitroimidazoles [22,25]. Access to alternative treatments is particularly limited in rural areas [24]. Due to its limitations, searching for alternative treatments is important to address issues of drug resistance and for effective treatment. Plant-based phytochemicals, Lactobacillus probiotics, and nanotechnology may treat *Giardia* infections by targeting the parasite's adhesion mechanisms and boosting the host immune response [4,6].

Without vaccines, sanitation, hygiene, and water safety take front stage in prevention. Essential practices are hand washing, safe food management, boiling or filtering of drinking water [4,5]. Environmental factors like warm, humid climates and widespread water pollution aggravate the higher transmission risks even more [1,22]. Public education and infrastructure improvements are essential to reducing giardiasis. [5,21].

In the Philippines and neighboring countries, poverty and insufficient sanitation infrastructure contribute significantly to the high burden of diseases. The limited documentation of resistance trends in the Philippines underscores the urgent need for localized research to guide public health policies effectively. Priorities should include the development of region-specific vaccines for *Giardia*, improved access to second-line treatments, and initiatives to enhance sanitation infrastructure and public health education [5,22,23].

VI. FUTURE DIRECTIONS

Giardiasis remains a significant public health challenge in the Philippines, particularly in underserved regions with inadequate water and sanitation infrastructure. The disease contributes to malnutrition, developmental stunting, and cognitive impairments, especially in children and impoverished communities. Despite being both preventable and treatable, the persistent high prevalence, environmental contamination, and zoonotic transmission emphasize the urgent need to address gaps in water sanitation and public health infrastructure.

While advancements in molecular diagnostics for giardiasis could enhance disease detection, the high costs and limited availability of resources in the country hinder the widespread use of these technologies. Furthermore, current epidemiological data is outdated, necessitating renewed efforts to accurately assess the burden of giardiasis and understand its transmission dynamics in the Philippines.

To effectively combat giardiasis, the Philippines must invest in public health campaigns and Water, Sanitation, and Hygiene (WASH) programs that emphasize hygiene, safe water handling, and early diagnosis. Public healthcare systems should prioritize the adoption of molecular diagnostic tools to improve detection and facilitate access to alternative treatments, addressing the challenge of drug resistance. Policymakers should focus on enhancing water treatment and waste management systems to mitigate environmental risks. Additionally, collaborative research between local and international institutions is essential for developing vaccines and supporting resource-limited disease control campaigns. By prioritizing these critical areas, the Philippines can significantly reduce giardiasis prevalence and its associated health impacts, ultimately improving the quality of life in affected communities.

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