

Review Article

The Intersection of Digital Health and Fascioliasis: A Narrative Review

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(Received 01 Sep 2026; accepted 26 Sep 2026)

Abstract

Fascioliasis, a foodborne and waterborne zoonotic disease caused by the liver flukes *Fasciola hepatica* and *F. gigantica*, remains a critical neglected tropical disease (NTD) that undermines public health and agricultural economies worldwide. Traditional control measures are hindered by late-stage clinical detection, a shortage of trained microscopists in endemic rural sectors, and a lack of active, unified surveillance. This paper examines how digital health innovations—specifically artificial intelligence (AI) computer vision, mobile health (mHealth), and geographic information systems (GIS)—are modernizing the diagnosis, treatment management, and epidemiological mapping of fascioliasis. By transitioning diagnostics from manual microscopy to expert-verified edge AI and integrating climate-driven machine learning models, digital health offers a scalable framework to achieve the WHO control targets.

Keywords: Fascioliasis; Digital health; Parasitology; Artificial intelligence

Introduction

Fascioliasis, or liver fluke infection, is caused by two parasitic agents: *Fasciola hepatica* and *F. gigantica*. It is a zoonotic disease shared between humans and ruminants. Within the human body, the parasite inhabits the bile ducts and the gallbladder. Humans and ruminants serve as the definitive hosts, while the intermediate host is an amphibious snail of the genus *Lymnaea* (1, 2). The two species *F. hepatica* and *F. gigantica* differ in terms of geographical distribution, intermediate and definitive hosts, morphology, and pathogenicity; however, accurately distinguishing between them is challenging. Distinguishing these two species is of particular importance for the prevention and implementation of control strategies for fascioliasis (3, 4).

Symptoms of the disease manifest in two stages—migration and establishment. The first stage involves colicky pain in the right upper abdominal quadrant, allergic reactions, fatigue, fever, and weight loss, primarily resulting from the migration of young immature parasites through the liver parenchyma. Once the parasite settles in the deep bile ducts, the aforementioned symptoms subside and signs of the establishment stage emerge; these include hyperplasia and hypertrophy of the bile ducts, hepatomegaly, obstructive jaundice, normochromic-normocytic anemia, and occasionally gallstones. Fibrosis and cirrhosis are generally not observed in humans, and fatal cases are extremely rare. The parasite can live for up to 13 years (1, 5).



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The reference method—or gold standard—for diagnosing the disease is stool examination to detect parasite eggs; however, this method lacks high sensitivity for the following reasons, making the use of complementary methods advisable: a) There is a lag of approximately three months between the ingestion of metacercariae and the excretion of eggs in the stool; consequently, diagnosing the disease during the acute phase using this method is not possible. b) The parasite's egg-laying rate is low, rendering standard stool examination methods ineffective for accurate diagnosis and necessitating specialized techniques such as the Kato-Katz method. c) Ingestion of infected liver can lead to the excretion of parasite eggs (transient infection), resulting in a false-positive stool test. Therefore, the ELISA method is currently the best diagnostic approach; specifically, the use of parasite excretory-secretory antigens significantly enhances the test's reliability (6, 7).

Cases of this disease have been reported globally in more than 60 countries. Worldwide, 2.6 million people are estimated infected with *Fasciola* spp., and over 180 million to be at risk (8, 9). According to the WHO, the disease was estimated to cause approximately 90,000 Disability Adjusted Life Years (DALYs) (8). The annual financial loss caused by fascioliasis amounts to over \$3 billion. These losses primarily affect the veterinary sector, particularly the livestock production and processing industries and the associated food supply chain. Impoverished nations are disproportionately affected by this problem (10, 11).

Given the significance of fascioliasis, it is crucial to re-evaluate diagnostic and treatment methods.

As previously noted, coprological diagnosis is prone to numerous errors and limitations; furthermore, distinguishing between acute and chronic cases—as well as detecting the disease following standard treatment—is extremely difficult and highly susceptible to error (1).

Digital health integration addresses these limitations by introducing decentralized, automated, and predictive toolsets. This paper synthesizes current innovations in AI-driven point-of-care diagnostics, geospatial One Health ecosystems, and mHealth tools aimed at controlling fascioliasis.

Digital Health Applications Across Fascioliasis Management

To improve disease monitoring and control, the following digital health approaches should be considered:

Automated Diagnosis via AI-Driven Microscopes

Advanced digital health systems—such as the Kubic FLOTAC Microscope (KFM)—utilize deep learning algorithms to rapidly scan microscopic images and automatically detect and quantify *Fasciola* eggs with high accuracy and minimal error (12).

As summarized in Table 1, integrating human-in-the-loop validation with edge-AI systems significantly improves diagnostic accuracy while minimizing error rates associated with fully autonomous pipeline regarding Soil transmitted helminths and fascioliasis.

Table 1: Comparison of manual microscopy, autonomous AI, and expert-verified AI for diagnosis (12, 13, 14)

Diagnostic Metric	Manual Microscopy	Autonomous AI	Expert-Verified AI
Sensitivity (Light Infections)	Moderate-Low (Often missed)	High (Prone to artifact noise)	Exceptional (>92-94%)
Specificity	High (Expert dependent)	Variable (Artifact confusion)	Excellent (>97%)
Processing Speed	Slow (~30 mins/sample)	Fast (<1 min/slide)	Optimized (~2-3 mins/slide validation)
Infrastructure Needed	Laboratory environment	High-power computing	Low (Smartphone + Edge adapter)

Predicting Disease Outbreaks Using Big Data and AI

The *Fasciola* parasite requires freshwater snails and humid climatic conditions to complete its life cycle (5). Using digital health technologies, researchers feed environmental data—including meteorological parameters and satellite imagery on soil moisture, vegetation cover, and climate variables—into artificial intelligence models. These predictive frameworks analyze transmission dynamics and forecast high-risk rural areas, enabling public health authorities to implement timely vector control and preventive interventions months before potential outbreaks (15-17).

Telemedicine and Health Monitoring Platforms in Underserved Areas (Mobile Health & Remote Care)

Because this disease predominantly affects rural and nomadic populations with limited access to specialized medical care, digital health solutions can help bridge this gap (18).

Mobile Health (mHealth) Applications: Livestock owners and community health workers can utilize mobile applications to log clinical observations—such as fever, abdominal pain, or jaundice in suspected human cases and characteristic symptoms in livestock—enabling rapid reporting and early disease detection (19, 20, 21). These apps standardize clinical protocols and guide safe treatment pathways.

Telemedicine: Specialized physicians in major urban centers can remotely evaluate patients' liver function tests and ultrasonographic findings, enabling prompt prescription of targeted anthelmintic therapy (such as triclabendazole) (19, 20, 21).

Antibody Detection Devices: Using a simple fingerstick blood sample, a rapid test produces visible bands indicating exposure. The operator captures an image of the test strip using a smartphone camera, and an embedded diagnostic app computes the pixel density of the test band, reducing user subjectivity in reading faint lines (22).

One Health Surveillance & Geospatial Mapping

The "One Health" concept is based on the principle that the health of humans, animals (livestock), and the environment is inextricably linked. Fascioliasis lies precisely at the intersection of these three domains:

Humans: Definitive hosts and those affected by the disease;

Livestock (cattle and sheep): Primary reservoirs of the disease and the source of economic loss;

Environment: Presence of *Lymnaea* snails in freshwater, soil moisture, and vegetation cover.

Consequently, controlling transmission requires a One Health framework that links human, veterinary, and environmental health variables (23).

Predictive Environmental Modeling via GIS

By utilizing GIS paired with machine learning, epidemiologists can map risk surfaces based on satellite-derived ecological indicators. Satellites monitor key parameters such as the Normalized Difference Vegetation Index (NDVI), surface temperature, and rainfall patterns. AI models parse these inputs to forecast the distribution of lymnaeid snail populations. This spatial intelligence enables public health agencies to deliver targeted preventive chemotherapy (triclabendazole) to high-risk zones before major outbreaks unfold (19, 23).

Integrated Genomic and Travel Networks

Centralized digital bio-platforms allow veterinary officers and clinicians to log phenotypic data alongside precise geographic coordinates. Platforms such as *WormBase ParaSite* <https://parasite.wormbase.org/index.html> integrate genomic and geospatial datasets, enabling researchers to trace selection markers for drug resistance—particularly against triclabendazole (TCBZ), the frontline anthelmintic agent recommended by the WHO (24). Additionally, emerging digital monitoring systems implemented at cross-border transport hubs record travel and movement histories from hyperendemic regions, helping prevent the re-establishment of parasites into cleared geographical domains (2, 20).

Technical Obstacles and Future Guidelines

Despite compelling proof-of-concept successes, the wide-scale deployment of digital health frameworks in NTD management faces several challenges:

Algorithmic Bias and Sample Noise: AI models optimized on pristine laboratory slides often suffer significant performance degradation when processing real-world clinical samples. Fecal debris, plant fibers, and air bubbles create confounding artifacts that escalate false-positive rates if the model's training data lacks heterogeneity (13, 14). In addition, there is the difficulty of distinguishing *Fasciola* eggs from morphologically similar trematodes (e.g., *Fasciolopsis buski*) using current object-detection architectures (6).

The Digital Divide and Operational Literacy: The deployment of edge AI and cloud-linked diagnostic networks assumes basic digital literacy, steady electrical grids, and hardware accessibility. If target communities lack sustainable access to smartphones or technical training, digital diagnostic tools risk exacerbating health disparities between connected urban clinics and isolated endemic zones (14, 20).

Future efforts should focus on building open-access, multi-institutional repositories containing annotated images of *Fasciola* eggs alongside overlapping helminths. Standardizing training datasets can help build resilient, generalized computer vision networks capable of operational deployment across globally diverse field conditions (18, 20).

Conclusion

Digital health innovations offer transformative potential for modernizing the management, diagnostic accuracy, and epidemiological surveillance of fascioliasis. By integrating human-in-the-loop edge AI, GIS-driven environmental modeling, and mHealth platforms, decentralized care can reach vulnerable rural and nomadic communities. Furthermore, leveraging cross-border tracking and genomic bio-platforms within a unified One Health ecosystem strengthens proactive outbreak prevention and drug-resistance monitoring.

However, overcoming key operational hurdles—such as algorithmic sample noise and the digital infrastructure divide—remains essential for sustainable field deployment. Standardizing open-access diagnostic repositories may ultimately pave the way for resilient digital toolsets to achieve the WHO control targets.

Acknowledgments

No financial support was received for this study.

Conflict of interest

The author declares no conflict of interest.

References

1. Rokni MB. *Fasciola hepatica* and *F. gigantica*. In: Motarjemi Y, ed. *Encyclopedia of food safety*. ELSEVIER Publication; 2014:140-145.
2. Mas-Coma S. Human fascioliasis emergence risks in developed countries: From individual patients and small epidemics to climate and global change impacts. *Enferm Infecc Microbiol Clin (Engl Ed)*. 2020;38:253-256.
3. Mas-Coma S, Bargues MD, Valero MA. Fascioliasis and other plant-borne trematode zoonoses. *Int J Parasitol*. 2005;35:1255-1278.
4. Rokni MB, Lotfy WM, Ashrafi K, Murrel D. Fasciolosis in the MENA region. In: McDowell MA, Rafati S, eds. *Neglected Tropical Diseases - Middle East and North Africa*. Springer Vienna; 2014:59-90.
5. Mas-Coma S, Bargues M. Human liver flukes: A review. *Res Rev Parasitol*. 1997;57:145-218.
6. Rokni MB, Massoud J, O'Neill SM, Parkinson M, Dalton JP. Diagnosis of human fasciolosis in the Gilan province of northern Iran: Application of cathepsin L-ELISA. *Diagn Microbiol Infect Dis*. 2002;44:175-179.
7. Espinoza JR, Timoteo O, Herrera-Velazquez P. Fas2-ELISA in the detection of human infection by *Fasciola hepatica*. *J Helminthol*. 2005; 79(3):235-40.
8. World Health Organization. Report of the WHO informal meeting on use of triclabendazole in fascioliasis control, who headquarters, Geneva, Switzerland, 17–18 october 2006. *WHO/CDS/NTD/PCT/2007.1*. 2007:01-38.

9. Havelaar AH, Kirk MD, Torgerson PR, Gibb HJ, Hald T, Lake RJ, et al. World health organization global estimates and regional comparisons of the burden of foodborne disease in 2010. *PLoS Med.* 2015;12:e1001923.
10. May K, Bohlsen E, König S, Strube C. *Fasciola hepatica* seroprevalence in northern German dairy herds and associations with milk production parameters and milk ketone bodies. *Vet Parasitol.* 2020;277:109016.
11. Caravedo MA, Cabada MM. Human fascioliasis: Current epidemiological status and strategies for diagnosis, treatment, and control. *Res Rep Trop Med.* 2020;11:149-158.
12. Capuozzo S, Maurelli MP, Marrone S, Celano B, Martone G, Vitiello P, et al. A dedicated deep learning workflow for automatic *Fasciola hepatica* and *Calicophoron daubneyi* egg detection using the kubic flotac microscope. *Int J Parasitol.* 2026;56:104719.
13. von Bahr J, Suutala A, Kucukel H, Kaingu H, Kinyua F, Muinde M, et al. AI-supported versus manual microscopy of Kato-Katz smears for diagnosis of soil-transmitted helminth infections in a primary healthcare setting. *Sci Rep.* 2025;15:20332.
14. von Bahr J, Suutala A, Diwan V, Mårtensson A, Lundin J, Linder N. AI-supported digital microscopy diagnostics in primary health care laboratories: Scoping review. *J Med Internet Res.* 2026;28:e78500.
15. Fox NJ, White PCL, McClean CJ, Marion G, Evans A, et al. Predicting Impacts of Climate Change on *Fasciola hepatica* Risk. *PLoS One.* 2011; 6(1): e16126. doi:10.1371/journal.pone.0016126.
16. Parandin F, Noormohamadi H, Soleymani E, Etemadi S, Mirbadie SR, Rahimi Esboei B, et al. Spatial modeling and risk mapping of human fascioliasis in Iran: A geographical information system-based survey from 2013 - 2022. *Arch Clin Infect Dis.* 2024;19:e148819.
17. Modabbernia G, Meshgi B, Kinsley AC. Climatic variations and fasciola: A review of impacts across the parasite life cycle. *Parasitol Res.* 2024;123:300.
18. Tanabe MB, Caravedo MA, Clinton White A, Jr., Cabada MM. An update on the pathogenesis of fascioliasis: What do we know? *Res Rep Trop Med.* 2024;15:13-24.
19. Mas-Coma S, Bargues MD, Valero MA. Human fascioliasis infection sources, their diversity, incidence factors, analytical methods and prevention measures. *Parasitology.* 2018;145:1665-1699.
20. Rosas-Hostos Infantes LR, Paredes Yataco GA, Ortiz-Martínez Y, Mayer T, Terashima A, Franco-Paredes C, et al. The global prevalence of human fascioliasis: A systematic review and meta-analysis. *Ther Adv Infect Dis.* 2023;10:20499361231185413.
21. Mas-Coma S, Valero MA, Bargues MD. One Health for fascioliasis control in human endemic areas. *Trends Parasitol.* 2023 Aug;39(8):650-667. doi: 10.1016/j.pt.2023.05.009. Epub 2023 Jun 28. PMID: 37385922.
22. Tenda K, van Gerven B, Arts R, Hiruta Y, Merckx M, Citterio D. Paper-based antibody detection devices using bioluminescent bRET-switching sensor proteins. *Angewandte Chemie International Edition.* 2018;57:15369-15373.
23. Moloo A. Human fascioliasis: Review provides fresh perspectives on infection and control. 2018. Information Officer WHO/UCN/NTD. <https://www.who.int/news/item/26-07-2018-human-fascioliasis-review-provides-fresh-perspectives-on-infection-and-control>
24. Marcos L, Maco V, Terashima A. Triclabendazole for the treatment of human fascioliasis and the threat of treatment failures. *Expert Rev Anti Infect Ther.* 2021;19:817-823.