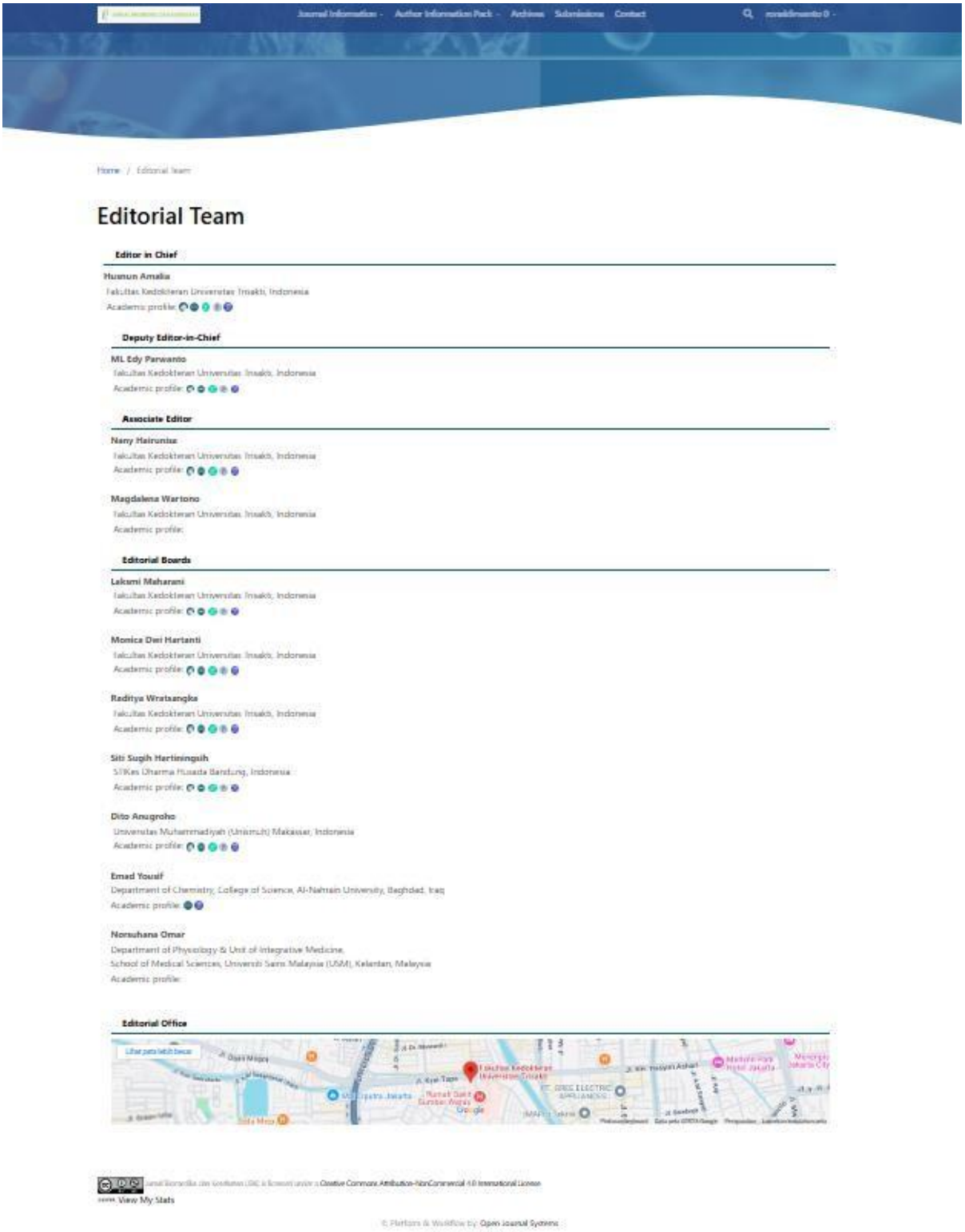
COVER

LAMAN: https://jbiomedkes.org/index.php/jbk/article/view/653

Published: 2025-07-30

EDITORIAL TEAM

LAMAN: https://jbiomedkes.org/index.php/jbk/about/editorialTeam



Home / Editorial team

Editorial Team

Editor in Chief

Husnun Amalia
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Deputy Editor-in-Chief

ML Edy Purwanto
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Associate Editor

Nany Hairunisa
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Magdalena Wartono
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Editorial Boards

Laksmi Maharani
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Monica Dwi Hartanti
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Raditya Wratsangka
Fakultas Kedokteran Universitas Trisakti, Indonesia
Academic profile:

Siti Sugih Hertiningsih
STIKes Dharma Husada Bandung, Indonesia
Academic profile:

Dito Anugroho
Universitas Muhammadiyah (Unismuh) Makassar, Indonesia
Academic profile:

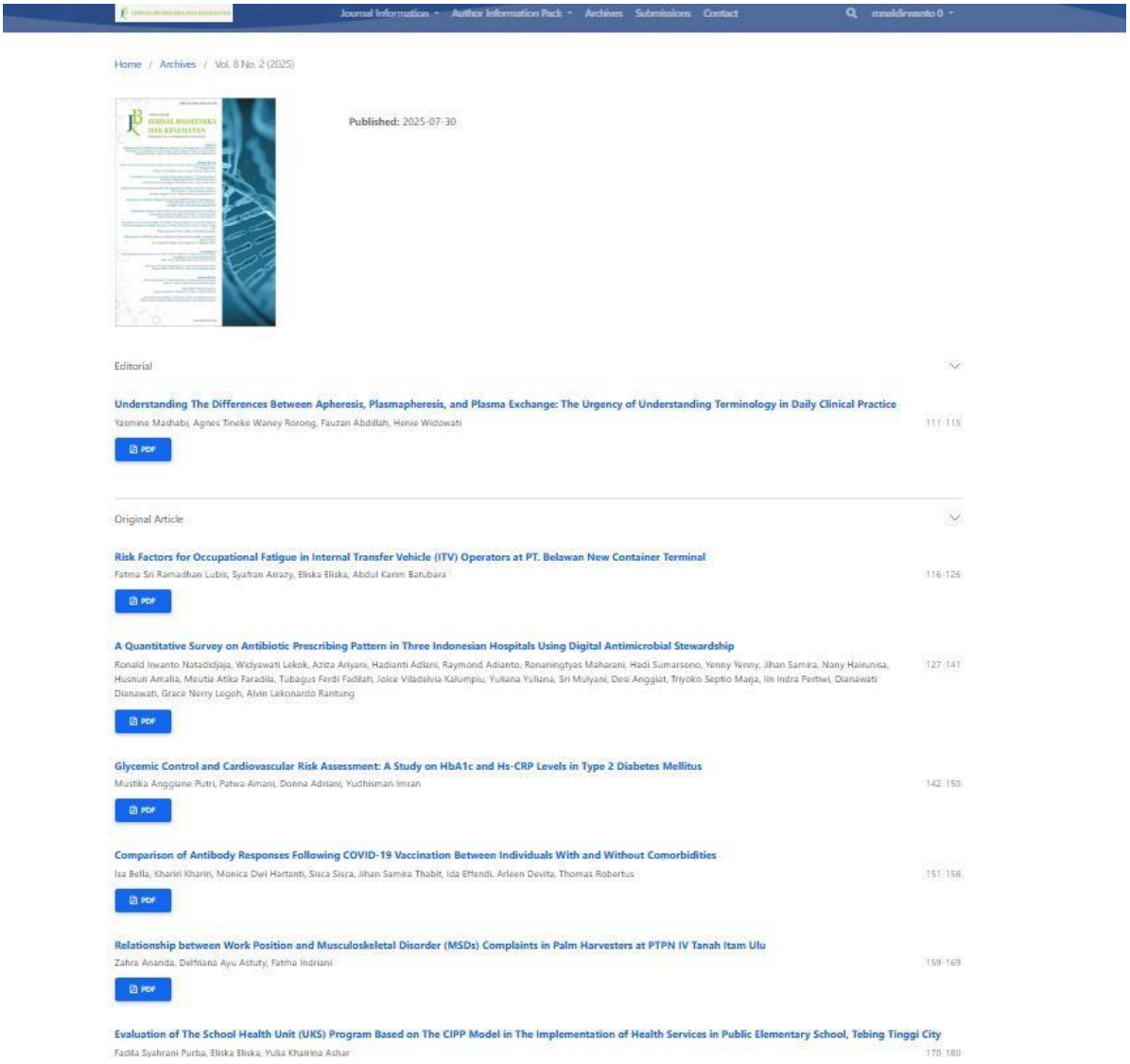
Emad Yousif
Department of Chemistry, College of Science, Al-Nahrain University, Baghdad, Iraq
Academic profile:

Norsuhana Omar
Department of Physiology & Unit of Integrative Medicine,
School of Medical Sciences, Universiti Sains Malaysia (USM), Kelantan, Malaysia
Academic profile:

Editorial Office

DAFTAR ISI

LAMAN: https://jbiomedkes.org/index.php/jbk/issue/view/27



Journal Information · Author Information Pack · Archives · Submissions · Contact · rinaldirwanto 0

Home / Archives / Vol. 8 No. 2 (2025)

Published: 2025-07-30

Editorial

Understanding The Differences Between Apheresis, Plasmapheresis, and Plasma Exchange: The Urgency of Understanding Terminology in Daily Clinical Practice
Yasmine Mashabi, Agnes Tineke Waney Rorong, Fauzan Abdillah, Henie Widowati — 111-115
PDF

Original Article

Risk Factors for Occupational Fatigue in Internal Transfer Vehicle (ITV) Operators at PT. Belawan New Container Terminal
Fatma Sri Ramadhan Lubis, Syafrin Arrazy, Eliska Eliska, Abdul Karim Batubara — 116-126
PDF

A Quantitative Survey on Antibiotic Prescribing Pattern in Three Indonesian Hospitals Using Digital Antimicrobial Stewardship
Ronald Irwanto Natadidjaja, Widyawati Lekok, Aziza Ariyani, Hadianti Adlani, Raymond Adianto, Ronaningtyas Maharani, Hadi Sumarsono, Yenny Yenny, Jihan Samira, Nany Hairunisa, Husnuri Amalia, Meutia Atika Faradila, Tubagus Ferdi Fadilah, Joice Viladelvia Kalumpiu, Yuliana Yuliana, Sri Mulyani, Desi Anggiat, Triyoko Septio Marja, Iin Indra Pertiwi, Dianawati Dianawati, Grace Nerry Legoh, Alvin Lekonardo Rantung — 127-141
PDF

Glycemic Control and Cardiovascular Risk Assessment: A Study on HbA1c and Hs-CRP Levels in Type 2 Diabetes Mellitus
Mustika Anggiane Putri, Patwa Amani, Donna Adriani, Yudhisman Imran — 142-150
PDF

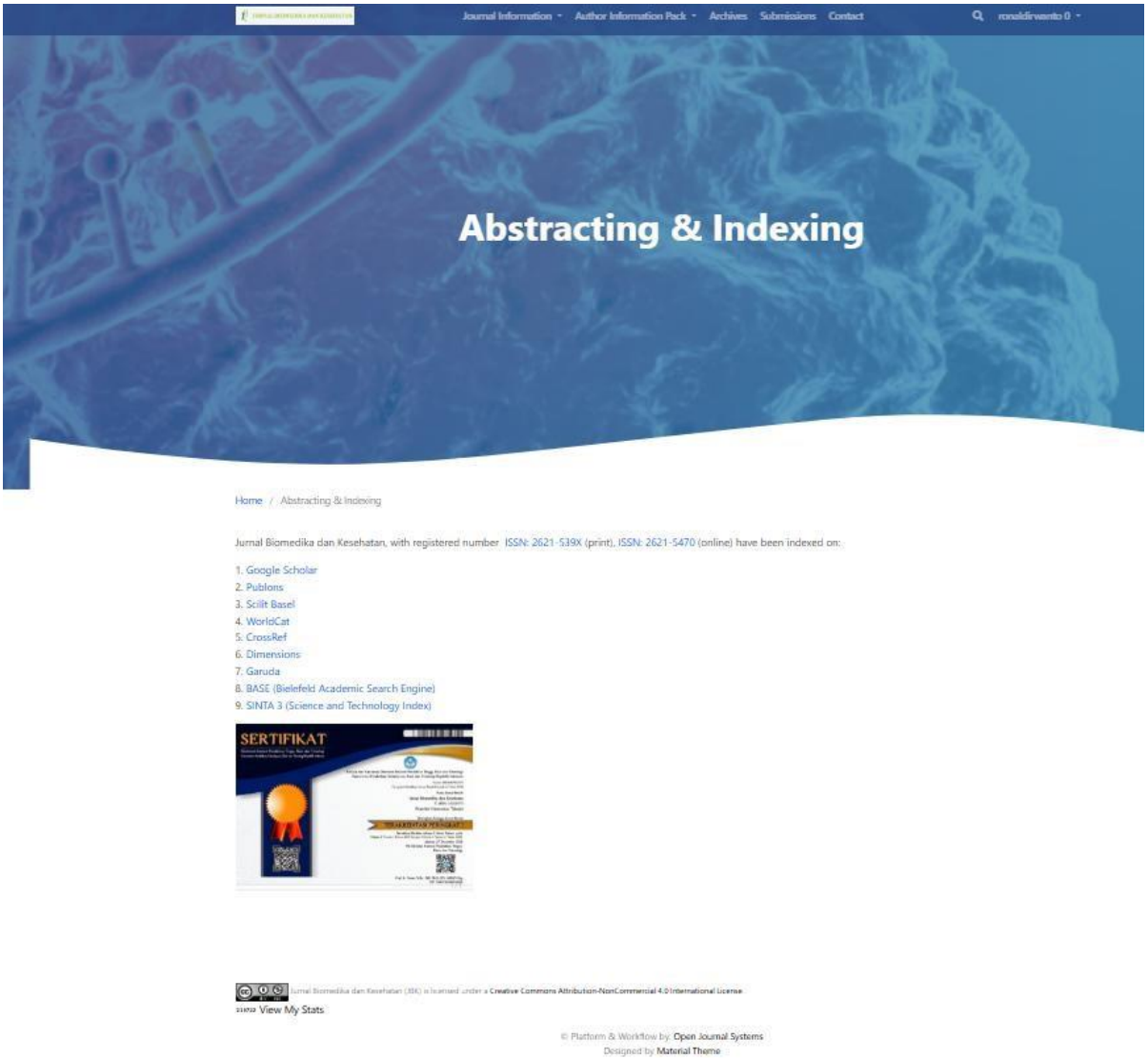
Comparison of Antibody Responses Following COVID-19 Vaccination Between Individuals With and Without Comorbidities
Isa Bella, Khariri Khariri, Monica Dwi Hartanti, Sisca Sisca, Jihan Samira Thabit, Ida Effendi, Arleen Devita, Thomas Robertus — 151-158
PDF

Relationship between Work Position and Musculoskeletal Disorder (MSDs) Complaints in Palm Harvesters at PTPN IV Tanah Itam Ulu
Zahra Ananda, Delfriana Ayu Astuty, Fatma Indriani — 159-169
PDF

Evaluation of The School Health Unit (UKS) Program Based on The CIPP Model in The Implementation of Health Services in Public Elementary School, Tebing Tinggi City
Fadila Syahrani Purba, Eliska Eliska, Yulia Khairina Ashar — 170-180

PERINGKAT JURNAL: SINTA 3

LAMAN: https://jbiomedkes.org/index.php/jbk/indexing



DAFTAR ISI

- **Blood trematodes: Schistosomiasis in Central Nervous System**

Yuliana Yuliana, Machrumnizar Machrumnizar
208-217
    - PDF

RESEARCH ARTICLE

LAMAN: https://jbiomedkes.org/index.php/jbk/article/view/653

Blood trematodes: Schistosomiasis in Central Nervous System

Yuliana Yuliana
Department of Parasitology, Faculty of Medicine, Universitas Trisakti, Indonesia

Machrumnizar Machrumnizar
Department of Parasitology, Faculty of Medicine, Universitas Trisakti, Indonesia

Keywords:

Brain, Schistosoma, Schistosomiasis, Spine, Tropical Disease

Abstract

Schistosomiasis (bilharzia) is a disease caused by blood trematode worms of the genus *Schistosoma, which can be acute or chronic*. There are five species of *Schistosoma* (*S. japonicum, S. mansoni, S. intercalatum, S. Mekongi, and S. haematobium*) known to infect humans, which are distributed across a wide geographic range. Severe clinical symptoms of schistosomiasis infection on the central nervous system (CNS) are caused by the deposition of eggs when adult worms migrate abnormally to the brain or spinal cord. As a result, radiculopathy, myelopathy, increased intracranial pressure, and clinical sequelae occur. Each species shows different tendencies for atopic infections and clinical symptoms. The most common neurological symptom associated with *Schistosoma mansoni* or *S. haematobium* infections is myelopathy, while severe encephalitis is more likely to be caused by *S. japonicum* infections. The symptoms of encephalopathy can manifest as headache, vision disturbances, delirium, convulsions, motor limitations, and ataxia. Spinal abnormalities may lead to backache, lower limb radiating discomfort, muscular weakness, loss of sensation, and urinary impairment. Histopathological analysis, which shows granulomas and *Schistosoma* eggs, is necessary for a definitive diagnosis. Current management involves surgical procedures, steroids, and schistosomicide drugs. Corticosteroids are administered in the acute stage, and praziquantel is given after the female worm begins to lay eggs. If medical intervention fails to relieve compression or medullary degeneration, surgery should be postponed in some instances. The earlier a diagnosis is identified and proper therapy begins, the better the patient's outcome.

PDF

Published
2025-07-30

How to Cite
Yuliana Y, Machrumnizar M. Blood trematodes: Schistosomiasis in Central Nervous System. J Biomedika dan Kesehat [Internet]. 2025 Jul. 30 [cited 2025 Sep. 3];8(2):208-17. Available from: https://jbiomedkes.org/index.php/jbk/article/view/653

More Citation Formats

JURNAL BIOMEDIKA DAN KESEHATAN
(JOURNAL OF BIOMEDIKA AND HEALTH)

Vol. 8 No. 2 (2025) pp. 208-217 e-ISSN: 2621-5470

REVIEW ARTICLE

Blood trematodes: Schistosomiasis in Central Nervous System

Trematoda Darah: Schistosomiasis pada Sistem Saraf Pusat

Yuliana Yuliana[1], Machrumnizar Machrumnizar[1]

[1]Department of Parasitology, Faculty of Medicine, Universitas Trisakti, Indonesia.

machrumnizar_md@trisakti.ac.id

https://doi.org/10.18051/JBiomedKes.2024.v8.208-217

ABSTRACT

Schistosomiasis (bilharzia) is a disease caused by blood trematode worms of the genus *Schistosoma, which can be acute or chronic*. There are five species of *Schistosoma* (*S. japonicum, S. mansoni, S. intercalatum, S. Mekongi, and S. haematobium*) known to infect humans, which are distributed across a wide geographic range. Severe clinical symptoms of schistosomiasis infection on the central nervous system (CNS) are caused by the deposition of eggs when adult worms migrate abnormally to the brain or spinal cord. As a result, radiculopathy, myelopathy, increased intracranial pressure, and clinical sequelae occur. Each species shows different tendencies for atopic infections and clinical symptoms. The most common neurological symptom associated with *Schistosoma mansoni* or *S. haematobium* infections is myelopathy, while severe encephalitis is more likely to be caused by *S. japonicum* infections. The symptoms of encephalopathy can manifest as headache, vision disturbances, delirium, convulsions, motor limitations, and ataxia. Spinal abnormalities may lead to backache, lower limb radiating discomfort, muscular weakness, loss of sensation, and urinary impairment. Histopathological analysis, which shows granulomas and *Schistosoma* eggs, is necessary for a definitive diagnosis. Current management involves surgical procedures, steroids, and schistosomicide drugs. Corticosteroids are administered in the acute stage, and praziquantel is given after the female worm begins to lay eggs. If medical intervention fails to relieve compression or medullary degeneration, surgery should be postponed in some instances. The earlier a diagnosis is identified and proper therapy begins, the better the patient's outcome.

Keywords: Brain; *Schistosoma*; Schistosomiasis; Spine; Tropical Disease.

ABSTRAK

Schistosomiasis adalah suatu penyakit akut sekaligus kronis yang disebabkan oleh cacing trematoda darah dari genus *Schistosoma*. Terdapat lima spesies *Schistosoma* (*S. japonicum, S. mansoni, S. intercalatum, S. Mekongi,* dan *S. haematobium*) yang diketahui menginfeksi manusia dan tersebar di rentang geografis yang luas. Gejala klinis berat akibat infeksi schistosomiasis pada sistem saraf pusat (SSP) disebabkan oleh deposit telur ketika cacing dewasa bermigrasi secara abnormal ke otak atau sumsum tulang belakang. Akibatnya, terjadi radikulopati, mielopati, peningkatan tekanan intrakranial, dan sekuel klinis. Setiap spesies menunjukkan kecenderungan infeksi atopik dan gejala klinis yang berbeda. Gejala neurologis paling umum yang disebabkan oleh infeksi *Schistosoma mansoni* (*S. mansoni)* atau *S. haematobium* adalah mielopati, sementara ensefalitis berat lebih sering terjadi pada infeksi *S. japonicum*. Gejala ensefalopati dapat berupa sakit kepala, gangguan penglihatan, delirium, kejang, keterbatasan motorik, dan ataksia. Kelainan tulang belakang dapat menyebabkan nyeri punggung, rasa tidak nyaman yang menjalar ke tungkai bawah, kelemahan otot, hilangnya sensasi, dan gangguan berkemih. Analisis histopatologi yang menunjukkan granuloma dan telur *Schistosoma* diperlukan untuk diagnosis pasti. Penanganan saat ini mencakup prosedur bedah, steroid, dan obat schistosomisida; kortikosteroid diberikan pada tahap akut, dan praziquantel digunakan setelah cacing betina mulai bertelur. Jika intervensi medis gagal meredakan kompresi atau degenerasi medula, pembedahan dapat dipertimbangkan dalam kasus tertentu. Semakin dini diagnosis ditegakkan dan terapi yang tepat dimulai, semakin baik prognosis pasien.

Kata Kunci: Otak; *Schistosoma*; Schistosomiasis; Tulang Belakang; Penyakit Tropis.

INTRODUCTION

The COVID-19 pandemic and efforts to control it in 2021 resulted in a reduced focus on the part of governments and healthcare providers, particularly on the availability of interventions and treatments for neglected tropical diseases (NTDs), including schistosomiasis.[1–3] Schistosomiasis (bilharzia) is a disease caused by blood trematode worms of the genus *Schistosoma, characterized as both acute and chronic.*[4] Schistosomiasis is prevalent in tropical and subtropical regions, especially in poor communities that do not have access to safe drinking water and adequate sanitation.[5] World Health Organization (WHO) reports that schistosomiasis in all its forms has been transmitted in 78 countries, of which 51 are endemic countries requiring preventive chemotherapy (**Figure 1**).[6]

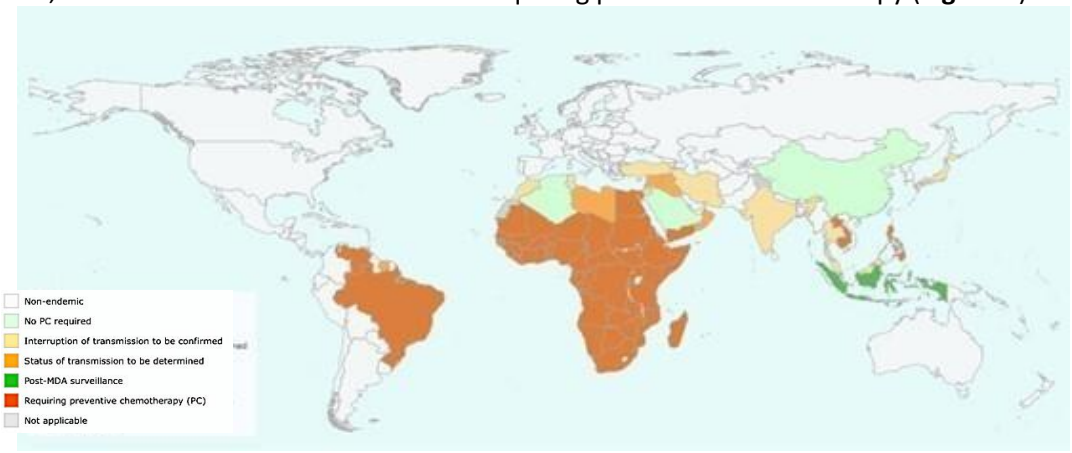


Figure 1. Map of the geographical distribution of schistosomiasis. (Source: https://www.who.int/data/gho/data/themes/topics/schistosomiasis)

It is estimated that around 251.4 million people required preventive treatment for schistosomiasis in 2021, and more than 75 million people have received treatment.[6] There are five species of *Schistosoma* known to infect humans that are distributed across a wide geographic range.[6,7] Infections with *S. japonicum, S. mansoni, S. intercalatum,* and *S. mekongi* have been linked to protracted intestinal and liver fibrosis. In contrast, chronic infections of *S. haematobium* are prone to the

formation of fibrosis, narrowing, and a calcified bladder.[8,9] Ectopic eggs of the species *Schistosoma* migrate to various organs and give rise to clinical manifestations based on the affected organs, such as the skin, brain, muscles, eyes, adrenal glands, and genitourinary system. Granulomas can form in the fallopian tubes, ovaries, and uterus.[9]

The term "neuro-schistosomiasis" refers to schistosomiasis of brain tissue, which is the most severe clinical form of *Schistosoma* infection and can arise either symptomatically or asymptomatically due to the presence of schistosomes.[10] Neuro-schistosomiasis cases have been found in soldiers and workers serving in schistosomiasis endemic areas, as well as in tourists who rarely visit these areas.[11] *Schistosoma japonicum, S. mansoni, and S. haematobium* are common species that cause neuroschistosomiasis. Infection of *S. japonicum* typically leads to acute encephalitis involving the cerebral cortex, basal ganglia, subcortical white matter, or inner capsule. Infections with *S. mansoni* or *S. haematobium* can cause neurological manifestations, particularly myelopathy (acute transverse myelitis and subacute myeloradiculopathy), linked to necrotic inflammation in the lumbar-sacral area.[13,14]

Methods

A literature search was performed between September and October 2023 using the following keywords: "schistosomiasis" OR "*Schistosoma*" OR "infection AND brain AND *Schistosoma*" OR "schistosomiasis AND brain" OR "schistosomiasis AND nervous system AND central" OR "schistosomiasis AND spinal" OR "schistosomiasis AND bone and back." Literature was gathered from electronic databases, including PubMed, Scopus, and Google Scholar, as well as the bibliographies of relevant publications. The search was limited to freely accessible full-text articles in English, but no systematic methodology was applied to the search and selection process.

RESULTS

Life Cycle

Schistosoma has a complex life cycle (**Figure 2**), involving freshwater snails as intermediate hosts and higher vertebrates, such as mammals, as definitive hosts, where *Schistosoma* lives in the bloodstream of these mammals.[15] Click or tap here to enter text. Male and female *Schistosoma* worms mate, with the female residing in the male's ventral gynaecophoric canal. Female *S. mansoni* lays 100–300 eggs daily, *S. haematobium* lays 20–200, and *S. japonicum* lays 500–3,500. Egg shape and location help differentiate species, as they accumulate in the target organ's capillaries.[16] Highly antigenic eggs migrate through the intestinal wall or bladder and are excreted in feces or urine.[16,17]

Once expelled into freshwater, eggs hatch into miracidia within ten days, which infect specific snail intermediate hosts, transforming into sporocysts and later into cercariae. The cercariae, capable of free-swimming for up to 72 hours, must find and penetrate a definitive mammalian host within 12–24 hours to continue the life cycle.[16,17] Each *Schistosoma* species has a distinct snail host in endemic regions; for example, *Oncomelania hupensis* hosts *S. japonicum*, while *Biomphalaria* species host *S. mansoni*. Cercariae penetrate intact skin using suckers and proteolytic enzymes, shed their tails, and migrate via the lymphatic system to the lungs, where they develop immune-resistant schistosomula. These schistosomula travel to the liver's portal vessels, mature into adult worms, and form pairs before migrating to their target organs, completing the life cycle.[18] This complex parasitic process underpins the persistence of schistosomiasis in endemic regions.

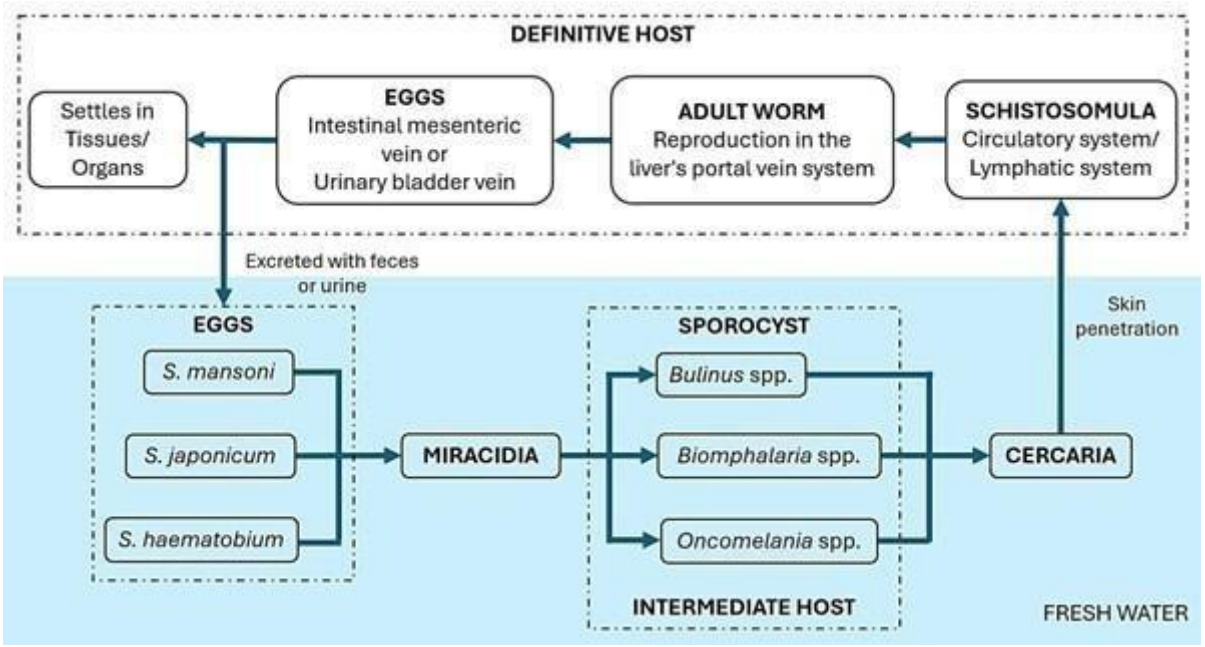


Figure 2. Life cycle of the worm *Schistosoma* spp.

Pathogenesis

After the worms develop into adults, they reproduce and produce eggs. *Schistosoma* can enter the central nervous system. After maturation and reproduction, *Schistosoma* can invade the central nervous system (CNS). Eggs must enter Batson's epidural venous plexus, linking the portal vein and vena cava systems to the spinal cord and cerebral veins, to induce CNS symptoms. Through this route, mature worms may deposit eggs near the CNS or embolize large numbers

from mesenteric vessels. The smaller, spherical eggs of *S. japonicum* can reach the CNS, while the larger eggs of *S. mansoni* and *S. haematobium* are typically confined to the lower vertebral cord.[13,16,19] In chronic hepatosplenic and cardiopulmonary schistosomiasis, venous or arterial invasion mechanisms can result in CNS implication without symptoms.[13,20] . The rare detachment of eggs and the absence of a peri-ovular inflammatory response associated with severe chronic infections result in the lack of symptoms.[20]

Schistosomiasis pathology primarily arises from the intense inflammatory response to trapped eggs, not the worms themselves. Eggs contain miracidia, which can mature into adults within 5–20 days. Chronic disease is driven by host immune reactions and granulomatous responses to antigens, particularly glycoproteins, secreted by miracidia. Granulomas predominantly form in areas where eggs accumulate, *specifically* in the intestines and liver for S. mansoni and *S. japonicum, and* in the genitourinary tract for S. haematobium . [19,21] Granulomas may form in tissues such as the brain, muscles, skin, lungs, and adrenal glands. Perioval granulomas consist of fibroblasts, eosinophils, and plasma cells, with necrotic centers containing egg clusters surrounded by giant cells, lymphocytes, and epithelioid cells. While single eggs are reabsorbed, tissue damage can lead to the development of fibrosis. Chronic infections lead to the formation of calcified eggs and excessive extracellular matrix deposition, resulting from granulomatous inflammation. Immune responses dynamically regulate collagen deposition, crosslinking, contraction, and reabsorption.[21]

Clinical Manifestations

Schistosomiasis of the cerebral

Brain involvement in schistosomiasis is more frequent with *S. japonicum* infections (4–28%) than with other *Schistosoma* species. The primary neurological manifestations are diffuse encephalopathy and seizures. The smaller eggs of *S. japonicum* have a higher likelihood of penetrating the brain.[19] Granulomatous lesions and increased intracranial pressure in the subcortical white matter, cortex, internal capsule, or basal ganglia commonly manifest as neurological disturbances, including fever, headache, nystagmus, speech difficulties, and motor weakness. One possible outcome of high pressure in the brain is papilledema. Neurological symptoms typical of cerebral complications due to infection *S. japonicum* are seizures, both focal and generalized. Brain granulomas caused by *Schistosoma* can trigger partial motor seizures and secondary generalized tonic-clonic seizures. In the absence of systemic infection, partial motor seizures may serve as an early and sole indicator of neuroschistosomiasis.[22] Brain infection-related complications of *S. haematobium* or *S. mansoni* typically affect the brain cortex, cerebellum, and leptomeninges.[23]

Pseudo-tumoral encephalic schistosomiasis (PES), primarily caused by *S. japonicum*, occurs predominantly in individuals aged 10–40 from endemic regions without other schistosomiasis manifestations. While all brain lobes may be affected, the cerebellum, occipital lobe, and frontal lobe are most commonly involved. PES may also present extracerebral lesions on the dura mater's inner surface. Neurological symptoms result from slow-growing brain lesions, edema, and mass effects, leading to increased intracranial pressure, intracranial hypertension, or hydrocephalus. Common symptoms include headaches, motor and sensory disorders, visual disturbances, mental status changes, vertigo, speech disorders, vomiting, and ataxia, with cerebral nerve paralysis and meningeal signs being rare. Diagnosis relies on identifying eggs or granulomas via biopsy, as other diagnostic methods are nonspecific.[24]

Schistosomiasis of the spine

The predominant form of neuroschistosomiasis, spinal cord schistosomiasis (SCS), is primarily caused by *Schistosoma mansoni* and typically occurs without other symptoms of infection.[10,13]

However, previous reports mentioned that SCS occurred during *acute toxemic schistosomiasis* (ATS), immediately afterwards, or simultaneously with hepatosplenic types. SCS is more common in children, adolescents, and young adults than in older people. The clinical manifestations of SCS are classified into three forms: [1] *Medullary form*, primarily involving the spinal cord; [2] *Myeloradicular form*, affecting both the spinal cord and nerve roots; [3] *Conus-cauda equina syndrome*, which is predominantly involved in the *conus* or *cauda equina*. Medullary schistosomiasis typically presents with symmetrical sensorimotor anomalies, rapid progression, and severe weakness. In contrast, conus-cauda equina syndrome progresses more slowly, with asymmetrical sensorimotor changes and milder weakness. The myeloradicular type, the most common form, presents intermediate features and is primarily caused by *S. mansoni* and *S. haematobium.*[25]

Other symptoms in neuroschistosomiasis

Immunocompromised individuals with schistosomiasis may develop cerebral vasculitis, mediated by eosinophil-induced toxicity. During the acute stage, schistosomula have not matured, and eggs are undetectable, as *Schistosoma* begins egg production 1–2 months post- infection. Severe cases, such as *S. mansoni* infestations, can result in hyper-eosinophilic syndrome, leading to ischemic infarctions and chronic endomyocardial fibrosis.[26] Granulomatous inflammation around *Schistosoma* eggs may cause cerebral arterial necrosis, resulting in subacute hematomas, cerebellar hematomas, or subarachnoid hemorrhage. These neurological complications highlight the severe impact of schistosomiasis on the central nervous system.[27]

Diagnosis

Conventional microscopic detection

The parasitological detection of *Schistosoma* eggs in urine or feces is crucial for diagnosing active schistosomiasis, with the Kato-Katz method and the miracidia hatching technique (MHT) considered the "gold standard," particularly in endemic areas. The Kato-Katz method, using 25–50 mg of stool, is valued for its simplicity, cost-effectiveness, and ability to identify species and estimate worm burden. However, it is less effective in detecting low-intensity infections, especially in non-endemic or low-prevalence areas.[28]

The Helmintex test, which employs paramagnetic beads, offers higher sensitivity than the Kato-Katz method but requires further evaluation for cost-effectiveness and field applicability. For superior diagnostic accuracy, rectal biopsy with an ovogram, which has a sensitivity of 95–100%, is often preferred for diagnosing active schistosomiasis.[29,30]

Radiology features of neuroschistosomiasis

Diagnosis of neuroschistosomiasis by neuroimaging using *computerized tomography* scan (CT) and *magnetic resonance imaging* (MRI) can provide effective results. Additionally, CT and MRI can assess the severity of the disease process and its complications in the target organ.[31] CT images in neuroschistosomiasis are associated with inflammatory reactions and granuloma formation due to egg deposition in the brain and spinal cord, generally showing mass lesions with hyperdense centers surrounded by edematous shadows or calcification, and hypodense areas with varying contrast enhancements. Granulomatous lesions are also associated with secondary bleeding.[32]

MRI is effective in diagnosing cerebral and spinal schistosomiasis, revealing masses with scattered or clustered nodular "mud-like" enhancements in cortical or subcortical areas. Spinal schistosomiasis typically presents as lesions accompanied by spinal edema, conus medullaris involvement, cauda equina involvement, and irregular thickening of the cauda equina nerve roots.

MRI also detects spinal cord compression.[24,32] The MRI images of neuroschistosomiasis typically show enlargement of the spinal cord, especially in the ventral area, due to the formation of intramedullary Schistosoma granulomas. These granulomas may appear as unevenly nodular, multiple lesions resembling beaded strands, diverse, highly intense lesions with ill-defined boundaries, or moderate extensions of the distally located medulla that are iso-intense compared to the medulla oblongata.[14] Spinal cord atrophy can be found in longstanding cases.[22]

Immunology detection

Immunological methods for detecting *Schistosoma* antibodies are highly sensitive, cost- effective, and simple, making them useful for early screening and surveillance in endemic areas. These methods, including ELISA, IHA, and immunofluorescence, detect IgG, IgM, or IgE antibodies against soluble egg or adult worm antigens. While serology is beneficial for diagnosing travelers and patients without eggs, such as those with Katayama syndrome, it is less specific compared to fecal screening due to cross-reactivity with other worms [28,30]

Molecular technique

Nucleic acid detection, particularly PCR, offers superior sensitivity and specificity for diagnosing schistosomiasis, effectively detecting *Schistosoma* DNA in various samples, including feces, urine, blood, and environmental specimens. Blood-based PCR is promising for the diagnosis of acute schistosomiasis, while real-time PCR can estimate the burden of *S. mansoni* infection. However, these methods require costly infrastructure and rigorous validation for broader application in control programs.[29,33,34]

Treatment

Praziquantel

A pyrazinoisoquinoline derivative, praziquantel, is a secure schistosomicidal, very potent, and effective oral drug against every adult worm of the *Schistosoma* species.[34] Praziquantel has been widely used since its development in the mid-20th century due to its safety and efficacy. Due to currently no vaccine for immunization, praziquantel has become the backbone of schistosomicidal. The precise mode of action of praziquantel remains undetermined, and while the calcium-ions pathway of *Schistosoma* was recently proposed as a molecular target, the data is yet inconclusive.[35]

Artemether

Artemether and artesunate, derived from *Artemisia annua*, were first identified as anti-*schistosoma*l agents in the 1980s, particularly against *S. japonicum*. These artemisinin derivatives, initially used for malaria, are effective against juvenile *Schistosoma* within the first three weeks of infection. Administering artemether biweekly effectively targets and eliminates schistosomula in humans and animals.[35]

Corticosteroid

For encephalopathy schistosomiasis, prednisone (1.5–2.0 mg/kg daily for three weeks) combined with praziquantel is recommended during the egg-laying period to reduce CNS granulomatous inflammation. However, no randomized trials have confirmed the effects of corticosteroids on the spinal cord. Praziquantel is not advised during acute infection due to its inability to target immature schistosomula (3–21 days). Corticosteroids remain the preferred treatment, while the potential use of artemether, alone or with corticosteroids, for neurologic complications requires further study.[25,36,37]

Disease Prevention

Research on schistosomiasis vaccines, including *S. mansoni* smFABP and DNA-based approaches, shows promising progress. While praziquantel lacks preventive effects, artemether offers prophylactic potential when taken biweekly, effectively targeting all major *Schistosoma* species.[8] In addition to vaccination and alternative medicine, there are several essential factors in efforts to control schistosomiasis, especially in endemic areas[6]: (1) Provide population-based preventive chemotherapy; (2) Ensure a safe water supply; (3) Health education for improved water sanitation; (4) Avoiding urine or stool contaminated with schistosome is a prerequisite; (5) Eradicating snails reduces worm transmission and adds further control. Visitors to endemic regions should be aware of potential exposure to freshwater larvae. Prompt treatment is recommended upon clinical suspicion or confirmed diagnosis of schistosomiasis to reduce disease burden. Topical lotions containing N, N-diethyl-m-toluamide effectively kill *Schistosoma* cercariae with minimal risk to humans.[38]

CONCLUSION

Neuro-schistosomiasis, with symptoms of *Schistosoma* involvement in the CNS, is a serious condition. Despite increasing reports of the disease in endemic areas and among tourists, it remains underdiagnosed. *Schistosoma* infestations can result in harm to the central nervous system and spinal cord. The stage of infection and the clinical form have a significant impact on the etiology, clinical presentation, and prognosis. Reducing irreversible neurological consequences and improving clinical outcomes requires the immediate identification and intervention of these conditions. To effectively treat neuroschistosomiasis, the best treatment is to combine targeted anti-*Schistosoma* treatment with rapid surgical debridement. Early diagnosis, accompanied by prompt and appropriate treatment, can significantly improve a patient's prognosis.

ACKNOWLEDGEMENT

None.

AUTHORS CONTRIBUTION

All authors contributed to this article.

FUNDING

None.

CONFLICT OF INTEREST

All authors declare that they have no conflict of interest concerning the submitted manuscript.

REFERENCES

1. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, et al. Global Challenges to Public Health Care Systems during the COVID-19 Pandemic: A Review of Pandemic Measures and Problems. J Pers Med. 2022;12(1295):1–22.
2. Hrynick TA, Ripoll Lorenzo S, Carter SE. COVID-19 response: Mitigating negative impacts on other areas of health. BMJ Glob Health. 2021;6(4):1–11.
3. Kokaliaris C, Garba A, Matuska M, et al. Effect of preventive chemotherapy with praziquantel on schistosomiasis among school-aged children in sub-Saharan Africa: a spatiotemporal modelling study. Lancet Infect Dis. 2022;22(1):136–49.

4. Abdel-Naser MB, Altenburg A, Zouboulis CC, et al. Schistosomiasis (bilharziasis) and male infertility. Andrologia. 2019;51(1).
5. Phillips AE, Ower AK, Mekete K, et al. Association between water, sanitation, and hygiene access and the prevalence of soil-transmitted helminth and schistosome infections in Wolayita, Ethiopia. Parasit Vectors. 2022;15(1).
6. World Health Organization. WHO guideline on control and elimination of human schistosomiasis. 2022. Available from: https://iris.who.int/bitstream/handle/10665/351856/9789240041608-eng.pdf?sequence=1
7. Rey O, Webster BL, Huyse T, et al. Population genetics of African Schistosoma species. Vol. 89, Infection, Genetics and Evolution. Elsevier B.V.; 2021.
8. McManus DP, Bergquist R, Cai P, et al. Schistosomiasis—from immunopathology to vaccines. Vol. 42, Seminars in Immunopathology. Springer; 2020. p. 355–71.
9. McManus DP, Dunne DW, Sacko M, et al. Schistosomiasis. Nat Rev Dis Primers. 2018 Dec 1;4(1).
10. Carbonell C, Rodríguez-alonso B, López-bernús A, et al. Clinical spectrum of schistosomiasis: An update. J Clin Med. 2021;10(23).
11. Aula OP, McManus DP, Jones MK, et al. Schistosomiasis with a focus on Africa. Trop Med Infect Dis. 2021;6(3).
12. Garcia HH, Nath A, Del Brutto OH. Parasitic Infections of the Nervous System. Semin Neurol. 2019;39(3):358–68.
13. Dastoli PA, Leite AL, da Costa MDS, et al. Medullary neuroschistosomiasis in adolescence: case report and literature review. Vol. 37, Child's Nervous System. Springer Science and Business Media Deutschland GmbH; 2021. p. 2735–41.
14. Majmundar N, Patel PD, Dodson V, et al. Parasitic infections of the spine: Case series and review of the literature. Neurosurg Focus. 2019;46(1).
15. Bu L, Zhong D, Lu L, et al. Compatibility between snails and schistosomes: insights from new genetic resources, comparative genomics, and genetic mapping. Commun Biol. 2022;5(1).
16. Nation CS, Da'dara AA, Marchant JK, et al. Schistosome migration in the definitive host. Vol. 14, PLoS Neglected Tropical Diseases. Public Library of Science; 2020. p. 1–12.
17. Candido RRF, Favero V, Duke M, et al. The affinity of magnetic microspheres for Schistosoma eggs. Int J Parasitol. 2015;45(1):43–50.
18. Deslyper G, Doherty DG, Carolan JC, et al. The role of the liver in the migration of parasites of global significance. Vol. 12, Parasites and Vectors. BioMed Central Ltd.; 2019.
19. Costain AH, MacDonald AS, Smits HH. Schistosome Egg Migration: Mechanisms, Pathogenesis and Host Immune Responses. Vol. 9, Frontiers in Immunology. Frontiers Media S.A.; 2018.
20. Macháček T, Leontovyč R, Šmídová B, et al. Mechanisms of the host immune response and helminth-induced pathology during Trichobilharzia regenti (Schistosomatidae) neuroinvasion in mice. PLoS Pathog. 2022;18(2).
21. Schwartz C, Fallon PG. Schistosoma "Eggs-iting" the host: Granuloma formation and egg excretion. Front Immunol. 2018;9:249. DOI: 10.3389/fimmu.2018.02492
22. Zaqout A, Abid F Ben, Murshed K, et al. Cerebral schistosomiasis: Case series from Qatar. International Journal of Infectious Diseases. 2019;86:167–70.
23. Rose MF, Zimmerman EE, Hsu L, et al. Atypical presentation of cerebral schistosomiasis four years after exposure to Schistosoma mansoni. Epilepsy Behav Case Rep. 2014;2(1):80–5.
24. Cimini A, Ricci M, Gigliotti PE, et al. Medical imaging in the diagnosis of schistosomiasis: A review. Pathogens. 2021;10(8): 1058. DOI: 10.3390/pathogens10081058
25. Haman NO, Bello F, Ndome TO, et al. Spinal cord schistosomiasis in a 6-year-old child with complete recovery after spine surgery and medical treatment: case report and discussion. Child's Nervous System. 2024;40(2):327–33. DOI: 10.1007/s00381-024-06282-2

26. Del Brutto OH. Parasitic infections of the central nervous system. In: CNS Infections: A Clinical Approach: Second Edition. Springer International Publishing; 2018. p. 181–97.
27. Garcia HH. Parasitic Infections of the Nervous System. Vol. 27, CONTINUUM Lifelong Learning in Neurology. Lippincott Williams and Wilkins; 2021. p. 943–62.
28. Wen SCH, Anderson R, Ryan MM, et al. Pediatric neuroschistosomiasis: A case report and review of the literature. Vol. 8, Journal of the Pediatric Infectious Diseases Society. Oxford University Press; 2019. p. 489–91.
29. Halili S, Grant JR, Pilotte N, et al. Development of a novel real-time polymerase chain reaction assay for the sensitive detection of Schistosoma japonicum in human stool. PLoS Negl Trop Dis. 2021;15(10). DOI: https://doi.org/10.1371/journal.pntd.0009877
30. Ferrari TCA, Albricker ACL, Gonçalves IM, et al. Schistosome-Associated Pulmonary Arterial Hypertension: A Review Emphasizing Pathogenesis. Front Cardiovasc Med. 2021;8:724254. DOI : 10.3389/fcvm.2021.724254
31. Alanazi RF, Al Karawi M, Almalki A, et al. Schistosomiasis Involving the Central Nervous System: Case Report of a Rare Complication. Case Rep Surg. 2023;2023: 9968155. DOI: 10.1155/2023/9968155
32. Suthiphosuwan S, Lin A, Gao AF, et al. Delayed presentation of cerebral schistosomiasis presenting as a tumor-like brain lesion. Neuroradiology Journal. 2018;31(4):395–8. DOI: 10.1177/1971400917703991
33. de Wilton A, Aggarwal D, Jäger HR, et al. Delayed diagnosis of spinal cord schistosomiasis in a non- endemic country: A tertiary referral centre experience. PLoS Negl Trop Dis. 2021;15(2): 1-15. DOI: https://doi.org/10.1371/journal.pntd.0009161
34. Wang XY, He J, Juma S, et al et al. Efficacy of China-made praziquantel for treatment of Schistosomiasis haematobium in Africa: A randomized controlled trial. PLoS Negl Trop Dis. 2019;13(4). DOI: https://doi.org/10.1371/journal.pntd.0007238
35. Abou-El-Naga IF, Amer EI, Boulos LM, et al. Biological and proteomic studies of Schistosoma mansoni with decreased sensitivity to praziquantel. Comp Immunol Microbiol Infect Dis. 2019;66:101341. DOI: 10.1016/j.cimid.2019.101341
36. Ahmed MMZE, Osman HHM, Mohamed AHA, et al. Surgical management outcome of cerebral schistosomiasis: a case report and review of the literature. J Med Case Rep. 2021;15(1):268. DOI: 10.1186/s13256-021-02828-z
37. Chauvin A, Ghazali A, Le Jeunne C, et al. Acute paraplegia due to schistosomiasis: an uncommon cause in developed countries. J Neurovirol. 2019;25(3):434–7. DOI: 10.1007/s13365-018-0713-6
38. Torres-Vitolasid CA, Trienekens SCM, Zaadnoordijk W, et al. Behaviour change interventions for the control and elimination of schistosomiasis: A systematic review of evidence from low- and middle- income countries. PLoS Negl Trop Dis. 2023;17(5). DOI: https://doi.org/10.1371/journal.pntd.0011315

Blood trematodes: Schistosomiasis in Central Nervous System

by Yuliana

Submission date: 04-Nov-2025 09:05AM (UTC+0700)
Submission ID: 2400879299
File name: artikel-ra-653-for-review.docx (6.92M)
Word count: 4040
Character count: 25389

REVIEW ARTICLE

Blood trematodes: Schistosomiasis in Central Nervous System

Trematoda Darah: Schistosomiasis pada Sistem Saraf Pusat

ABSTRACT

Schistosomiasis (bilharzia) is an acute and chronic disease caused by blood trematode worms of the genus *Schistosoma*. There are five species of *Schistosoma* (*S. japonicum, S. mansoni, S. intercalatum, S. Mekongi,* dan *S. haematobium*) known to infect humans that are distributed across a wide geographic range. Severe clinical symptoms of schistosomiasis infection on the central nervous system (CNS) are caused by the deposition of eggs when adult worms migrate abnormally to the brain or spinal cord. As a result, radiculopathy, myelopathy, increased intracranial pressure, and clinical sequelae occur. Each species shows different tendencies for atopic infections and clinical symptoms. The most common neurological symptom caused by *Schistosoma mansoni* or *S. haematobium* infections is myelopathy, and severe encephalitis is most likely caused by *S. japonicum* infections. The symptoms of encephalopathy can manifest as headache, vision disturbances, delirium, convulsions, motor limitations, and ataxia. Spinal abnormalities may lead to backache, lower limb radiating discomfort, muscular frailty, the lapse of sensation, and urinary impairment. Histopathological analysis showing granulomas and *Schistosoma* eggs is necessary for a definitive diagnosis. Current management involves surgical procedures, steroids, and schistosomicide drugs. Corticosteroids are administered in the acute stage, and praziquantel is given after the female worm begins to lay eggs. If medical intervention fails to relieve compression or medullary degeneration, surgery should be postponed in certain cases. The earlier a diagnosis is identified, and proper therapy begins, the better the patient's outcome.

Keywords: tropical disease; *schistosoma*; schistosomiasis; brain; spine

ABSTRAK

Schistosomiasis adalah suatu penyakit akut sekaligus kronis yang disebabkan oleh cacing trematoda darah dari genus *Schistosoma*. Terdapat lima spesies *Schistosoma* (*S. japonicum, S. mansoni, S. intercalatum, S. Mekongi,* dan *S. haematobium*) yang diketahui menginfeksi manusia dan tersebar di rentang geografis yang luas. Gejala klinis berat akibat infeksi schistosomiasis pada sistem saraf pusat (SSP) disebabkan oleh deposit telur ketika cacing dewasa bermigrasi secara abnormal ke otak atau sumsum tulang belakang. Akibatnya, terjadi radikulopati, mielopati, peningkatan tekanan intrakranial, dan sekuel klinis. Setiap spesies menunjukkan kecenderungan infeksi atopik dan gejala klinis yang berbeda. Gejala neurologis paling umum yang disebabkan oleh infeksi *Schistosoma mansoni* (*S. mansoni)* atau *S. haematobium* adalah mielopati, sementara ensefalitis berat lebih sering terjadi pada infeksi *S. japonicum*. Gejala ensefalopati dapat berupa sakit kepala, gangguan penglihatan, delirium, kejang, keterbatasan motorik, dan ataksia. Kelainan tulang belakang dapat menyebabkan nyeri punggung, rasa tidak nyaman yang menjalar ke tungkai bawah, kelemahan otot, hilangnya sensasi, dan gangguan berkemih. Analisis histopatologi yang menunjukkan granuloma dan telur *Schistosoma* diperlukan untuk diagnosis pasti. Penanganan saat ini mencakup prosedur bedah, steroid, dan obat schistosomisida; kortikosteroid diberikan pada tahap akut, dan praziquantel digunakan setelah cacing betina mulai bertelur. Jika intervensi

medis gagal meredakan kompresi atau degenerasi medula, pembedahan dapat dipertimbangkan dalam kasus tertentu. Semakin dini diagnosis ditegakkan dan terapi yang tepat dimulai, semakin baik prognosis pasien.

Kata kunci: penyakit tropis; *Schistosoma*; schistosomiasis; otak; tulang belakang

INTRODUCTION

The COVID-19 pandemic and efforts to control it in 2021 resulted in a reduced focus of governments and healthcare providers, particularly on the availability of interventions and treatments for neglected tropical diseases (NTDs), including schistosomiasis. Schistosomiasis (bilharzia) is an acute and chronic disease caused by blood trematode worms of the genus *Schistosoma*.[4] Schistosomiasis is prevalent in tropical and subtropical regions, especially in poor communities that do not have access to safe drinking water and adequate sanitation.[5] World Health Organization (WHO) reports that schistosomiasis in all its forms has been transmitted in 78 countries, of which 51 are endemic countries requiring preventive chemotherapy (**Figure 1**).[6]

Figure 1. Map of the geographical distribution of schistosomiasis.
Source: https://www.who.int/data/gho/data/themes/topics/schistosomiasis

It is estimated that around 251.4 million people required preventive treatment for schistosomiasis in 2021 and more than 75 million people have received treatment.[6] There are five species of *Schistosoma* known to infect humans that are distributed across a wide geographic range.[6,7] Infections with *S. japonicum, S. mansoni, S. intercalatum,* and *S. mekongi* have been linked to protracted intestinal and liver fibrosis, while chronic infections of *S. haematobium* are prone to the formation of fibrosis, narrowing, and calcified bladder.[8,9] Ectopic

eggs of the species *Schistosoma* migrate to various organs and give rise to clinical manifestations based on the affected organs, such as the skin, brain, muscles, eyes, adrenal glands, and genitourinary system. Granulomas can form in the fallopian tubes, ovaries, and uterus.[9]

The term "neuro-schistosomiasis" refers to schistosomiasis of brain tissue, which is the most severe clinical form of *Schistosoma* infection and can arise symptomatically or asymptomatically due to schistosomes.[10] Neuro-schistosomiasis cases have been found in soldiers and workers serving in schistosomiasis endemic areas, as well as in tourists who rarely visit these areas.[11] *Schistosoma japonicum, S. mansoni, S. haematobium* are common species that cause neuro-schistosomiasis. Infection of *S. japonicum* typically leads to acute encephalitis involving the cerebral cortex, basal ganglia, subcortical white matter, or inner capsule.[12] Infections of *S. mansoni* or *S. haematobium* can cause neurological manifestations, particularly myelopathy (acute transverse myelitis and subacute myeloradiculopathy) linked to necrotic inflammation in the lumbo-sacral area.[13,14]

METHODS

A literature search was conducted between September and October 2023 using the keywords "schistosomiasis" OR "*Schistosoma* " OR "infection AND brain AND *Schistosoma* " OR "schistosomiasis AND brain" OR "schistosomiasis AND nervous system AND central" OR "schistosomiasis AND spinal" OR "schistosomiasis AND bone and back". Literature is gathered from the electronic databases PubMed, Scopus, and Google Scholar, and the bibliographies of relevant publications. The search was limited to freely accessible full-text articles in English, but no systematic methodology was applied to the search and selection process.

RESULTS

Life Cycle

Schistosoma has a complex life cycle (**Figure 2**), involving freshwater snails as intermediate hosts and higher vertebrates or mammals as definitive hosts, where *Schistosoma* lives in the bloodstream of mammals.[15] Male and female *Schistosoma* worms mate, with the female residing in the male's ventral gynaecophoric canal. Female *S. mansoni* lays 100–300 eggs daily, *S. haematobium* lays 20–200, and *S. japonicum* lays 500–3,500. Egg shape and location help differentiate species, as they accumulate in the target organ's capillaries.[16] Highly antigenic eggs migrate through the intestinal wall or bladder and are excreted in feces or urine.[16,17]

Once expelled into freshwater, eggs hatch into miracidia within ten days, which infect specific snail intermediate hosts, transforming into sporocysts and later into cercariae. The cercariae, capable of free-swimming for up to 72 hours, must find and penetrate a definitive mammalian host within 12–24 hours to continue the life cycle.[16,17] Each *Schistosoma* species has a distinct snail host in endemic regions; for example, *Oncomelania hupensis* hosts *S. japonicum*, while *Biomphalaria* species host *S. mansoni*. Cercariae penetrates intact skin using

suckers and proteolytic enzymes, sheds their tails, and migrate via the lymphatic system to the lungs, where they develop immune-resistant schistosomula. These schistosomula travel to the liver's portal vessels, mature into adult worms, and form pairs before migrating to their target organs, completing the life cycle.[18] This complex parasitic process underpins the persistence of schistosomiasis in endemic regions.

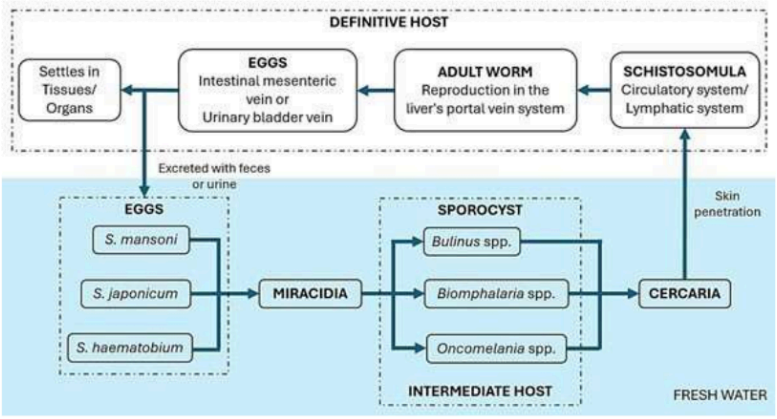


Figure 2. Life cycle of the worm *Schistosoma* spp.

Pathogenesis

After the worms develop into adults, they reproduce, and produce eggs. *Schistosoma* can enter the central nervous system. After maturation and reproduction, *Schistosoma* can invade the central nervous system (CNS). Eggs must enter Batson's epidural venous plexus, linking the portal vein and vena cava systems to the spinal cord and cerebral veins, to induce CNS symptoms. Through this route, mature worms may deposit eggs near the CNS or embolize large numbers from mesenteric vessels. The smaller, spherical eggs of *S. japonicum* can reach the CNS, while the larger eggs of *S. mansoni* and *S. haematobium* are typically confined to the lower vertebral cord.[13,16,19] In chronic hepatosplenic and cardiopulmonary schistosomiasis, venous or arterial invasion mechanisms can result in CNS implication without symptoms.[13,20] The rare detachment of eggs and the lack of a peri-ovular inflammatory response associated with severe chronic infections result in an absence of symptoms.[20]

Schistosomiasis pathology primarily arises from the intense inflammatory response to trapped eggs, not the worms themselves. Eggs contain miracidia, which can mature into adults within 5–20 days. Chronic disease is driven by host immune reactions and granulomatous responses to antigens, particularly glycoproteins, secreted by miracidia. Granulomas predominantly form where eggs accumulate: *S. mansoni* and *S. japonicum* in the intestines and liver, and *S. haematobium* in the genitourinary tract.[19,21] Granulomas may form in tissues such

as the brain, muscles, skin, lungs, and adrenal glands. Perioval granulomas consist of fibroblasts, eosinophils, and plasma cells, with necrotic centers containing egg clusters surrounded by giant cells, lymphocytes, and epithelioid cells. While single eggs are reabsorbed, tissue damage can lead to fibrosis. Chronic infections result in calcified eggs and excess extracellular matrix deposition due to granulomatous inflammation. Collagen deposition, crosslinking, contraction, and reabsorption are dynamically regulated by immune responses.[21]

Clinical Manifestations

Schistosomiasis of the cerebral

Brain involvement in schistosomiasis is more frequent with *S. japonicum* infections (4–28%) than with other *Schistosoma* species. The primary neurological manifestations are diffuse encephalopathy and seizures. The smaller eggs of *S. japonicum* have a higher likelihood of penetrating the brain.[19] Granulomatous lesions and increased intracranial pressure in the subcortical white matter, cortex, internal capsule, or basal ganglia commonly manifest as neurological disturbances, including fever, headache, nystagmus, speech difficulties, and motor weakness. One possible outcome of high pressure in the brain is papilledema. Neurological symptoms typical of cerebral complications due to infection *S. japonicum* are seizures, both focal and generalized. Brain granulomas caused by *Schistosoma* can trigger partial motor seizures and secondary generalized tonic-clonic seizures. In the absence of systemic infection, partial motor seizures may serve as an early and sole indicator of neuro-schistosomiasis.[22] Brain infection-related complications of *S. haematobium* or *S. mansoni* typically affect the brain cortex, cerebellum, and leptomeninges.[23]

Pseudo-tumoral encephalic schistosomiasis (PES), primarily caused by *S. japonicum*, occurs predominantly in individuals aged 10–40 from endemic regions without other schistosomiasis manifestations. While all brain lobes may be affected, the cerebellar, occipital, and frontal lobes are most involved. PES may also present extracerebral lesions on the dura mater's inner surface. Neurological symptoms result from slow-growing brain lesions, edema, and mass effects, leading to increased intracranial pressure, intracranial hypertension, or hydrocephalus. Common symptoms include headaches, motor and sensory disorders, visual disturbances, mental status changes, vertigo, speech disorders, vomiting, and ataxia, with cerebral nerve paralysis and meningeal signs being rare. Diagnosis relies on identifying eggs or granulomas via biopsy, as other diagnostic methods are nonspecific.[24]

Schistosomiasis of the spine

The predominant form of neuro-schistosomiasis, spinal cord schistosomiasis (SCS), is primarily caused by *Schistosoma mansoni* and typically occurs without other infection symptoms. [10,13] However, previous reports mentioned that SCS occurred during *acute toxemic schistosomiasis* (ATS), immediately afterwards or simultaneously with hepatosplenic types. SCS is more common in children, adolescents, and young adults than in the elderly. The clinical manifestations of SCS are classified in three forms: [1]

Medullary form, mainly involving the spinal cord; [2] *Myeloradicular*, involving the spinal cord and nerve roots; [3] *Conus-cauda equina syndrome*, dominant involving the *conus* or *cauda equina*. Medullary schistosomiasis typically presents with symmetrical sensorimotor anomalies, rapid progression, and severe weakness. In contrast, conus-cauda equina syndrome progresses more slowly, with asymmetrical sensorimotor changes and milder weakness. The myeloradicular type, the most common form, presents intermediate features and is primarily caused by *S. mansoni* and *S. haematobium*.[25]

Other symptoms in neuro-schistosomiasis

Immunocompromised individuals with schistosomiasis may develop cerebral vasculitis, mediated by eosinophil-induced toxicity. During the acute stage, schistosomula have not matured, and eggs are undetectable, as *Schistosoma* begins egg production 1–2 months post-infection. Severe cases, such as *S. mansoni* infestations, can result in hyper-eosinophilic syndrome, leading to ischemic infarctions and chronic endomyocardial fibrosis.[26] Granulomatous inflammation around *Schistosoma* eggs may cause cerebral arterial necrosis, resulting in subacute hematomas, cerebellar hematomas, or subarachnoid hemorrhage. These neurological complications highlight the severe impact of schistosomiasis on the central nervous system.[27]

Diagnosis

Conventional microscopic detection

Parasitological detection of *Schistosoma* eggs in urine or feces is critical for diagnosing active schistosomiasis, with the Kato-Katz method and miracidia hatching technique (MHT) considered the "gold standard," particularly in endemic areas. The Kato-Katz method, using 25–50 mg of stool, is valued for its simplicity, cost-effectiveness, and ability to identify species and estimate worm burden. However, it is less effective in detecting low-intensity infections, especially in non-endemic or low-prevalence areas.[28]

The Helmintex test, employing paramagnetic beads, offers higher sensitivity than Kato-Katz but requires further evaluation for cost-effectiveness and field applicability. For superior diagnostic accuracy, rectal biopsy with ovogram, which has 95–100% sensitivity, is often preferred for diagnosing active schistosomiasis.[29,30]

Radiology feature of neuro-schistosomiasis

Diagnosis of neuro-schistosomiasis by neuroimaging using *computerized tomography* scan (CT) and *magnetic resonance imaging* (MRI) can provide effective results. In addition, CT and MRI can evaluate the severity of the disease process and its complications in the target organ.[31] CT images in neuro-schistosomiasis are associated with inflammatory reactions and granuloma formation due to egg deposition in the brain and spinal cord, generally showing mass lesions with hyperdense lesions surrounded by edematous shadows or calcification of hypodense with varying contrast enhancements. Granulomatous lesions are also associated with secondary bleeding.[32]

MRI is effective in diagnosing cerebral and spinal schistosomiasis, revealing masses with scattered or clustered nodular "mud-like" enhancements in cortical or subcortical areas. Spinal schistosomiasis typically appears as lesions with spinal edema, conus medullaris, cauda equina involvement, and irregular thickening of the cauda equina nerve roots. MRI also detects spinal cord compression.[24,32] The MRI images of neuro-schistosomiasis usually show enlargement of the spinal cord, especially in the ventral area of the spinal cord, due to the formation of intramedullary Schistosoma granulomas. These granulomas may emerge as unevenly nodular multiple lesions resembling beaded strands, diverse highly intense lesions with ill-defined boundaries, or moderate extensions of distally located medulla that are iso-intense compared to the medulla oblongata.[14] Spinal cord atrophy can be found in longstanding cases.[22]

Immunology detection

Immunological methods for detecting *Schistosoma* antibodies are highly sensitive, cost-effective, and simple, making them useful for early screening and surveillance in endemic areas. These methods, including ELISA, IHA, and immune fluorescence, detect IgG, IgM, or IgE against soluble egg or adult worm antigens. While serology is beneficial for diagnosing travelers and patients without eggs, such as those with Katayama syndrome, it is less specific compared to fecal screening due to cross-reactivity with other worms.[28,30]

Molecular technique

Nucleic acid detection, particularly PCR, offers superior sensitivity and specificity for diagnosing schistosomiasis, effectively detecting *Schistosoma* DNA in various samples, including feces, urine, blood, and environmental specimens. Blood-based PCR is promising for acute schistosomiasis, while real-time PCR can estimate *S. mansoni* infection burden. However, these methods require costly infrastructure and rigorous validation for broader application in control programs. [29,33,34]

Treatment

Praziquantel

A pyrazinoisoquinoline derivative, praziquantel is a secure schistosomicidal, very potent, and effective oral drug against every adult worm of *Schistosoma* species.[34] Praziquantel has been widely used since its invention in the middle of the last century because of its safety and potency. Due to currently no vaccine for immunization, praziquantel has become the backbone of schistosomicidal. The precise mode of action of praziquantel remains undetermined, and while the calcium-ions pathway of *Schistosoma* was recently proposed as a molecular target, the data is yet inconclusive. [35]

Artemether

Artemether and artesunate, derived from *Artemisia annua*, were first identified as anti-*schistosoma*l agents in the 1980s, particularly against *S. japonicum*. These artemisinin

derivatives, originally used for malaria, are effective against juvenile *Schistosoma* within the first three weeks of infection. Administering artemether biweekly effectively targets and eliminates schistosomula in humans and animals. [35]

Corticosteroid

For encephalopathy schistosomiasis, prednisone (1.5–2.0 mg/kg daily for three weeks) combined with praziquantel is recommended during the egg-laying period to reduce CNS granulomatous inflammation, though no randomized trials have confirmed corticosteroid effects on the spinal cord. Praziquantel is not advised during acute infection due to its inability to target immature schistosomula (3–21 days). Corticosteroids remain the preferred treatment, while the potential use of artemether, alone or with corticosteroids, for neurologic complications requires further study. [25,36,37]

Disease Prevention

Research on schistosomiasis vaccines, including *S. mansoni* smFABP and DNA-based approaches, shows a promising progress. While praziquantel lacks preventive effects, artemether offers prophylactic potential when taken biweekly, effectively targeting all major *Schistosoma* species.[8] In addition to vaccination and alternative medicine, there are several important factors in efforts to control schistosomiasis, especially in endemic areas[6]: [1]. Provide population-based preventive chemotherapy; [2]. Ensure a safe water supply; [3]. Health education for improved water sanitation; [4]. Avoiding urine or stool contaminated with schistosome is a prerequisite; [5]. Eradicating snails reduces worm transmission and adds further control. Visitors to endemic regions should be aware of potential exposure to freshwater larvae. Prompt treatment is recommended upon clinical suspicion or confirmed diagnosis of schistosomiasis to reduce disease burden. Topical lotions containing N, N-diethyl-m-toluamide effectively kill *Schistosoma* cercariae with minimal risk to humans.[38]

CONCLUSION

Neuro-schistosomiasis with symptoms of *Schistosoma* involvement in the CNS is a serious condition. Despite increasing reports of the disease in endemic areas and among tourists, it remains underdiagnosed. *Schistosoma* infestations can result in harm to the central nervous system and spinal cord. The stage of infection and the clinical form affect the etiology, clinical picture and prognosis. Reducing irreversible neurological consequences and improving clinical outcomes requires immediate identification and intervention. To effectively treat neuro-schistosomiasis, the best treatment is to combine targeted anti-*Schistosoma* treatment with rapid surgical debridement. Early diagnosis accompanied by prompt and appropriate treatment will improve the patient's prognosis.

ACKNOWLEDGEMENT
None.

AUTHORS CONTRIBUTION
All authors contributed to this article.

FUNDING
None.

CONFLICT OF INTEREST
All authors declare that they have no conflict of interest concerning the submitted manuscript.

REFERENCES

1. Filip R, Gheorghita Puscaselu R, Anchidin-Norocel L, Dimian M, Savage WK. Global Challenges to Public Health Care Systems during the COVID-19 Pandemic: A Review of Pandemic Measures and Problems. J Pers Med. 2022;12(1295):1–22.
2. Hrynick TA, Ripoll Lorenzo S, Carter SE. COVID-19 response: Mitigating negative impacts on other areas of health. BMJ Glob Health. 2021 Apr 15;6(4):1–11.
3. Kokaliaris C, Garba A, Matuska M, Bronzan RN, Colley DG, Dorkenoo AM, et al. Effect of preventive chemotherapy with praziquantel on schistosomiasis among school-aged children in sub-Saharan Africa: a spatiotemporal modelling study. Lancet Infect Dis. 2022 Jan 1;22(1):136–49.
4. Abdel-Naser MB, Altenburg A, Zouboulis CC, Wollina U. Schistosomiasis (bilharziasis) and male infertility. Andrologia. 2019 Feb 1;51(1).
5. Phillips AE, Ower AK, Mekete K, Liyew EF, Maddren R, Belay H, et al. Association between water, sanitation, and hygiene access and the prevalence of soil-transmitted helminth and schistosome infections in Wolayita, Ethiopia. Parasit Vectors. 2022;15(1).
6. World Health Organization. WHO guideline on control and elimination of human schistosomiasis [Report] [Internet]. 2022 [cited 2023 Dec 21]. Available from: https://iris.who.int/bitstream/handle/10665/351856/9789240041608-eng.pdf?sequence=1
7. Rey O, Webster BL, Huyse T, Rollinson D, Van den Broeck F, Kincaid-Smith J, et al. Population genetics of African Schistosoma species. Vol. 89, Infection, Genetics and Evolution. Elsevier B.V.; 2021.
8. McManus DP, Bergquist R, Cai P, Ranasinghe S, Tebeje BM, You H. Schistosomiasis—from immunopathology to vaccines. Vol. 42, Seminars in Immunopathology. Springer; 2020. p. 355–71.
9. McManus DP, Dunne DW, Sacko M, Utzinger J, Vennervald BJ, Zhou XN. Schistosomiasis. Nat Rev Dis Primers. 2018 Dec 1;4(1).

10. Carbonell C, Rodríguez-alonso B, López-bernús A, Almeida H, Galindo-pérez I, Velasco-tirado V, et al. Clinical spectrum of schistosomiasis: An update. J Clin Med. 2021;10(23).

11. Aula OP, McManus DP, Jones MK, Gordon CA. Schistosomiasis with a focus on Africa. Trop Med Infect Dis. 2021;6(3).

12. Garcia HH, Nath A, Del Brutto OH. Parasitic Infections of the Nervous System. Semin Neurol. 2019;39(3):358–68.

13. Dastoli PA, Leite AL, da Costa MDS, Nicácio JM, Pinho RS, Ferrarini MAG, et al. Medullary neuroschistosomiasis in adolescence: case report and literature review. Vol. 37, Child's Nervous System. Springer Science and Business Media Deutschland GmbH; 2021. p. 2735–41.

14. Majmundar N, Patel PD, Dodson V, Tran A, Goldstein I, Assina R. Parasitic infections of the spine: Case series and review of the literature. Neurosurg Focus. 2019;46(1).

15. Bu L, Zhong D, Lu L, Loker ES, Yan G, Zhang SM. Compatibility between snails and schistosomes: insights from new genetic resources, comparative genomics, and genetic mapping. Commun Biol. 2022;5(1).

16. Nation CS, Da'dara AA, Marchant JK, Skelly PJ. Schistosome migration in the definitive host. Vol. 14, PLoS Neglected Tropical Diseases. Public Library of Science; 2020. p. 1–12.

17. Candido RRF, Favero V, Duke M, Karl S, Gutiérrez L, Woodward RC, et al. The affinity of magnetic microspheres for Schistosoma eggs. Int J Parasitol. 2015 Jan 1;45(1):43–50.

18. Deslyper G, Doherty DG, Carolan JC, Holland CV. The role of the liver in the migration of parasites of global significance. Vol. 12, Parasites and Vectors. BioMed Central Ltd.; 2019.

19. Costain AH, MacDonald AS, Smits HH. Schistosome Egg Migration: Mechanisms, Pathogenesis and Host Immune Responses. Vol. 9, Frontiers in Immunology. Frontiers Media S.A.; 2018.

20. Macháček T, Leontovyč R, Šmídová B, Majer M, Vondráček O, Vojtěchová I, et al. Mechanisms of the host immune response and helminth-induced pathology during Trichobilharzia regenti (Schistosomatidae) neuroinvasion in mice. PLoS Pathog. 2022;18(2).

21. Schwartz C, Fallon PG. Schistosoma "Eggs-iting" the host: Granuloma formation and egg excretion. Front Immunol. 2018;9.

22. Zaqout A, Abid F Ben, Murshed K, Al-Bozom I, Al-Rumaihi G, Al Soub H, et al. Cerebral schistosomiasis: Case series from Qatar. International Journal of Infectious Diseases. 2019 Sep 1;86:167–70.

23. Rose MF, Zimmerman EE, Hsu L, Golby AJ, Saleh E, Folkerth RD, et al. Atypical presentation of cerebral schistosomiasis four years after exposure to Schistosoma mansoni. Epilepsy Behav Case Rep. 2014;2(1):80–5.

24. Cimini A, Ricci M, Gigliotti PE, Pugliese L, Chiaravalloti A, Danieli R, et al. Medical imaging in the diagnosis of schistosomiasis: A review. Pathogens. 2021;10(8).

25. Haman NO, Bello F, Ndome TO, Baboke I, Fogue D, Djientcheu VDP. Spinal cord schistosomiasis in a 6-year-old child with complete recovery after spine surgery and medical treatment: case report and discussion. Child's Nervous System. 2024 Feb 1;40(2):327–33.

26. Del Brutto OH. Parasitic infections of the central nervous system. In: CNS Infections: A Clinical Approach: Second Edition. Springer International Publishing; 2018. p. 181–97.

27. Garcia HH. Parasitic Infections of the Nervous System. Vol. 27, CONTINUUM Lifelong Learning in Neurology. Lippincott Williams and Wilkins; 2021. p. 943–62.

28. Wen SCH, Anderson R, Ryan MM, Kumbla S, Wray A, Steer A. Pediatric neuroschistosomiasis: A case report and review of the literature. Vol. 8, Journal of the Pediatric Infectious Diseases Society. Oxford University Press; 2019. p. 489–91.

29. Halili S, Grant JR, Pilotte N, Gordon CA, Williams SA. Development of a novel real-time polymerase chain reaction assay for the sensitive detection of Schistosoma japonicum in human stool. PLoS Negl Trop Dis. 2021;15(10).

30. Ferrari TCA, Albricker ACL, Gonçalves IM, Freire CMV. Schistosome-Associated Pulmonary Arterial Hypertension: A Review Emphasizing Pathogenesis. Front Cardiovasc Med. 2021;8(724254):1.

31. Alanazi RF, Al Karawi M, Almalki A, Sufiani F, Al Karawi S. Schistosomiasis Involving the Central Nervous System: Case Report of a Rare Complication. Case Rep Surg. 2023 Dec 12;2023:1–5.

32. Suthiphosuwan S, Lin A, Gao AF, Munoz DG, Spears J, Bharatha A. Delayed presentation of cerebral schistosomiasis presenting as a tumor-like brain lesion. Neuroradiology Journal. 2018;31(4):395–8.

33. de Wilton A, Aggarwal D, Jäger HR, Manji H, Chiodini PL. Delayed diagnosis of spinal cord schistosomiasis in a non-endemic country: A tertiary referral centre experience. PLoS Negl Trop Dis. 2021;15(2).

34. Wang XY, He J, Juma S, Kabole F, Guo J gang, Dai JR, et al. Efficacy of China-made praziquantel for treatment of Schistosomiasis haematobium in Africa: A randomized controlled trial. PLoS Negl Trop Dis. 2019;13(4).

35. Abou-El-Naga IF, Amer EI, Boulos LM, El-Faham MH, Abou Seada NM, Younis SS. Biological and proteomic studies of Schistosoma mansoni with decreased sensitivity to praziquantel. Comp Immunol Microbiol Infect Dis. 2019;66:1–13.

36. Ahmed MMZE, Osman HHM, Mohamed AHA, Ginawi A. Surgical management outcome of cerebral schistosomiasis: a case report and review of the literature. J Med Case Rep. 2021;15(1).

37. Chauvin A, Ghazali A, Le Jeunne C, Plaisance P, Szwebel TA, Costedoat-Chalumeau N, et al. Acute paraplegia due to schistosomiasis: an uncommon cause in developed countries. J Neurovirol. 2019;25(3):434–7.

38. Torres-Vitolasid CA, Trienekens SCM, Zaadnoordijk W, Gouvras AN. Behaviour change interventions for the control and elimination of schistosomiasis: A systematic review of evidence from low- and middle-income countries. PLoS Negl Trop Dis. 2023;17(5).

Blood trematodes: Schistosomiasis in Central Nervous System

ORIGINALITY REPORT

11%	5%	9%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Mohamud A Verjee. " Schistosomiasis: Still a Cause of Significant Morbidity and Mortality ", Research and Reports in Tropical Medicine, 2020 Publication	2%
2	"Challenges in Infectious Diseases", Springer Science and Business Media LLC, 2013 Publication	1%
3	Joseph Opare, Tei Hervie, Ernest Mensah, Charles Brown-Davies et al. "Schistosomiasis in Ghana from baseline to now: the impact of fifteen years of interventions", Frontiers in Public Health, 2025 Publication	1%
4	Submitted to unikal Student Paper	1%
5	Xiaodong Yang, Xuefei Yang, Zhiyong Hou, Minghui Li et al. "Efficient removal of aqueous ciprofloxacin antibiotic by ZnO/CuO-bentonite composites synthesized via carbon-bed pyrolysis of bentonite and metal co-precipitation", Science of The Total Environment, 2024 Publication	1%
6	www.coursehero.com Internet Source	1%

7	Applied Anatomy of the Back, 1985. Publication	1 %
8	seimc.org Internet Source	1 %
9	apps.who.int Internet Source	1 %
10	Submitted to National University of Ireland, Galway Student Paper	<1 %
11	Anushree Bansal, Joselv Eullaran Albano, Dheeraj Jayakumar. "Neuroschistosomiasis presenting as recurrent seizures: A case report", Surgical Neurology International, 2025 Publication	<1 %
12	en.wikipedia.org Internet Source	<1 %
13	opencivilengineeringjournal.com Internet Source	<1 %
14	surgicalneurologyint.com Internet Source	<1 %
15	Rickenbacher, Josef, Alex M. Landolt, Karl Theiler, Heinrich Scheier, Jean Siegfried, Franz J. Wagenhäuser, R. R. Wilson, and D. P. Winstanley. "Vertebral Region", Applied Anatomy of the Back, 1985. Publication	<1 %
16	Thiago Augusto Vasconcelos Miranda, Kazuhiro Tsuchiya, Leandro Tavares Lucato. "Imaging of Central Nervous System Parasitic Infections", Neuroimaging Clinics of North America, 2023 Publication	<1 %

17	medbox.org Internet Source	<1%
18	pmc.ncbi.nlm.nih.gov Internet Source	<1%

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		

Blood trematodes: Schistosomiasis in Central Nervous System

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

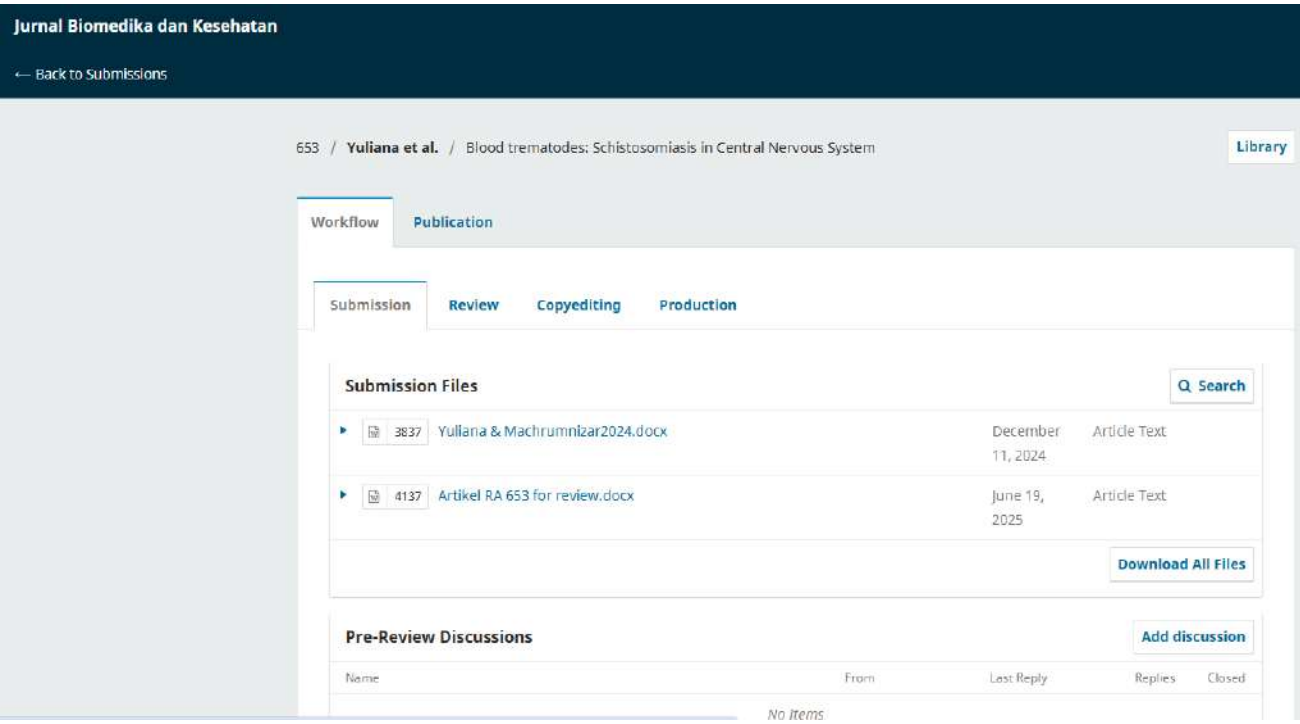
PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12


Jurnal Biomedika dan Kesehatan
← Back to Submissions
653 / Yuliana et al. / Blood trematodes: Schistosomiasis in Central Nervous System
Library
Workflow
Publication
Submission
Review
Copyediting
Production
Submission Files
Search
3837 Yuliana & Machrumnizar2024.docx
December 11, 2024
Article Text
4137 Artikel RA 653 for review.docx
June 19, 2025
Article Text
Download All Files
Pre-Review Discussions
Add discussion
Name
From
Last Reply
Replies
Closed
No items

[JBK] Editor Decision 2025-06-23 10:33 AM

Reviewer's Attachments Search

4156 Artikel RA 653 for revision.docx	June 23, 2025	

Revisions Search Upload File

4203 artikel-ra-653-for-revisi.docx	July 4, 2025	Article Text
4204 Blood trematodes_ Schistosomiasis in Central Nervous System.pdf	July 4, 2025	Article Text

Review Discussions Add discussion

Name	From	Last Reply	Replies	Closed
No Items				