



Challenges of Intestinal Parasitic Infections in Children in Coastal Areas: A Literature Review on Prevalence and Risk Factors

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ABSTRACT

Background: Intestinal Parasitic Infections (IPIs), particularly soil-transmitted helminths (STHs), remain a significant burden for children in low-and middle-income countries. Coastal ecosystems that characterized by sandy soil, high water tables, and tidal flooding, present unique ecological determinants that create transmission pathways distinct from inland settings.

Methods: This review synthesizes data from over 50 studies (2000–2025), specifically focusing on coastal settlements, fishermen villages, and tidal flood-prone areas across Indonesia and Southeast Asia.

Results: Findings indicate that coastal children face elevated risks, with STH prevalence in Indonesian hotspots reaching 30%–70%. While *Trichuris trichiura* and *Ascaris lumbricoides* dominate due to humidity, sandy terrains specifically favor the persistence of hookworms and *Strongyloides*. Crucially, high water tables and tidal inundation render conventional sanitation (pit latrines/septic tanks) ineffective, causing direct fecal contamination of the environment.

Conclusion: Standard terrestrial sanitation is maladapted to coastal hydrological contexts. Mitigation requires the deployment of amphibious infrastructure, such as the Tripikon-S system and elevated latrines, combined with targeted behavioral change communication to disrupt littoral transmission cycles.

KEYWORDS: Intestinal Parasitic Infection, Soil-Transmitted Helminths, Coastal Sanitation, Children's Health, Indonesia, Hookworm, Tidal Flooding, Environmental Health.

INTRODUCTION

The global burden of intestinal parasitic infections (IPIs) constitutes one of the most persistent public health challenges in the developing world. It is estimated that over 1.5 billion people, or approximately 24% of the world's population, are infected with soil-transmitted helminths (STHs) worldwide. These infections are primarily caused by a group of nematode worms comprising *Ascaris lumbricoides* (roundworm), *Trichuris trichiura* (whipworm), and the hookworms (*Necator americanus* and *Ancylostoma duodenale*). Concurrently, intestinal protozoa such as *Giardia lamblia*, *Entamoeba histolytica*, and *Blastocystis hominis* contribute significantly to the burden of diarrheal disease and malabsorption syndromes. While these infections are widely distributed across tropical and subtropical regions, their epidemiology is not uniform. The transmission dynamics are intimately linked to environmental conditions, sanitation infrastructure, and human behavior. Within this broad epidemiological landscape, coastal and maritime communities represent a distinct and complex ecological niche that warrants specialized attention. [1–3]

Children are the demographic most vulnerable to the deleterious effects of IPIs. The physiological and developmental consequences of chronic parasitic infection during childhood are profound and multifaceted. Helminth infections are major contributors to iron-deficiency anemia, protein-energy malnutrition, and physical stunting. For instance, heavy infections with *Trichuris trichiura* can lead to Trichuris dysentery syndrome and chronic colitis, while hookworm infection is a leading cause of pathological blood loss leading to anemia. Protozoan infections, particularly giardiasis, are associated with malabsorption of fats and carbohydrates, leading to failure to thrive and cognitive deficits. In coastal areas, these vulnerabilities are often exacerbated by unique environmental hazards that are distinct from those found in inland or highland regions. [4–6]

Coastal communities, particularly in the archipelagic nations of Southeast Asia such as Indonesia, the Philippines, and Vietnam, are frequently characterized by high population density, rapid urbanization, and settlement patterns that encroach upon the intertidal zone. These "amphibious" living conditions introduce specific risk factors not present in inland areas. These include tidal inundation (locally known as "rob" in Indonesia), saline intrusion into freshwater aquifers, and specific soil compositions. The



coastal environment presents a paradox in parasitology. On one hand, saline environments might be expected to inhibit the development of certain helminth eggs due to osmotic stress. On the other hand, the sandy soil texture typical of coastal regions is an ideal medium for the development and migration of hookworm and *Strongyloides* larvae, potentially increasing transmission risk. [7,8]

Furthermore, the hydrology of coastal settlements—often situated on water-saturated land with high water tables—renders conventional sanitation solutions like pit latrines and standard septic tanks ineffective or environmentally hazardous. The failure of sanitation infrastructure in these high-water-table environments leads to the direct contamination of surface water and soil, creating a persistent cycle of reinfection that mass drug administration (MDA) programs alone struggle to break. Consequently, coastal populations often exhibit prevalence rates that remain stubbornly high despite national control efforts. [3,8,9]

This review focuses heavily on the Southeast Asian context, with a particular emphasis on Indonesia, a nation with the second-longest coastline in the world and a significant population residing in coastal zones. Despite national efforts to control STH through school-based deworming programs, prevalence rates in many coastal districts remain high, often exceeding the World Health Organization's (WHO) thresholds for morbidity control. By synthesizing available literature on prevalence data, risk factors, and sanitation challenges, this article aims to provide a comprehensive analysis of the unique challenges of controlling intestinal parasitic infections in coastal children. It seeks to inform future public health strategies by highlighting the need for geographically tailored interventions that address the specific environmental and infrastructural determinants of health in littoral zones. [10,11]

MATERIALS AND METHODS

Search Strategy and Data Sources

A systematic literature search was conducted to identify relevant studies regarding the prevalence, risk factors, and environmental determinants of intestinal parasitic infections in coastal regions. Electronic databases including PubMed (National Library of Medicine), ScienceDirect, Scopus, and Google Scholar were queried for peer-reviewed articles published between January 2000 and December 2025. To capture region-specific data and local epidemiological insights, national indexing portals such as Garuda (Garba Rujukan Digital) and SINTA (Science and Technology Index) were also utilized to access Indonesian-language journals and grey literature.

The search strategy employed a combination of Medical Subject Headings (MeSH) terms and free-text keywords combined using Boolean operators (AND, OR) to refine the results. The syntax structure was designed to intersect three primary domains: the pathogen/disease, the target population, and the environmental setting. Key search terms included combinations of the following keywords: "intestinal parasitic infection," "soil-transmitted helminths," "STH," "helminthiasis," "protozoa," "*Ascaris*," "*Trichuris*," "Hookworm," "*Giardia*," "*Blastocystis*," "*Strongyloides*," "children," "school-aged children," "coastal," "maritime," "fishermen village," "tidal flood," "sandy soil," "sanitation," "Indonesia," "Southeast Asia," "Philippines," "Vietnam," "Thailand," "Malaysia," and "Myanmar."

Eligibility Criteria

To be included in this review, studies were required to meet the following criteria:

- **Population:** The study population must primarily consist of children (aged 0–18 years), including preschool-aged children (PSAC) and school-aged children (SAC), who are the most vulnerable group for STH-related morbidity.
- **Location:** The study setting must be explicitly described as "coastal," "littoral," "beachside," or located in districts with significant coastal characteristics (e.g., tidal flooding, sandy soil, fishing communities). Studies from inland, highland, or purely urban non-coastal settings were excluded unless used for direct comparison.
- **Outcome Measures:** The study must report prevalence rates of at least one intestinal parasite (helminth or protozoa). Studies reporting on risk factors (sanitation, hygiene, environmental parameters) without prevalence data were included if they provided context on transmission mechanisms in coastal zones.
- **Geography:** Priority was given to studies conducted in Indonesia and the broader Southeast Asian region (ASEAN) due to the high density of coastal populations and similar climatic conditions.
- **Language:** Sources written in English or Indonesian were considered.



Data Extraction and Synthesis

Data were extracted regarding the study location, sample size, diagnostic methods used (e.g., Kato-Katz, direct wet mount, molecular qPCR), prevalence of specific parasites, and identified risk factors. The synthesis of data was narrative, aiming to identify patterns and themes across the different geographical locations. Quantitative data (prevalence percentages) were tabulated where appropriate to facilitate comparison, but a formal meta-analysis was not conducted due to the heterogeneity of study designs and diagnostic sensitivities. The review pays particular attention to the "grey literature" and local university reports from Indonesia to capture granular data often missed in global burden studies. This includes thesis abstracts and local journal publications that provide specific insights into the micro-epidemiology of Indonesian coastal villages. [1,8]

RESULTS

Prevalence of Intestinal Parasitic Infection in Coastal Regions

The epidemiological landscape of intestinal parasitic infections in coastal Southeast Asia reveals a persistent burden of disease. Despite decades of control efforts, coastal communities often represent "hotspots" where transmission continues unabated. The following sections detail the prevalence findings by country, with a deep dive into the diverse archipelago of Indonesia.

Indonesia: The Archipelagic Burden

Indonesia's vast coastline hosts millions of children living in environments conducive to parasite transmission. The prevalence varies significantly across the archipelago, influenced by local sanitation practices, soil types, and socioeconomic status.

Sumatra and Java

In the western part of Indonesia, studies have highlighted significant infection rates in coastal settlements. In North Sumatra, particularly in coastal fishermen villages like Percut Sei Tuan and the districts surrounding Medan Belawan, STH prevalence rates in school-aged children have been reported between 35.9% and over 50%. A defining characteristic of infection in these regions is the dominance of *Trichuris trichiura* (whipworm). For example, a study in North Sumatra found that among infected children, 76.8% harbored *Trichuris trichiura*, while *Ascaris lumbricoides* accounted for 10.9% and hookworms for 0.7%. This high prevalence of trichuriasis is often attributed to the parasite's eggs being highly resilient in the moist, shaded soil conditions typical of dense coastal settlements, and less responsive to single-dose albendazole treatment compared to ascariasis. [1,12]

In Java, the northern coast (Pantura) faces severe environmental challenges, including land subsidence and tidal flooding (rob). In the coastal city of Semarang, a study involving 443 children under seven years of age reported an overall STH prevalence of 32.5%. Consistent with findings in Sumatra, *Trichuris trichiura* was the most common infection (34.0%), followed closely by *Ascaris lumbricoides* (27.7%). In some specific villages in Semarang, historical prevalence has been recorded as high as 80-90% prior to intense intervention. Further west, in the coastal districts of Cirebon and Indramayu (West Java), prevalence rates remain significant, with studies linking infection to poor hygiene practices and contact with sandy soils. [13,14]

Madura and Sulawesi

A comparative study conducted in Sumenep District on Madura Island provided explicit evidence of the coastal-inland dichotomy. Researchers compared a coastal elementary school (Dasuk Timur) with a non-coastal one (Kolor II). The study found a striking disparity: the prevalence of intestinal parasitic infection in the coastal school was 70.5%, compared to 33.3% in the non-coastal school. Interestingly, this study highlighted a dominance of intestinal protozoa, specifically *Blastocystis hominis* (70.5%), rather than helminths. This suggests that in some coastal areas, the primary transmission route may be waterborne due to saline intrusion and contamination of shallow wells, rather than solely soil-transmitted. [1]

In Sulawesi, particularly in the coastal areas of Makassar and Campalagian, historical and recent data indicate extremely high holoendemic transmission. Surveys have shown *Trichuris* rates of 59.3% and hookworm rates of 68.3% in coastal villages. The notably high prevalence of hookworm in these areas contrasts with some Javanese sites and is likely linked to the specific sandy-loam soil characteristics of the Sulawesi coastline, which favor hookworm larval survival and migration. [15,16]

Eastern Indonesia (Nusa Tenggara and Maluku)

The eastern provinces, characterized by different climatic patterns and distinct coastal poverty profiles, show varied infection profiles. In East Nusa Tenggara (NTT), particularly on Sumba island, protozoan infections like *Blastocystis* and *Giardia* are prevalent (20%), alongside helminths. In West Sumba, STH prevalence in young children was found to be 32.5%. [17]



In Maluku (Ambon), a study of primary school children identified *Trichuris trichiura* as the most common parasite (29.1%), followed by *Ascaris* (19.2%) and *Schistosoma mansoni* (13.5%). The presence of schistosomiasis is notable in specific ecological niches. The dominance of *Trichuris* appears to be a consistent theme across many Indonesian coastal sites, likely due to the egg's durability in the humid, warm, and shaded soil conditions often found in dense coastal settlements. [18]

Southeast Asia: Regional Comparisons

The patterns observed in Indonesia are mirrored in neighboring countries, reinforcing the notion that coastal environments create a specific risk profile for intestinal parasites.

The Philippines

As an archipelagic nation similar to Indonesia, the Philippines struggles with high STH prevalence in coastal zones. National surveys and specific studies in provinces like Capiz, Laguna, and Cavite have reported prevalence rates ranging from 23% to 67% among schoolchildren, despite long-standing Mass Drug Administration (MDA) programs. A study in a coastal rural area of Cavite found an alarming 100% prevalence of intestinal parasites among students, with *Ascaris* (37.3%) and *Giardia* (15.1%) being most common. In Capiz, a coastal province, a study in 2022 found an STH prevalence of 66.9%, with moderate-to-heavy intensity infections being common. The recurrence of infection is high; even after treatment, reinfection rates in coastal areas remain robust due to continuous environmental contamination. [11,19,20]

Vietnam

In Vietnam, the Red River Delta and central coastal provinces exhibit distinct parasitological profiles. Research has highlighted that hookworm infection is particularly prevalent in coastal areas compared to mountainous regions. This is often attributed to the use of human excreta (night soil) in agriculture, which is practiced in the sandy soils of the coastal plains where hookworm larvae thrive. Recent studies in 2023 still report high STH rates (76.1%) in some high-risk areas, with *Trichuris* and *Ascaris* co-infections being common. [21,22]

Malaysia and Thailand

In Malaysia, rural and coastal children, particularly from indigenous (Orang Asli) groups, show high infection rates. A study in rural coastal Malaysia found a 54.5% prevalence of STH, with *Trichuris* accounting for the majority of infections (50.9%). This highlights the difficulty of eradicating *Trichuris* in these settings. In contrast, Thailand has achieved significant control in many areas, with prevalence rates in some southern coastal districts (e.g., Thasala) dropping to as low as 3.1%. However, vulnerable populations such as the Moken (sea gypsies) living in coastal Ranong still exhibit prevalence rates exceeding 60%, highlighting that ethnicity, legal status, and access to care are critical modifiers of coastal risk. [23–25]

Myanmar

In Myanmar, studies in the Bago region compared coastal and plain areas. Prevalence of *Ascaris* and *Trichuris* was found to be highest in the coastal region compared to hilly or plain regions. A study using qPCR detection in rural Myanmar found an overall STH prevalence of 78.8%, with *Trichuris* being the most prevalent (67.1%), followed by *Ascaris* (54.9%) and *Ancylostoma* (29.6%) [3,11].

Table 1. Summary of Selected Studies on IPI Prevalence in Coastal Children (2015–2025)

Country	Location	Sample Size	Prevalence	Dominant Parasite	Reference
Indonesia	Sumenep, Madura	44 (Coastal)	70.5%	<i>Blastocystis hominis</i>	[1]
Indonesia	North Sumatra	384	35.9%	<i>Trichuris trichiura</i>	[12]
Indonesia	Semarang	443	32.5%	<i>Trichuris</i> & <i>Ascaris</i>	[13]
Philippines	Capiz	251	66.9%	<i>Ascaris</i> & <i>Trichuris</i>	[11]
Philippines	Cavite	185	100%	<i>Ascaris</i>	[19]
Vietnam	Ha Giang	386	76.1%	<i>Trichuris</i> & <i>Ascaris</i>	[21]
Malaysia	Rural Coastal	638	54.5%	<i>Trichuris trichiura</i>	[24]
Thailand	Ranong (Moken)	169	61.8%	STH & Protozoa	[25]
Myanmar	Bago Region	1000	17% (Coastal high)	<i>Ascaris</i> & <i>Trichuris</i>	[26]



Specific Risk Factors in the Coastal Environment

The high prevalence of parasitic infections in coastal children is not merely a function of poverty but is driven by a convergence of unique environmental and behavioral factors. This section analyzes the specific determinants that make coastal zones "hotspots" for parasitic transmission.

Geographic and Geological Factors: The Role of Sandy Soil

One of the most critical determinants of helminth distribution, particularly for hookworms (*Ancylostoma* and *Necator*) and *Strongyloides stercoralis*, is soil texture. Coastal regions are predominantly characterized by sandy or sandy-loam soils. Hookworm larvae require specific soil conditions to survive and migrate. Studies have demonstrated that sandy soils, with their larger particle size and better aeration compared to clay, provide an optimal habitat for hookworm larvae. The porous nature of sand allows larvae to move vertically through the soil column. They can retreat deep into the soil to avoid desiccation during the heat of the day and migrate upwards to the surface when moisture is present (e.g., morning dew or after rain) to seek a host. A study in East Kalimantan confirmed that sandy soil texture was significantly correlated with higher hookworm prevalence compared to clay soils [15,27,28]. Similar to hookworm, *Strongyloides* larvae thrive in sandy, moist environments. Research in Cambodia and coastal Southeast Asia has noted that while *Strongyloides* is often under-diagnosed due to diagnostic challenges, its prevalence tracks closely with hookworm in these sandy zones [28,29]. Conversely, *Ascaris* and *Trichuris* eggs are hardier and can survive in a wider range of soil types. However, the sandy soils of the coast do not inhibit them, and the high humidity and shade provided by dense coastal vegetation prevent the desiccation that would otherwise kill these eggs. [30]

Hydrological Factors: High Water Tables and Tidal Flooding

The hydrology of coastal settlements is perhaps the single largest barrier to effective sanitation and parasite control. In many coastal villages, the groundwater level is extremely close to the surface, often within 0.5 to 1 meter. This geological reality renders standard pit latrines and septic tanks dysfunctional. If a pit latrine is dug into a high water table, the pit essentially becomes a direct conduit to the groundwater, contaminating the village's shallow wells with fecal pathogens. This creates a direct fecal-oral transmission route for protozoa like *Giardia* and *Entamoeba*, explaining their high prevalence in areas like Sumenep where well water is frequently contaminated. [1,8]

Many low-lying coastal areas in Indonesia (e.g., Semarang, Pekalongan, North Jakarta) experience regular tidal flooding. This phenomenon, exacerbated by land subsidence and climate change, has catastrophic implications for sanitation. When tidal waters rise, they can inundate septic tanks and open drains, causing "backflow" where fecal sludge is flushed out of containment and disseminated throughout the community. This distributes parasitic eggs and larvae across playgrounds, house floors, and public spaces, making infection almost unavoidable for children playing in these waters. Research indicates that households in tidal flood areas have significantly higher rates of diarrhea and parasitic infection due to this mechanism.

Salinity and Parasite Survival

The interaction between seawater salinity and parasite survival is nuanced. *Ascaris* and *Trichuris* eggs are remarkably resilient. While high salinity (100% seawater) can retard development, studies suggest that in brackish water or diluted seawater (common in estuarine settlements), these eggs can survive and remain infective for extended periods. *Ascaris* eggs, in particular, have a thick lipid layer that protects them from osmotic stress. [7,31]

Hookworm and *Strongyloides* larvae are generally more sensitive to salinity and desiccation than eggs. Exposure to high salinity can reduce their survival time. However, the micro-environments of coastal villages—such as soil shaded by vegetation or mixed with fresh rainwater—often create pockets of low salinity where larvae can thrive despite the general proximity to the sea. Furthermore, the adaptation of parasites to brackish environments suggests that saline intrusion does not provide a complete barrier to transmission. [32–35]

Behavioral and Occupational Factors

Behavioral patterns in coastal communities are deeply influenced by the maritime lifestyle. In many fishing villages, there is a cultural and practical reliance on the sea for waste disposal. The use of "hanging latrines" over the water or direct defecation on the beach is common, driven by the belief that the tide will wash away the waste. While the tide does remove visible waste, it often recirculates pathogens along the shoreline where children play. A study in Indramayu found that despite programs to build latrines, the cultural habit of using the "great open toilet" of the sea persisted, reinforced by the lack of functional land-based



sanitation options [36,37]. Children in coastal areas frequently play barefoot on sandy beaches. Given that the beach is often a site of open defecation (especially at night or early morning), this behavior creates a high-risk interface for hookworm penetration (Cutaneous Larva Migrans or systemic infection). Scarcity of fresh water is a chronic issue in coastal zones due to saline intrusion into wells. When fresh water is expensive or hard to obtain, it is prioritized for drinking and cooking rather than handwashing or hygiene. This lack of water for washing directly correlates with higher rates of protozoan and Ascaris infections. [10,13,30]

Table 2. Specific Risk Factors in Coastal Environments

Factor Category	Specific Determinant	Mechanism of Transmission Impact	Source
Soil Characteristics	Sandy/Sandy-Loam Soil	High porosity and aeration facilitate Hookworm and <i>Strongyloides</i> larval survival and vertical migration.	[15]
Hydrology	High Water Table (<1m)	Causes pit latrine failure; direct contamination of shallow groundwater/wells with fecal pathogens (Giardia, E. coli).	[8]
Climate Event	Tidal Flooding (Rob)	Inundates septic tanks causing backflow; disseminates eggs/larvae into public spaces and households; increases diarrhea risk.	[38]
Water Chemistry	Salinity / Brackish Water	While high salinity can inhibit some eggs, Ascaris/Trichuris eggs are resilient. Brackish water may support vector snails or survival of certain stages.	[7]
Behavioral	Open Defecation (Beach)	"Sea as toilet" mentality leads to accumulation of feces on sand where children play (risk of Cutaneous Larva Migrans).	[37]
Socio-Economic	Freshwater Scarcity	Saline intrusion reduces availability of wash water, leading to poor hand hygiene and higher protozoan infection rates.	[10]

DISCUSSION

The Coastal Trap: Reinfection and Treatment Failure

The findings of this review point to a distinct "coastal trap" where environmental conditions conspire to maintain high transmission rates despite interventions. Standard Mass Drug Administration (MDA) programs, which typically administer albendazole or mebendazole once or twice a year, rely on the assumption that reinfection will be slow enough to reduce the overall worm burden over time. However, in coastal environments, the rate of reinfection is often rapid. Studies in the Philippines have shown that prevalence rates can bounce back to pre-treatment levels within months if environmental sanitation is not addressed [9]. Furthermore, the dominance of *Trichuris trichiura* in many coastal Indonesian studies presents a specific pharmacological challenge. Single-dose albendazole is known to have low cure rates for *Trichuris* compared to Ascaris or hookworm. The persistence of *Trichuris* in these communities suggests that current drug regimens may be insufficient for the specific parasite mix found in coastal zones, necessitating alternative strategies such as triple-dose regimens or combination therapy (albendazole plus ivermectin) [12,13].

Sanitation Technology Mismatch

A critical insight from this review is the fundamental mismatch between standard sanitation technologies and coastal hydrology. Government programs often promote standard septic tanks or pit latrines. In high-water-table environments, these technologies fail. Pit latrines overflow or contaminate groundwater. Standard septic tanks cannot function when the drainfield is saturated. This failure necessitates the adoption of adaptive sanitation technologies. The Tripikon-S system, developed in Indonesia, offers a viable solution. It consists of three concentric PVC pipes embedded vertically, allowing for anaerobic digestion in a contained



environment that is less susceptible to groundwater infiltration. Studies in Kalimantan and Yogyakarta have shown Tripikon-S to be effective in swampy and riverbank areas. Similarly, "flying latrines" (elevated latrines built on concrete rings) are used in tidal flood areas like Demak to keep the containment vessel above the flood line. However, these solutions are often more expensive and technically complex to build than standard latrines, limiting their spontaneous adoption by poor fishing households without targeted subsidies [39,40].

Impact on Child Development

The burden of IPIs in coastal children is not just an infection issue but a developmental emergency. The coexistence of heavy worm burdens with environmental enteropathy (caused by chronic fecal ingestion) likely contributes to the high rates of stunting observed in coastal districts. The "coastal" phenotype of malnutrition—where children have access to protein (fish) but suffer from chronic malabsorption due to parasites and enteropathy—requires a holistic approach integrating deworming, WASH (Water, Sanitation, and Hygiene), and nutrition [4,41].

CONCLUSION

Summary of Findings

Children in coastal areas of Southeast Asia face a convergence of risks that sustain high rates of intestinal parasitic infection. The prevalence of STH and protozoa remains high, often exceeding 50%, driven by sandy soils that favor hookworm, high water tables that compromise sanitation, and tidal flooding that disseminates pathogens. *Trichuris trichiura* is often the most persistent parasite, while waterborne protozoa exploit contaminated groundwater. Standard interventions have had limited success due to rapid reinfection and technological maladaptation.

Recommendations

To address these entrenched challenges, a shift from generic to context-specific interventions is necessary, beginning with technological innovations that prioritize the deployment of "amphibious" sanitation systems such as Tripikon-S and elevated latrines in coastal settlements while officially discouraging standard latrine designs in high-water-table zones. This approach must be supported by critical septic tank management, specifically the implementation of scheduled desludging services to prevent the frequent overflows common in these environments. Furthermore, enhanced therapeutic strategies are essential; given the high prevalence of *Trichuris* and its poor response to single-dose albendazole, health departments in coastal districts should consider alternative regimens, such as triple-dose albendazole or a combination of albendazole and ivermectin, which has demonstrated significantly higher efficacy. On the environmental and behavioral front, improving access to piped, clean water remains a non-negotiable requirement to reduce protozoan infections, while targeted health education must be employed to dismantle the misconception that the sea naturally "cleans" waste. By fostering community-based monitoring of beach hygiene to shift social norms regarding open defecation and conducting future research on how sea-level rise and frequent tidal flooding accelerate parasite transmission, stakeholders can move beyond one-size-fits-all approaches. Ultimately, by recognizing the unique "coastal phenotype" of intestinal parasitic infections, it is possible to implement targeted, resilient solutions that protect the health and development of millions of children living on the frontlines of the ocean-land interface.

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