



Strengthening Parasitic Infection Prevention and Control Practices: An Aspect of Health Promotion

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Author's contribution

The sole author designed, analyzed, interpreted and prepared the manuscript.

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ABSTRACT

Aims: to describe aspects of specific health promotion which will strengthening parasitic infection prevention and control practices.

Discussion: Health promotion is a dynamic and continuous process of enabling people to have increase control over and to improve their own health by finding the root causes of health problems and its underlying condition and to overcome barriers and also to improve aspects of socioeconomic, level of knowledge, environmental improvement, political and legislative arrangement and even law enforcement if necessary. Those aspects, which also work in the case of Parasitic diseases such as malaria and STH, are important part of early intervention and disease prevention and can be used to help build social and physical environments that support healthy behaviors. Health promotion approach for parasitic disease is always specific and based on the existing knowledge regarding the parasite's life cycle and its existence in nature and interaction with other organism inhabitants of the same environment.

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Conclusion: The complexity of specific health promotion regarding parasitic infection, in which programs to control or eliminate parasitic diseases are positioned, and the development of better understanding regarding its contributing factors are still a major issue in parasite disease control. The competition for resources in the health as well as other social sectors will be a continuing challenge; effective parasite control will be dependent on how such resources are accessed and deployed to effectively address well-defined problems some of which are readily amenable to successful interventions with proven methods. Failure to sustain control of parasites is always a threat for the society, but health promotion and health education is always being a primary option to prevent parasite transmission, controlling the parasitic epidemiology and followed by the establishment of better healthy community.

Keywords: *Soil transmitted helminthiasis; malaria; neglected tropical diseases; socio-economic; level of knowledge; environmental change.*

1. INTRODUCTION

Human parasitic infections such as soil transmitted helminthiasis (Chen et al., 2024), malaria (Liu et al., 2021), and many parasitic neglected tropical diseases (NTDs) (Hudu et al., 2024), have long delineated an enigma in global public health problem (Chen et al., 2024; Liu et al., 2021; Hudu et al., 2024), even in the era of postmodern pandemic such as Covid-19 (Ung et al., 2021). It is actually originated since ancient era (Mitchell, 2024), its persistence ability to some extent (Tarannum et al., 2023), and supremely difficult to prevent and to become a major challenge (Sato et al., 2018). The actual problem is still hiding underneath as an iceberg phenomenon (Scott, 2023). Understanding the scope of the problem is a critical entry point for health promotion and health education regarding parasitic infection.

“Morbidity and mortality due to parasitic diseases and its long-term consequences” (Izquierdo-Condoy et al., 2024; Khalil et al., 2018) is enormous. The disease burden due to most parasites is highly decisive and results in significant annual global morbidity and mortality (Chen et al., 2024; Liu et al., 2021; Hudu et al., 2024; Ung et al., 2021; Izquierdo-Condoy et al., 2024; Khalil et al., 2018) among vulnerable subpopulations such as children (Štrkolcová et al., 2024) and women (Gonzales et al., 2016), immigrants (Requena-Méndez et al., 2023) or asylum seeker (Ceccarelli et al., 2018) or refugee (Müller et al., 2022) and also travelers or tourists (Steverding, 2020; Norman et al., 2015) or other imported cases (Song et al., 2018).

Malaria as the major blood based parasitic disease killer, estimated responsible for 228 million cases of malaria with 405,000+ deaths in 2018 just for malaria falciparum only

(Zekar, 2023), predominantly in very young children in sub-Saharan Africa (Oshagbemi et al., 2023) “while parasitic kinetoplastid infections represented by visceral Leishmaniasis (95% mortality rate if left untreated and associated with associated with 2,357,000 disability-adjusted life years (DALYs)” (Yeshaw et al., 2020), Chagas disease with reported mortality rate varies widely, ranging from 0.2–19.2% per year (Cucunubá et al., 2016), and “African trypanosomiasis also known as African sleeping sickness, has a mortality rate of almost 100% if left untreated” (Hollingshead & Bermudez, 2024).

Other common parasitic infection, namely intestinal protozoan infections caused by Cryptosporidiosis cause over 50,000 deaths each year (Gerace et al., 2019) and amoebiasis is responsible for 40,000 to 110,000 deaths per year (Zulfiqar et al., 2023). Overall, foodborne parasitic disease, excluding the already mention enteric protozoa, caused a roughly calculated 23.2 million morbidities with cases of annual mortality estimated 45,927 cases; and this resulting in an approximated 6.64 million DALYs (Torgerson et al., 2015). Furthermore, the darling of STH namely *Ascaris* infection has a global prevalence of 11.01% from 2010 to 2021 (Holland et al., 2022) and was the most common foodborne parasitic diseases in human (de Lima Corvino & Horrall, 2023). In other important but commonly forgotten aspect of parasitic infection causing DALYs, Human cysticercosis affected 1.61 million DALYs just in the year of 2017 (Abraham et al., 2020), foodborne trematodosis overelaborate 780,000 DALYs (Sithithaworn et al., 2024) and foodborne toxoplasmosis with 32,700 DALYs just in in the United States, Canada and Europe (Scallan et al., 2015); “these three resulted in the sky-scraping burdens in terms of DALYs, primarily due to physico-socio-economic impact on years lived with disability.

Regarding Foodborne enteric protozoa, published elsewhere, actually responsible for an extra 67.2 million illnesses or at least 492,000 DALYs” (Bintsis, 2017).

No matter how great the research method, how broad the scope and number of samples or respondents analyzed, whatever the scientific approach, there will always be weaknesses found in research stage (Siagian, 2023). Major limitations in the effort to correctly measure the scope of the problem commonly consist of considerable data gaps due to different reporting models and methods between countries (Nilashi et al., 2023) which “potentially caused significant loss of data, e.g., data that had to be filled by imputation and suffer from the uncertainties that surround such models. Another reason for the discrepancies is due to certain local resource limitations which was also not possible to consider all potentially foodborne parasites” (Scallan et al., 2015).

A primary aim of any type of health system is actually addressing to prevent disease to occur in the first place (Caron et al., 2023), intervene as early as possible, and reduce ill health (National Academies of Sciences, Engineering, and Medicine, 2019) so that people remain as healthy as possible for as long as they can; and these in combination so called prevention strategies (Kisling & Das, 2023). Most parasitic infections are often linked to areas with inadequate sanitation and poor practice of personal hygiene. Successful control of such parasitic infections must be supported by economic development and welfare leap, in combination with improved health consciousness through health promotion. This paper aim to describe aspects of specific health promotion which will strengthening parasitic infection prevention and control practices.

2. HEALTH PROMOTION

“Health promotion is an eclectic term that has as its bedrock on the continuous process of enabling people to increased control over and to improve their own health” (WHO; Caron et al., 2023). Health promotion activities are active steps to seek the root causes of health problems and its underlying condition and to overcome barriers and also to improve aspects of:

1. socio-economic by managing social determinants of health (SDOH). SDOH are

real conditions that can exert influence on health status, and recent study shows that these conditions can be more paramount than just regular health care service or lifestyle choices (Chelak & Chakole 2023),

2. level of knowledge through health education or health literacy, by providing sufficient education and proper information, and also by establishing supportive environments based on the improvement level of knowledge (Naik & Naik, 2024). Furthermore, it can improve people’s awareness to make healthier choices and have more control over their health,
3. “environmental change where health promotion professionals are uniquely qualified to develop initiatives to address climate change by shifting beliefs and attitudes” (Johnson et al., 2021) through exploring public health/health promotion responses to climate change and the health and well-being of vulnerable sub population,
4. political and legislative condition. health promotion is politically imperative because it is actually funded by the government and involves shifting and balancing power. It is also a way to make healthier choices the easier choice for policymakers (de Leeuw et al., 2021; van Dijk et al., 2019),
5. law enforcement, e.g., in condition of public health emergencies during Covid pandemic. Law enforcement can promote health by working with public health agencies to address the root causes of crime and improve community safety. This approach is called a public health approach to policing (Institute of Medicine (US) Committee on Assuring the Health of the Public in the 21st Century, 2002).

“Holistic conditions needed to be establish in order to promote health, while recognizing the wider determinants of health such as biology, social and environmental” (Pérez-Stable & Sayre, 2019). “Achieving equity in health is an ultimate aspect of health promotion, that is, minimizing the differences in health status and ensuring equal opportunities and resources to all people to ensure optimal health” (Deepika et al., 2024). Next, we will discuss these aspects further in a more limited scope, namely in the health sector within the framework of prevention and/or control of parasitic diseases.

3. SPECIFIC HEALTH PROMOTION REGARDING CONTROL AND PREVENTION OF PARASITIC DISEASE

Health promotion activities such as education, social marketing, legislation and regulation, are an important part of early intervention and disease prevention and can be used to help build social and physical environments that support healthy behaviors. Health promotion approach for certain parasitic disease is always specific and based on the existing knowledge regarding the parasite's life cycle and its existence in nature and interaction with other organism inhabitants of the same environment.

"The effort to control and combat parasitic diseases of humans (PDH) has been embraced since the identification of definite parasitic organism (etiology) and natural history of the infections (port de entry, transmission, disease course, sign and symptom) was studied and recognized. In response to the growing impact of PDHs, more advanced detection techniques have been researched, carefully explored and developed. To clearly identify these parasites, the diagnostic method's efficacy is paramount; In view of the above, microscopy as a traditional gold method is now assisted by the more advanced approach, e.g., immunoassay, serology and molecular biological apparatus" (Bahk et al., 2018). "The modern technological tools will help to assess the efficacy of eliminating these parasitic illnesses and future control programs" (Ndao 2009, Bahk et al., 2018).

"The unwanted and deleterious effects of these parasites on human health and well-being is carefully scrutiny by academicians, policy makers, medical practitioners and public health experts. However, some parasitic infections have proved difficult to control such as malaria- as defined by a sustained reduction in incidence" (Liu et al., 2021; González et al., 2016; Requena-Méndez et al., 2023; Zekar & Sharman 2023; Oshagbemi et al., 2023) or other low prevalence human parasite which screening and diagnosis are also difficult to conduct (Lapat et al., 2024). On the other hand, some parasite, particularly intestinal helminth infections, can be fruitfully managed and controlled (Miao 2024). A good understanding of the biological characteristics of parasites, their specific and unique life cycles, their interactions with the environment and hosts, as well as transmission routes and modes of

infection is essential in prevention and control efforts (Fernández et al., 2019).

The possibility of different approaches to control this parasitic infection can be divided into (1) the patient perspective: starting from diagnosis, to pharmacology management until successful treatment which cure of the clinically infected patient, and (2) the community perspective: to control the transmission within the community by preventative chemotherapy and vector control.

In the following section, the concepts of approach via socio-economic, level of knowledge, environmental change, political condition and law enforcement in order to establish eradication, elimination and control of parasitic infection are defined and examples of success summarized.

Socio-economic approach to establish eradication, elimination and control of parasitic infection "Parasitic diseases present a significant socio-economic impact to society" (Fernández et al., 2019). "Mitigating the effects of these diseases may consist of attempts at eradicating specific diseases if possible at a global level" (Caron et al., 2023; Liu et al., 2021), "eliminating them at a national or local level or controlling them to minimize incidence" (Kisling & Das, 2023). "The choice of approach will be determined by the potential effectiveness of a disease control programme, its cost and the cost effectiveness or cost benefit of undertaking the intervention" (Bahk et al., 2023).

"Socioeconomic variables contribute to societal stratification and health disparities among persons of different social and economic classes, genders, and ethnicity. More specifically, Social determinants of health (SDOH) significantly influence diseases with environmental components, e.g., vector-borne parasitic diseases. A study conducted by Ibrahim et al analyzed how these SDOH factors influence vector-borne parasitic diseases (VBPDs) transmission in Chad and provide recommendations for policy improvement" (Ibrahim et al., 2025). Both nomadic and sedentary rural populations were incorporated to provide a comprehensive understanding. These researchers concluded that educational deficiencies, lack of protective measures against vectors, in-adequate healthcare resources, and lifestyle conditions aggravated by poor road infrastructure, limited transportation, and economic constraints contribute to worsened

VBPDs outcomes in these rural populations. Addressing these systemic issues in the surveyed communities is essential for improving health equity and VBPDs outcomes in these regions specifically and in similar populations settings more broadly.

In other study setting, Hasyim et al in Indonesia analyze the relation between socio-demographic factors and malaria prevalence (Hasyim et al., 2019). The analysis of baseline data (socio-demographic) acknowledged the ensuing independent risk variables correlated to malaria prevalence, e.g., gender, age, occupation, knowledge of the availability of healthcare services, measures taken to protect from mosquito bites, and housing condition of respondent's/study participants. Multivariate analysis found that respondents who were unaware of the accessibility of health facilities were 4.2 times more likely to suffer from malaria than those who were attentive to the existence of health facilities. These researchers concluded that several factors considered as manageable and would favor malaria elimination include a range of specific prevention practices at the individual level and applying the already established networks at the community level of primary health-care centers. This study also proposes that advancing the accessibility of a variety of health services/facilities in endemic regions, disseminate adequate information about the health services they provide, and also the correct access to these facilities are very important.

From at least those two studies we learnt that Improving SDOH can help reduce health disparities and improve health outcomes through health equity (Naik & Naik, 2024), including those affected by parasitic infection.

Level of knowledge approach to establish eradication, elimination and control of parasitic infection The underlying theory of knowledge, attitude and practice (KAP) studies is that increasing knowledge will change attitudes and practice (Bano et al., 2013). The application of KAP intervention have been used in an extensive health problems including intestinal helminths and protozoa infection among school children, especially in the rural region where transportation and health service were limited (Ahmed et al., 2017; Danish et al., 2021; Brice te al., 2020), survey of obstetrician-gynecologists in the United States about trichomoniasis (Liu et al., 2019), and epidemiologically important parasitic disease

control such as malaria (Hasyim et al., 2019). Sufficient awareness and appropriate knowledge of a disease are efficacious in warding off and domineering the disease. Better participatory strategies from the community are expected and one of the strategy is by proper health education to make a durable impact against parasitic infections. Community engagement and participation to certain health programme has played a critical role in successful disease control and elimination campaigns in many countries (Atkinson et al., 2019; Bardosh et al., 2023; Ezeigbo et al.,2016).

Nguyen et al reported the Effectiveness of health education in improving knowledge, attitude and practice regarding foodborne infection caused by zoonotic trematodes in Vietnam, with certain focus on the liver trematodes, *Clonorchis sinensis* (Nguyen et al., 2024). On the other hand, Khanna et al, employing patient-centric health education for the prevention of parasitic infections (Khanna et al., 2024). After sufficient health education interference, a statistically significant improvement was counted in patients' level of knowledge and attitudes toward parasitic infections, as exhibited by their post-test points contrasted to the result of their pretest points. In addition, there were pronounced improvements in handwashing skills following the implementation of the handwashing educational program.

Those researchers confirm that improving level of knowledge through proper health education and health promotion is vital in promoting adequate hygiene practice, reducing contact and preventing parasitic infections, and minimizing timely medical care for these unwanted conditions.

“Positive effect of increased knowledge on better practices towards parasitic infections have been reported. Health education activities organised in the local community resulted in a change in perception of risks associated with fish borne trematode transmission, as reported by Chaisiri from Thailand” (Chaisiri et al., 2018). “Other study from Africa regarding Malaria revealed that health education interventions are moderately effective in improving malaria knowledge and insecticide-treated nets (ITN) usage and have contributed to the effort of global malaria strategy” (Onyinyechi et al., 2023).

Environmental change approach to establish eradication, elimination and control of parasitic

infection. Environmental changes, such as climate change (Short et al., 2017), condition of deforestation (Estifanos et al., 2024), and human related development, can facilitate the transmission of parasitic diseases. These changes can shift the conditions of parasites dynamics (Estifanos et al., 2024) and their vectors which also affected their living condition, breeding ability, and transmitting disease (Confaloneri et al., 2014). Each environmental change actually shifts natural circumstance or through definite human intervention, causes the ecological imbalance and condition within which vectors and their parasites interact, e.g., breed, develop, and transmit disease. The mixture of vectors, their abundance and biodiversity, vectorial capacity and competence and host biting behavior can be affected by any one of the multifactorial shifts arising as ecological stability is disintegrated (Rocklöv & Dubrow, 2020; Pascual et al., 2022). The act of deforestation (Estifanos et al., 2024) and following “changes in land use, human settlement, commercial development, construction of roads, water control systems (channel for shipping, irrigation systems, canals, dams, reservoirs), and climate, singly and in combination, have been escorted by global increases in morbidity and mortality from a number of emergent parasitic diseases” (Chu & Karr, 2017).

Nearly all infectious organisms, especially parasites, were actually “environmentally arbitrated” to some extent meaning that their existence in the environment can be considered as bio indicators (Nachev & Sures, 2016). In the environment, parasite also spend time in reservoirs and can be transmitted from those reservoirs to human hosts (Davenport et al., 2024).

Fortunately, many infectious diseases were primarily controlled through environmental interventions, e.g., vector control (Wilson et al., 2020), water sanitation (Budge et al., 2022). On contrary, few were primarily controlled by integrated methods, i.e., combining medical and environmental interventions (Maqbool et al., 2017). By continuous improvement and active surveillance of systems-based approaches directed for better controlling environmentally mediated diseases of humans, in an era where the environment is rapidly altering, is one of the key factor to control environmentally related parasitic disease. (Hopkins et al., 2022).

Political and legislative approach to establish eradication, elimination and control of parasitic

infection Bao et al reported how legislative approach successfully prevent the spread of *Anisakis spp*, a nematode which parasitize many commercial fish species and are responsible for a fish-borne zoonosis (anisakiasis) and allergic reactions (Bao et al., 2019). The hidden problem with Anisakis is that it can further cause consumer distrust in any fishery products and responsible for economic losses to the fish industry.

Previously, only visual inspection (and candling) of fishery products was required by EU legislation (The Commission of the European Communities, 2005); but unfortunately, it is not sufficient for parasite detection. Consequently, visible (and non-visible) Anisakis reach the free market and may be encountered (and even eaten) by vulnerable consumers. Marine fish appears to be the only industrial food product that is at high risk of containing parasites when placed on the market.

“Anisakiasis and allergy caused by the nematode Anisakis are concealed and underestimated global emerging zoonosis” (Siagian & Maryanti, 2021). “There is an urgency to better understand the impact of these zoonosis on individual health and particularly exposed human populations, and to continuously screens the risk constituted by Anisakis allergens in deep sea fishery products” (Fruscione et al., 2024). “Quantitative risk assessment (QRA) is identified as an appropriate methodology as it estimates the risk from fishing ground to human disease” (Bao et al., 2017).

Continuous improvements in parasite control legislation and procedures (e.g. establishment of research-based and standardized parasite detection methodologies, appropriate sampling methods, development of non-destructive techniques for detection and removal of nematodes from fish products), suitable for use by seafood businesses, are recommended to improve protection of consumers and to protect the industry by minimizing Anisakis-associated economic losses. QRA may help to provide the scientific basis for improved food safety legislation and strategies to reduce the risk of anisakiasis/allergy in humans.

“The implementation of proven strategies as a result of solid resources within the health system in combination with centralization of health management through health-sector reform and the strong support of financial and human resources are strong example of political and

legislative approach to tackle parasitic infection; just as in the case of China's increasing involvement in international cooperation and the increased risk for (re)emerging tropical diseases in mind, the Chinese Government designated in 2017 a new Chinese Center for Tropical Disease Research to the National Institute of Parasitic Diseases (NIPD) at the Chinese Center for Disease Control and Prevention (China CDC) has been instrumental in supporting the remarkable progress from high prevalence to transmission interruption or low endemicity of several diseases. This has taken place through technical guidance, emergency response and scientific research as well as providing technical service, education, training, health promotion and international cooperation" (Chen et al., 2020).

Political and legislative approach or attempts in developing countries towards control of parasitic infections is rare and limited and does not give the complete picture regarding the effort to global parasitic eradication.

Law enforcement approach to establish eradication, elimination and control of parasitic infection So far, no articles in the internet have been found regarding law enforcement related to parasitic diseases, either in the context of establishing eradication, elimination and control of parasitic infection. However, learning from the experience of the spread and severity of Covid, it would be good for parasitologists to also be prepared for similar scenarios and their mitigation.

4. CONCLUSION

The complexity of specific health promotion regarding parasitic infection, in which programs to control or eliminate parasitic diseases are positioned, and the development of better understanding regarding its contributing factors are still a major issue in parasite disease control. The competition for resources in the health as well as other social sectors will be a continuing challenge; effective parasite control will be dependent on how such resources are accessed and deployed to effectively address well-defined problems some of which are readily amenable to successful interventions with proven methods. Failure to sustain control of parasites is always a threat for the society, but health promotion and health education is always being a primary option to prevent parasite transmission, controlling the parasitic epidemiology and followed by the establishment of better healthy community.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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