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Moving Beyond MDA to Control STH Infections through WASH, Hygiene Education, and Community Engagement

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ABSTRACT The main types of soil-transmitted helminths (*Ascaris lumbricoides*, *Ancylostoma duodenale*, *Necator americanus*, and *Trichuris trichiura*) infected approximately 1.45 billion people in 2010, making them collectively the most common parasitic disease that infects humans. Children residing in low and middle income countries without adequate water, sanitation, and hygiene bear the majority of the burden of morbidity and mortality from these infections. School-based mass drug administrations of oral anthelmintic treatments is recognized as the primary means of infection control; however, these treatments alone are not solely capable of eliminating infections and breaking the cycle of disease transmission. Other approaches, such as improvements to water sanitation infrastructure and increasing hygiene education, are also promising, although these approaches have too fallen short in their ability to eliminate infections on their own. The inclusion of community engagement in the development and implementation of interventional infrastructure is a concept that has been moving towards the forefront of community health research for some time. Research shows that the centering of host communities in the design, implementation and evaluation of mass drug administration, water sanitation and hygiene education programs produces sustainable reductions in infection and transmission rates, maximizes intervention success and ensures long-term deliveries of maximal program benefits. For the purposes of this paper, we elected to focus especially on the benefits of incorporating community engagement into water sanitation-based interventions. We reviewed thirty articles that discussed the benefits of intervention implementation in communities across South America, Asia, and Africa. While limiting factors included the short time frames of some of the studies and a lack of attention to potential confounding variables, we found a promising relationship between the integration of community engagement into intervention development, and the resulting success of the integrated interventions.

KEY WORDS Soil-Transmitted Helminth Infections, Mass Drug Administration, Water Sanitation,

Introduction

Over 1.5 billion people worldwide are afflicted by soil-transmitted helminth (STH) infections: *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Necator americanus*, and *Trichuris trichiura* (Ercumen et al., 2019). The disease burden mainly affects low and middle-income countries (LMICs) that lack adequate water, sanitation, and hygiene (WASH), since transmission mainly occurs via contact with soil contaminated with infected human feces (Khan et al., 2019). STH infections cause iron-deficiency anemia, malnutrition, and adverse outcomes in growth and cognitive development of children (Echazú et al., 2015). Infection control has relied on annual school-based mass drug

administration (MDA) of oral anthelmintic treatments, most commonly albendazole or mebendazole; however, MDA is not solely capable of eliminating STH infections because it does not interrupt the environmental transmission of infection, and therefore presents a high risk of re-infection (Khan et al., 2019; Vaz Nery et al., 2019; Ziegelbauer et al., 2012).

While improvements in WASH infrastructure - such as increased access to safely managed water sources and latrines, and adequate fecal management - are critical in the fight to reduce environmental transmission of STH infections, these infrastructures must be accepted by the host community and coupled with behavior changes in order to achieve long-term, sustainable reductions in infection and transmission rates (Ercumen et al., 2019; Worrell et al., 2016; Al-Delaimy et al., 2014; Parker et al., 2008; Watson et al., 2017).

The centering of host communities in the design, implementation and evaluation of WASH and MDA interventions increases intervention acceptance within the host community, which in turn maximizes the efficiency and beneficial outcomes of the programs (Clarke et al., 2018; Gyorkos et al., 2013; Muluneh et al., 2020).

Existing Interventions Combatting Soil Transmitted Helminth Infections

Interventions to control STH infections include MDA, WASH infrastructure improvements, and health education. Many health education and deworming programs are school-based, since children are most impacted by STH infections (Al-Delaimy et al., 2014; Gyorkos et al., 2013). Other interventions are community-based, focusing on improving hygiene behaviors within households (Dumba et al., 2013; Ercumen et al., 2019). A critical, but often forgotten, factor of any intervention is community engagement (Al-Delaimy et al., 2014; Clarke et al., 2013; Dumba et al., 2013). Peer-reviewed literature advocates for community-led integrated interventions, which combine MDA campaigns, WASH infrastructure and health education (Anderson et al., 2014; Khan et al., 2019).

Mass Drug Administration

School-based MDA campaigns have historically been the most common, and oftentimes only, intervention used to combat STH infections (Campbell et al., 2018). While MDA reduces STH infections substantially, it does not address reinfection and potential parasite reestablishment and drug resistance (Benjamin-Chung et al., 2015; Campbell et al., 2016; Khan et al., 2019). Mathematical modeling shows that MDA with school-aged children alone is insufficient in eliminating STH transmission without also including adults and preschool-aged children in MDA efforts (Anderson et al., 2014). Additionally, MDA campaigns in LMICs have been plagued with funding and delivery issues, making treatment inconsistent and eradication impossible (Campbell et al., 2018). MDA also does not address the environmental and structural root causes of STH infections (Benjamin-Chung et al., 2015; Khan et al., 2019).

WASH Infrastructure Interventions

Risk factors for high transmission rates in children include open defecation and a lack of handwashing (Nasr et al., 2013). The odds of contracting STH infections is shown to decrease with piped water and latrines (Campbell et al., 2016). Therefore, WASH infrastructure improvements are expected to interrupt the environmental transmission of STH infections and supplement the reductions in STH burden achieved by MDA (Anderson et al., 2014; Campbell et al., 2017).

However, there is significant inconsistency in the demonstrated impact of WASH intervention on reductions in STH infections (Vaz Nery et al., 2019). Freeman et al. (2013) found little impact of school-based WASH interventions on STH infections in Nyanza Province, Kenya in their cluster-randomized trial. Ercumen et al. (2019) studied the effects of WASH infrastructure improvements (water treatment, latrines, hand washing stations) in a cluster-randomized trial in rural Bangladesh. The water treatment and sanitation interventions reduced prevalence of some, but not all, STHs, and handwashing promotion had no effect on any of the STH infections (Ercumen et al., 2019). The lack of efficacy of handwashing promotion alone is also supported by a systematic review of school-based handwashing interventions in LMICs by Watson et al. (2017).

Health Education Interventions

School-based health education interventions alongside MDA have shown some success in reducing STH infections (Gizaw et al., 2019; Vaz Nery et al., 2019). Al-Delaimy et al. (2014) developed the STH Health Education Learning Package (HELP) for indigenous children in a highly endemic region of Malaysia. HELP improved the STH knowledge, attitudes, and practices of children, parents, and teachers. Additionally, stool

samples showed significantly lower incidence and intensity of infection among children in the intervention schools (Al-Delaimy et al., 2014). Similarly, in the Peruvian Amazon, Gyorkos et al. (2013) employed a school-based health education intervention. The children who received the intervention demonstrated increased knowledge of STH infections and reported improved hygiene behavior. However, there were no significant differences in the prevalence of STH infections between the intervention and control groups, though there was a significant reduction in *A. lumbricoides* intensity (Gyorkos et al., 2013). The inconsistencies of school-based interventions' success in reducing STH infections prevalence and intensity is indicative of an overlooked piece of STH and global health intervention efforts in general: community engagement.

Community Engagement

There are various ways to incorporate community input into the design, delivery, and decision-making processes of both school and community-based STH interventions. It is also important to note that while crucial, the incorporation of community engagement into an intervention does not automatically guarantee the intervention's success. Factors such as the amount and type of input, as well as the duration of the program design and implementation can lead to variety in efficacy across programs.

Extensive research into community engagement efforts and their effect on STH infections is lacking, but available research points to its utility and benefits if performed well. For example, Al-Delaimy et al. (2014) relied on the popular PRECEDE-PROCEED model to design their school-based health education intervention in Malaysia. This involved extensive communication with academic experts, community leaders and their members to understand all the factors that could influence infection control efforts. School teachers were employed as messengers of health promotion and children received the necessary products to improve hygienic behaviors. Results showed reduced infection rates and intensity of STH infections, as well as improved knowledge, attitudes, and practices regarding STH infections and WASH best practices among the teachers, students, and parents (Al-Delaimy et al., 2014). Gyorkos et al. (2013) suggests that the inclusion of family members as audiences for school-based health interventions is a critical engagement method to expand the intervention's benefits to the wider community.

Clarke et al. (2018) implemented an intervention in six villages in Timor-Leste. Six villages received the intervention, three of which received additional CLTS to encourage the construction of latrines. The CLTS villages saw 18.1% less children reporting open defecation compared to the school-based interventions (Clarke et al., 2018). There is evidence, therefore, that the most significant reductions in STH infections can be achieved through interventions in communities rather than in schools.

The effect of community-centered interventions on STH infections varies. Dumba et al. (2013) employed a community engagement-based education intervention in Uganda using the Participatory Hygiene and Sanitation Transformation (PHAST) method. Families who participated in the program identified the problem of poor sanitation, decided what aspects of sanitation needed improvement, and planned solutions via new facilities and behavior change. There was a notable change in hygienic behaviors among intervention participants; however, the reductions in STH infections were not significantly different between intervention and control communities. The researchers suggested that this was due to a short follow-up period, which did not give sufficient time for the reductions in environmental transmission that follow behavior change to become detectable in the communities (Dumba et al., 2013).

Hürlimann et al. (2018) used the participatory approach of community-led total sanitation (CLTS), which aims to sustain open-defecation free (ODF) communities. One year post-intervention, they did not find significant differences in STH reinfection rates between intervention and control communities (Hürlimann et al., 2018). On the other hand, CLTS was found to reduce STH infections in kebeles in Ethiopia by 49% in ODF communities (Muluneh et al., 2020). In ODP kebeles, children who used latrines had a 2.15 times lower risk of STH infections than those who did not (Muluneh et al., 2020).

Shortcomings of Current Studies

A short follow up period is often cited as a limitation in intervention studies (Ercumen et al., 2019; Gyorkos et al., 2013; Hürlimann et al., 2018). Each STH responds to WASH interventions differently, due to differences in lifespan, ova and other biological factors (Coffeng et al., 2018; Vaz Nery et al., 2019). Interventions need to be studied over substantial periods of time in order to understand their true impact on disease burden and behavior change.

Additionally, variations in intervention effect stem from variances in baseline prevalence (Vaz Nery et al., 2019). Significant infection reductions are easier to detect in highly endemic places, such as the region in Malaysia studied by Al-Delaimy et al. (2014), versus communities with a low baseline prevalence. A more appropriate gauge of intervention impact in low endemic areas is to measure intensity rather than prevalence of STH infections (Anderson et al., 2014; Baker et al., 2018; Vaz Nery et al., 2019), as was done by Gyorkos et al. (2013).

Even a household with improved WASH infrastructure and demonstrated hygienic knowledge is at risk of infection if its members continue with certain behaviors such as walking barefoot, geophagy, or poor maintenance of sanitation facilities (Freeman et al., 2013; Mather et al., 2020; Vaz Nery et al., 2019; Worrell et al., 2016)). Failing to consider behavioral variables as targets and outcomes of interventions can moderate and negatively impact the effect of WASH interventions (Mather et al., 2020; Vaz Nery et al., 2019).

Limitations and Future Research Recommendations

Given only 30 articles are examined out of a wider literature, the scope of this article is limited. Articles were selected to investigate the breadth of interventions that intend to control STH infections both alone and in combination: MDA, WASH, education programs, and community engagement. The studies chosen for analysis are recent (within the last 15 years) and all take place in LMICs. Each study compares additional WASH, education, or community engagement interventions with the standard treatment of MDA with dewormers.

STH interventions need to be tailored to the study site's endemic context and population behaviors through community engagement (Clarke et al., 2018; Sacolo-Gwbu et al., 2019). The Geshiyaro Project offers a guideline for designing such studies, aiming to determine the effects of community-based MDA, WASH, and health education on 1.9 million people in Ethiopia (Mekete et al., 2019). The forthcoming results of the project will be vital in informing the role of community engagement in working towards the eradication of STH infections through intervention methods that go beyond MDA programs (Mekete et al., 2019).

Conclusion

MDA, while effective, runs the risk of re-infection and future drug resistance, among other problems (Clarke et al., 2018; Parker et al., 2011). Total elimination of STH infections, therefore, requires interventions that interrupt environmental transmission, such as improved WASH infrastructure and hygiene education (Echazú et al., 2015; Mascarini-Serra 2011). The studies reviewed demonstrate that the reduction of STH risk factors can reduce the morbidity of STH infections (Nasr et al., 2013), though results do vary depending on setting and intervention. Studies that incorporate community engagement demonstrated that the impact of WASH infrastructure and hygiene education interventions can be maximized when the community is given a role in the intervention (Clarke et al., 2018; Muluneh et al., 2020). This includes expanding school-based interventions to reach adults in the larger community who can aid children in changing their health behaviors (Clarke et al., 2018). MDA programs must be supplemented by WASH interventions and health education that engage the community in order to achieve the eradication of STH infections.

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