ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 14, Issue, 02, pp. 64804-64809, February, 2024
https://doi.org/10.37118/ijdr.27774.02.2024

RESEARCH ARTICLE OPEN ACCESS

MITIGATING SOIL-TRANSMITTED HELMINTHS DISEASE: LATRINE IMPLEMENTATION AMONG SCHOOL-AGED CHILDREN IN DHARAVI SLUMS, INDIA

***Saumik Das**

Academies of Loudoun; Leesburg, VA, USA

ARTICLE INFO

Article History:
Received 04th January, 2024
Received in revised form
27th January, 2024
Accepted 11th February, 2024
Published online 26th February, 2024

Key Words:

Soil-transmitted Helminths, latrines, global health, health inequity, United Nations Sustainable Development Goals (UN SDGs), global sustainability.

****Corresponding author: Saumik Das,***

ABSTRACT

Background*:* Soil-transmitted Helminths (STH) infections affect 24% of the global population, with India reporting 375 million cases in 2013. The research explored the impact of constructing latrines to reduce STH transmission among school-aged children in Dharavi Slums, India. Open defecation, a prevalent issue, contributes to STH transmission. While mass drug administration has been the primary intervention, this research focused on building latrines to address infection reservoirs. A cluster randomized trial in 30 Dharavi subsections assessed STH prevalence through stool samples before and after latrine implementation, targeting children aged 6-12, the most vulnerable group. The intervention's success was measured by reduced STH prevalence and concentration in stool samples. The study bridged the gaps in existing research on the impact of sanitary infrastructure and incorporates hygiene education and behavioral change to address STH risk factors. The intervention aligned with UN Sustainable Development Goals (SDGs), specifically tackling SDG 6 – Sanitation, by striving for universal access to equitable sanitation and hygiene. Incorporating hygiene education ensured behavioral change, promoting proper handwashing and food handling. Overcoming social-cultural barriers was crucial for latrine acceptance, emphasizing community engagement and new public policy initiatives. This comprehensive approach contributes to SDG targets and underscores the significance of community-driven initiatives in achieving global health goals.

Citation*: *Saumik Das. 2024. *"Mitigating soil-transmitted helminths disease: Latrine implementation among school-aged children in dharavi slums, India". International Journal of Development Research*, 14, (02), 64804-64809.

INTRODUCTION

Global Health Issue & Disease Profile: Soil-transmitted helminth (STH) infections represent one of the most pressing neglected tropical diseases, affecting 24 percent of the world's population. Neglected tropical diseases are those that cause incredible ailment despite existing intercessions.[1] Neglected tropical diseases disproportionately affect the most underprivileged communities and contribute significantly to cyclical poverty and chronic morbidities. They are most common in tropical climates with poor sanitation, which means that developing regions in sub-Saharan Africa and East Asia are most afflicted.[2] India had 375 million cases in 2013, which is more than any other country.[3] Soil-transmitted helminths are a group of intestinal parasites. *Ascaris lumbricoides*, a type of roundworm, affects 807-1,121 million people; whipworm affects 604-795 million people; hookworm affects 576-740 million people.[1] In total, around 1.5 billion people worldwide suffer from an infection of one or more of these parasites.[2] Infection can lead to abdominal pain, diarrhea, blood loss, rectal prolapse, nutritional impairments, and issues with cognitive development, among other symptoms.[1] As such, children are considered the most at risk. More than 835 million preschool and school-aged children reside in regions where helminthic infections are extensively transmitted. Infection prevalence seems to decrease after the age of 15, but all ages can be affected.[4] Soil-transmitted helminth infections are contracted after exposure to parasitic eggs (in the case *Ascaris* and whipworm) or through contact with hookworm-infected soil. Eggs are generally passed through the feces of those infected, and subsequent contact will lead to ailment.[1]

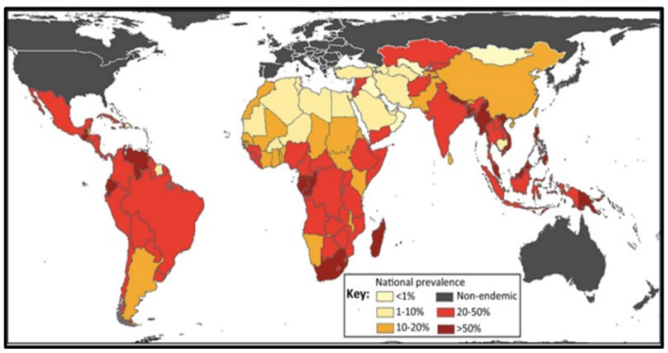

Figure 1. Prevalence map of STH (Campbell et al., 2016)

Numerous behaviors are associated with soil transmitted helminth infections. These behaviors include a lack of proper handwashing, poor food handling, and open defecation.[1-2] This study focuses on the target behavior of open defecation in the subcontinent of India. Approximately 15 percent of India's total population still participates in open defecation.[5] Open defecation can deposit helminth eggs into the soil and has become a significant reservoir of infection.

Subsequent contact with contaminated soil can spread the disease through communities. Many regions in India lack proper sanitary infrastructure, making open defecation not merely a habit, but an inevitability.[6] Open defecation is responsible for many chains of infection, making the need for intervention crucial.

Behavioral Risk Factors

***Figure 2*. Sanitation spectrum of behavior change (Our World in Data, 2019)**

(European Press, 2021)

Figure 3. Sample latrine implementation as a behavior change intervention model (European Press, 2021)

Existing Interventions and Gaps: Recent research regarding soil-transmitted helminth control has focused almost exclusively on mass drug administration to control infection.[3-4, 8-10] The WHO endorses the use of anti-parasitic such as albendazole and mebendazole.[2] India possesses the largest school-based deworming program in the world and delivers medication to combat soil-transmitted helminths in children aged 1-19 years old. Approximately 240 million students receive deworming twice a year. In 2019, 33 states and territories participated.[3] Deworming has been associated with improved nutritional status, cognition, and academic achievement. However, reinfection rates remain high, as deworming does not address the introduction of helminthiasis into communities.[11] Drug administration has performed remarkably well in terms of reducing mortality and morbidity, but it does not function as a preventative. It is proposed that communities shift their focus towards addressing infection reservoirs to work towards disease elimination as opposed to mediation. There has been little research done on the impact of introducing sanitary infrastructure into communities, though lack of latrine access has been positively correlated with soil-transmitted helminth infections.[12] In this study, I hope to address the goal of prevention through ensuring access to basic sanitation. Other studies have probed the relationship between student health education and frequency of soil-transmitted helminth infections. Promotion of healthy behaviors—for example, handwashing with soap and shoe and glove use—is integral in sustaining management of soil-transmitted helminths,[13-14] but it is not always inclusive to all community members, especially those that are most underprivileged. Over six million children in India do not attend school, and 29 percent of children drop out before completing elementary education.[15] Furthermore, the impact of education can only be fully realized if children have subsequent access to sanitation and hygiene resources. This study addresses this by establishing that infrastructure, to which all children (as well as adults) will have equal access to.

Novelty & Purpose: Through our study, we seek to investigate whether building proper defecation infrastructure in Dharavi, India, such as latrines, will reduce the transmission of soil-transmitted helminths among school-aged children. Based on prior research and knowledge of helminth routes of transmission, it can be hypothesized that the implementation of sanitary infrastructure like latrines can be aimed to curtail open defecation, leading to a lower prevalence of novel soil-transmitted helminths infections and by extension, greater community health.

MATERIALS AND METHODS

Study Design: This is a cohort study as the study population's health is being monitored over a long period of time, before and after the intervention. In this study, it will be determined whether building sanitation infrastructure such as latrines reduces the transmission of soil-transmitted helminths in India. Building proper infrastructure

such as toilets and latrines will provide the opportunity for more sanitary defecation and potentially reduce the rate of soil-transmitted helminth transmission. The study population is composed of school aged children (ranging from the ages 6-12),[16] which is the age group where soil-transmitted helminths infections primarily occur in developing countries such as India.[3] A cluster randomized trial performed in which 30 subsections within the Dharavi slums randomly selected and latrines be made for all 30 of those subsections. The control group in this study is the study population prior to the intervention.

there is approximately one toilet per 1,440 people, and the lack of appropriate drainage means that streets become channels for waste during months with heavy precipitation.[19] Participants recruited with assistance from local non-profit organizations with a trusted presence in the studied communities of the Dharavi slums.

Trained researchers, accompanied by health volunteers from the community, approach households within the 30 subsections to recruit individuals.

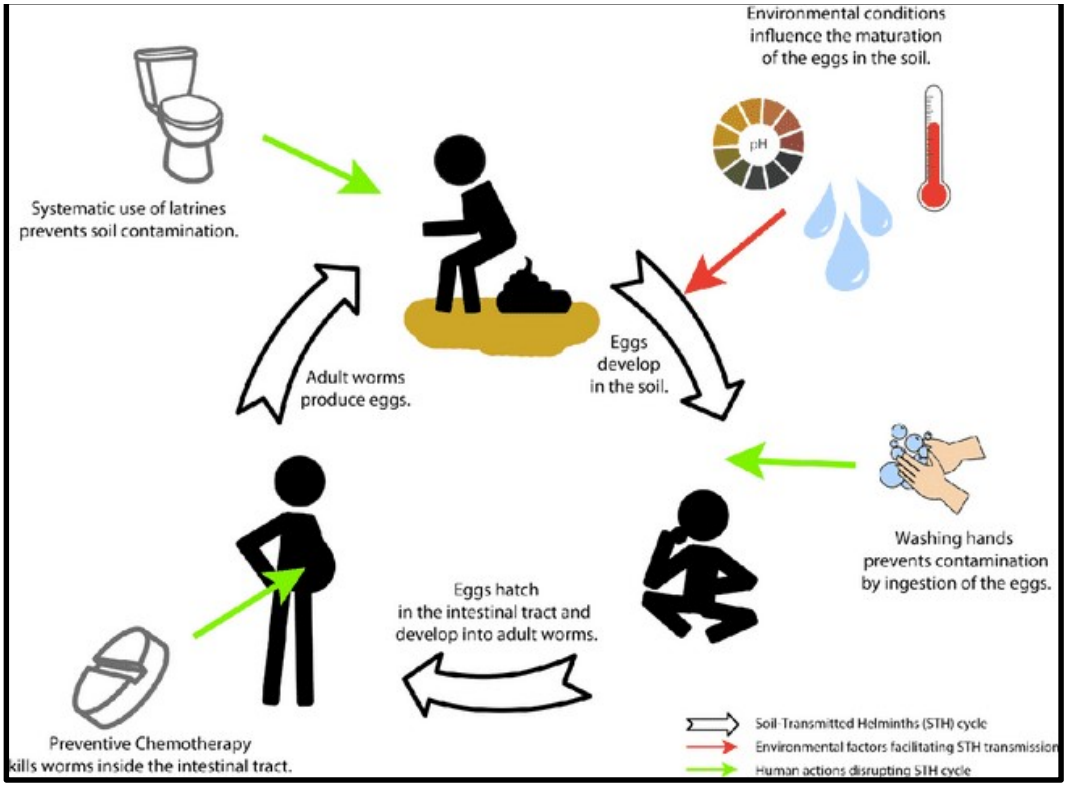

Figure 4. STH Transmission pathway and interventions (University of Geneva, 2015)

Figure 5. Dharavi slums overview (Das, 2022)

Participants & Recruitment: Study conducted in the Dharavi slums, located in Mumbai, India. This area was selected because it is Mumbai's largest slum and is densely populated with a population of approximately one million.[17] Dharavi is religiously and ethnically diverse and has a high prevalence of soil-transmitted helminth infections and very little sanitation infrastructure.[18] It is estimated that

Prior to the study, a questionnaire adapted from the United States Agency of International Development's (USAID) Hygiene Improvement Project (HIP)[20] survey tools to assess access and use of sanitary facilities, as well as prevailing attitudes about open defecation, latrine use, and sanitation in the community. The survey administered to recruited study participants to collect additional

population demographic data, including measures such as age, sex, gender, school attendance, and religion. Additionally, a household survey—also modified from HIP materials[20]—conducted and answered by the parents/guardians/parental figures of the study participants to ascertain generational attitudes about open defecation, latrine use, and sanitation in the community. The household survey consists of additional questions about household income, socioeconomic status, religion, and length of time lived in the location. The primary inclusion criteria is that the study participants must be in the age group of 6-12, and they must have a parental figure present to give consent. The primary exclusion criteria is that they are not in the specified age range, and if prospective study participants are malnourished. Potential study participants who meet the inclusion criteria assessed for malnourishment by measuring the BMI (body mass index); a BMI under 5th percentile[21] for children falls in the underweight category and the child determined as potentially malnourished. If deemed malnourished based upon anthropometric measures, they cannot participate in the study.

Intervention

As baseline data collection, all study participants fill out questionnaires regarding their demographic data, including measures such as age, sex, gender, school attendance and religion. Surveys assess views on open defecation, perspectives on latrines, and views on sanitation, as outlined in USAID HIP materials.[20] Parental figures of the study participants within the household fill out a household survey with questions about household income, socioeconomic status, religion, length of time lived in the location, and questions described by the HIP.[20.] Trained survey teams, accompanied by volunteers from the slums, explain the stool collection procedure to the study participants and their parents. Individuals provided with a sample collection kit. Participants from the randomly selected 30 subsections submit a stool sample every month to community health workers to be sent to the lab. A laboratory set up in district hospitals, and the lab team consist of lab technicians and parasitologists familiar with soil-transmitted helminth infections. This process continues across the period of 6 months before the intervention period.

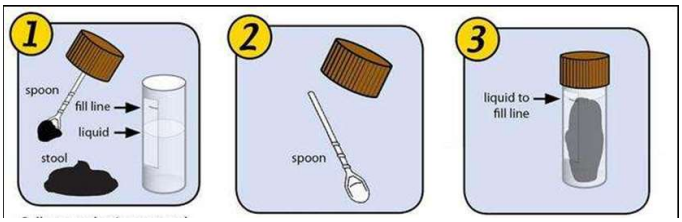

Figure 6. Stool sampling procedure (Aryal, 2021)

The latrines will be built in accordance with HIP suggestions to meet the highest standard of "adequate."[20] Latrines divided into a side for children only and another side for adults; as such, the ethical consideration of allowing people to have access to latrines addressed and focus can still be put on the study population. While randomization is accomplished through subsections being selected, blinding not possible as the study population will certainly be aware of the intervention. Following the implementation of latrine infrastructure, the study participants again submit stool samples monthly for the following six months. Upon completion of the intervention period, study participants assessed by measuring their BMI, as this provides useful follow up data to potentially investigate overall health changes in the population. To ensure the effectiveness of possible interventions, barriers were identified and addressed. Due to the scarcity of proper latrines in underprivileged regions, residents may have skepticism regarding the immediate benefits from the implementation of toilets and sanitation infrastructure.[7] This can be addressed by providing public education on soil-transmitted helminths to cultivate understanding of this pressing issue. Furthermore, identifying and encouraging leading members of the community to use latrines can persuade citizens to be more accepting of these facilities.

RESULTS

Data Collection & Analysis:

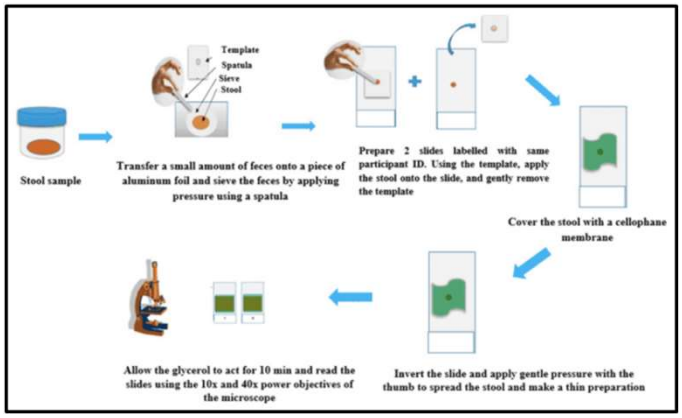

Figure 7. Kato-Katz method (Ngwese et al., 2020)

The transmission of soil transmitted-helminths measured by the prevalence and concentration of eggs and larvae in stool. Stool samples collected from participants monthly before and after intervention. The samples analyzed using the Kato-Katz method,[22] which includes the use of microscopes to describe helminthic infections both quantitatively and qualitatively. The prevalence calculated per gram of stool according to World Health Organization guidelines.[23] To measure malnutrition, the BMI, height, and weight of the study participants recorded. These anthropometric measurements used to determine if study participants are malnourished; a BMI of below the fifth percentile for children qualify as malnutrition.[18] BMI calculated using the height and weight measurements coming from a standard physician scale. To assess the preliminary demographic data, as well as baseline attitudes on sanitation, a survey adapted from USAID HIP materials deployed to individuals and households. Throughout the course of the study, researchers inspect latrines to ensure continuous functionality, monitor how often people in the experimental group are using the facilities, and maintain upkeep in accordance with HIP guidelines.[20] Some of the instruments that used: Sample collection kit – includes small spatula and slide template for collecting stool samples, Microscope – used to examine eggs in stool to determine prevalence of soil-transmitted helminths, Scale – used to measure the weight of a participant to calculate BMI and Stadiometer – used to measure the height of a participant to calculate BMI.

Table 1. Kato-Katz expected data for varying STH species (Fitriani *et al.*, 2018)

Type STH	Result	Kato-KatzTechnique	
		n	%
A.lumbricoides	Positive	5	6.25
	Negative	75	93.75
T. trichiura	Positive	22	27.5
	Negative	58	72.5
Hookworm	Positive	11	13.75
	Negative	69	86.25

DISCUSSION

Expected Outcomes: Following the intervention, we expect a decrease in the presence and concentration of eggs and larvae in the subjects' stool. We anticipate that the number of eggs per gram of stool will decrease, conveying a correlation between the implementation of latrines and the decrease in soil-transmitted helminth transmission. Previous studies have found that improvements in water, sanitation, and hygiene (WASH) are associated with lower helminth transmission rates.[24] Since our intervention markedly improves the accessibility to and standard of sanitation in the Dharavi slums through infrastructure construction, it should have similar positive results. Since open defecation also leads

to the transmission of other diseases such as typhoid and cholera,[25] we predict positive spillover within the population, potentially decreasing the rate of transmission for those diseases as well.

Review of Strengths & Limitations: The main strength of our proposed study is our ability to compare control and intervention groups without withholding treatment. Since the same individuals serve as the control group, only at an earlier date, we are able to have a base of comparison without preventing the use of latrines. An additional strength is our method of acquiring and analyzing stool samples. The Kato-Katz method, which is standard for the diagnosis of intestinal helminth infections, is easy and affordable.[22] Subjects can collect their own samples, which saves time and resources. Our study is also designed to avoid recall bias due to the data collection method in the prospective design. Finally, we predict greater acceptance of our data because the use of a cluster randomized trial allows for such when delivered on a population level. It is important that this study is accepted by the public for the intervention to be effective. Some limitations of the study include time, money, and hygiene habits. First, because this is a prospective cohort study, it requires an extended amount of time. The longer a study continues, the more resources it demands, and there is more room for error. Money can also be a limiting factor because the building of latrines requires significant resources and assistance, which will need to be achieved within the set budget for the study. Lastly, changing the habit of open defecation can prove to be difficult due to habit and convenience. Just because the opportunity to use the infrastructure will be there, does not mean that people will use it. Even if there is an incentive, some people may still choose not to use the toilets and latrines out of habit or fear of something new.[7]

Possible Biases: During our study, we may risk confounding bias and information bias. Due to the studying being done over a long period of time, extraneous variables may introduce confounding bias, distorting the measure of association between the intervention and the health outcome. In addition, since the subject is responsible for collecting their stool samples, information bias may be introduced due to a measurement error. Information bias may also occur if the number of eggs per gram of stool are incorrectly counted.

Public Health Implications: If the intervention is successful in decreasing the transmission rate of soil-transmitted helminths, we expect the public health implications to be wide-ranging. The prevalence of soil-transmitted helminth infections should decrease, ensuring the health of the population and limiting the necessity for deworming administration. The latrines in Dharavi should continue to be maintained, and the intervention should expand to other communities. Since open defecation also leads to the spread of other diseases,[25] improving the quality of sanitation may improve the overall health of the population and decrease the prevalence of associated illnesses.

CONCLUSION

The research proposes a novel approach to combat soil-transmitted helminth infections in the Dharavi slums by addressing the root cause of open defecation through the construction of proper sanitation infrastructure. Anticipated outcomes include a measurable reduction in the prevalence of helminth infections, particularly among school-aged children. The study's strengths lie in its robust design, incorporating a cluster randomized trial and widely accepted stool sample analysis methods. Successful intervention holds significant public health implications, potentially decreasing the burden of associated diseases and serving as a model for similar communities. While acknowledging challenges and potential biases, this research strives to contribute to a more sustainable and comprehensive strategy for neglected tropical disease control.

Acknowledgements: I would like to thank my research mentors, Dr. Jenna Golan, Ph.D (Cornell University) and Mr. Brian Markley (Director, Academies of Loudoun) for their crucial guidance, insightful feedback, and consistent support throughout the journey of my research. I appreciate Cornell University and Academies of Loudoun for allowing the use of their facilities and necessary resources to conduct this global sustainability research.

REFERENCES

About child & teen BMI. Centers for Disease Control and Prevention. https://www.cdc.gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi.html. Published March 17, 2021. Accessed July 17, 2023.

Adil A. Experts draw attention to India's open defecation problem. Anadolu Agency. https://www.aa.com.tr/en/asia-pacific/experts-draw-attention-to-indias-open-defecation-problem/2424082. Published November 18, 2021. Accessed July 28, 2023.

Aggarwal S. Is India really open-defecation-free? *Down To Earth.* https://www.downtoearth.org.in/news/rural-water-and-sanitation/is-india-really-open-defecation-free-here-s-what-numbers-say- Published July 13, 2021. Accessed July 28, 2023

Ajjampur SS, Kaliappan SP, Halliday KE, et al. Epidemiology of soil transmitted helminths and risk analysis of hookworm infections in the community: Results from the deworm3 trial in Southern India. PLOS Neglected Tropical Diseases. 2021;15(4). doi:10.1371/journal.pntd.000933

Avokpaho EF, Houngbégnon P, Accrombessi M, et al. Factors associated with soil-transmitted helminths infection in Benin: Findings from the deworm3 study. *PLOS Neglected Tropical Diseases*. 2021;15(8). doi:10.1371/journal.pntd.0009646

Bosch F, Palmeirim MS, Ali SM, Ame SM, Hattendorf J, Keiser J. Diagnosis of soil-transmitted helminths using the kato-katz technique: What is the influence of stirring, storage time and storage temperature on stool sample egg counts? *PLOS Neglected Tropical Diseases*. 2021;15(1). doi:10.1371/journal.pntd.0009032

Dahal AS, Francis EO, Francis JE, Wamtas FI. Soil-transmitted helminths and associated risk factors among elementary school pupils in Dadin Kowa, jos. *Nigerian Medical Journal*. 2019; 60(4):181. doi:10.4103/nmj.nmj_62_19

Disease threats and global wash killers: Cholera, typhoid, and other waterborne infections. Centers for Disease Control and Prevention. https://www.cdc.gov/healthywater/global/WASH.html. Published March 12, 2020. Accessed July 28, 2023.

Education. UNICEF India. https://www.unicef.org/india/what-we-do/education. Accessed July 28, 2023.

Genchi M, Potters I, Kaminsky RG, Montresor A, Magnino S. Bench aids for the diagnosis of intestinal parasites. World Health Organization. Published 2019. Accessed July 17, 2023.

Gichuki PM, Mbugua G, Kiplelgo EK, Irungu TW, Mwandawiro C. Long term school based deworming against soil-transmitted helminths also benefits the untreated adult population: Results from a community-wide cross sectional survey. *Journal of Tropical Medicine*. 2019;2019:1-8. doi:10.1155/2019/4151536

Goshu A, Alemu G, Ayehu A. Prevalence and intensity of soil-transmitted helminths and associated factors among adolescents and adults in Bibugn woreda, Northwest Ethiopia: A community-based cross-sectional study. *Journal of Tropical Medicine*. 2021;2021:1-9. doi:10.1155/2021/7043881

Health Improvement Project, Hernandez O, Tobias S. Washington, DC: USAID Hygiene Improvement Project; 2010

Mahapatra A, Mohanty N, Behera BK, Dhal S, Praharaj AK. Soil transmitted helminth infections among school going age children of slums from Bhubaneswar, Odisha. *Trop Parasitol*. 2020;10(1):34-38. doi:10.4103/tp.TP_30_19

Mao F-Z, Chen Y-Y, Xu X-Z, et al. Multi-intervention integrated deworming strategy for sustained control of soil-transmitted helminths infections: A case study in Jiangsu Province, China. *Infectious Diseases of Poverty*. 2021;10(1). doi:10.1186/s40249-021-00903-7

Montresor A, Mupfasoni D, Mikhailov A, et al. The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030. PLOS Neglected Tropical Diseases. 2020; 14(8). doi:10.1371/journal.pntd.0008505

Regan H, Suri M. Half of India couldn't access a toilet 5 years ago. Modi built 110M latrines – but will people use them? CNN.

https://www.cnn.com/2019/10/05/asia/india-modi-open-defecation-free-intl-hnk-scli/index.html. Published October 6, 2019. Accessed July 28, 2023.

Sinha K. 'One toilet for 1,440 people at Dharavi'. The Times of India. https://timesofindia.indiatimes.com/india/one-toilet-for-1440-people-at-dharavi/articleshow/387002.cms. Published November 10, 2006. Accessed July 26, 2023.

Soil-transmitted helminth infections. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections. Published January 10, 2022. Accessed July 26, 2023.

Soil-transmitted helminths. Centers for Disease Control and Prevention. https://www.cdc.gov/parasites/sth/index.html#:~:text=Soil%2Dtransmitted%20helminths%20refer%20to,Ancylostoma%20duodenale%20and%20Necator%20americanus Published February 2, 2022. Accessed July 26, 2023.

Strunz EC, Addiss DG, Stocks ME, Ogden S, Utzinger J, Freeman MC. Water, sanitation, hygiene, and soil-transmitted helminth infection: A systematic review and meta-analysis. *PLoS Medicine*. 2014;11(3). doi:10.1371/journal.pmed.1001620

The World's Largest Slums: Dharavi, Kibera, Khayelitsha & Neza. Habitat for Humanity https://www.habitatforhumanity.org.uk/blog/2017/12/the-worlds-largest-slums-dharavi-kibera-khayelitsha-neza/. Accessed July 17, 2023.

United Nations Development Programme, Watkins K. United Nations; 2006. https://hdr.undp.org/system/files/documents//human-development-report-2006-english.human-development-report-2006-english. Accessed July 17, 2023.

Witek-McManus S, Simwanza J, Chisambi AB, et al. Epidemiology of soil-transmitted helminths following sustained implementation of routine preventive chemotherapy: Demographics and baseline results of a cluster randomised trial in Southern malawi. *PLOS Neglected Tropical Diseases*. 2021;15(5). doi:10.1371/journal.pntd.0009292

Yaro CA, Kogi E, Luka SA, et al. Evaluation of school-based health education intervention on the incidence of soil-transmitted helminths in pupils of rural communities of Eastern Kogi State, North Central Nigeria. *Journal of Parasitology Research*. 2022;2022:1-13. doi:10.1155/2022/3117646

****