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Chefarzt: Professor Dr. med. Stich

Determining the prevalence and morbidity of *Schistosoma*, soil-transmitted-helminths and intestinal protozoa in orphans and street children in Mwanza city, Northern Tanzania

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Anemone Franz

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Referentenblatt

Referent: Prof. Dr. August Stich

Korreferent: Prof. Dr. Klaus Brehm

Dekan: Prof. Dr. Matthias Frosch

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Die Promovendin ist Ärztin

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Operational definitions

Orphans: Children who, at the time of the study, had their primary residence at an orphanage.

Street children: Children who stated that at the time of the study they had no permanent place to stay.

Street-connected children: We use this term to describe our entire study population, consisting of orphans and street children.

Introduction

Neglected tropical diseases (NTDs) are a group of 20 diseases that affect worldwide populations.(1) As the World Health Organisation (WHO) states in their roadmap for neglected tropical diseases 2021-2030, NTDs have "one single commonality: their impact on impoverished communities".(1) These diseases have detrimental effects on health and economy for over one billion people worldwide, and they disproportionally affect women and children.(2) For most NTDs, cost-effective intervention strategies exist.(3) However, the epidemiology is often complex, therefore requiring a holistic public health approach.

The WHO NTD classification includes helminth infections caused by schistosome species and soil-transmitted helminths. Parasitic infections present a considerable issue in low-income environments worldwide, especially in populations with limited access to healthcare and adequate sanitation. Approximately one-third of the almost three billion people who live on less than two US dollars per day are infected with one or more helminths.(4) The most frequent infections are caused by intestinal helminths, *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, followed by schistosomes.(4)

The issue of parasitic infections is not primarily the mortality caused but the long-term impact they have on the health and quality of life of those affected. Chronic infections with STH or schistosomes exacerbate malnutrition and can impair physical growth. Heavy infections are associated with anaemia and impaired intellectual development, leading to poor school performance in children and reduced work productivity in adults.(5,6)

The prevalence, intensity of infection, and transmission is determined by various causes, such as human behaviour, ecology, and biological factors related to the parasite.(7) According to a research study by Colley and Secor (2014), the initial infection often occurs between the ages of two to three years in endemic areas. The burden of infection increases during the next ten years because children are repeatedly reinfected with schistosomes. The highest prevalence and intensities of infection are typically found in young adolescents.(8)

As stated in reports from the United Nations, children and adolescents have the right to enjoy the highest standard of health and access to facilities for the treatment of illness.(9) Unfortunately, this is not guaranteed in every part of the world. Especially for children who lack the protection of a legal guardian, namely street children and orphans, it is difficult to ensure that they will make use of their rights.

Street children and orphans are threatened by more health risks due to poverty, sleeping in unsafe environments, and a lack of access to clean water and sufficient food. In addition, they often cannot profit from existing medical treatments.(10) As studies suggest, street children and orphans have little to no access to health care, due to the high hospitalization and consultation costs in health care facilities.(10) Other factors include a lack of time to visit a health center, being dependent upon the money they earn during the day as well as stigmatization by health care providers.(10)

For most NTDs, safe and cost-effective treatment options exist. However, as these diseases predominantly affect people in LMICs, limited resources are used to alleviate the burden of disease. The existing treatment programs in LMICs targeting children often take advantage of the existing infrastructure of schools. As orphans and street children are less frequently part of school systems, they may miss any intervention programs offered.

This study was designed to collect data on the prevalence of parasitic infections in street children and orphans. As of this date, there are limited data on the topic. It is important to draw attention to this issue since, left untreated, most helminthic infections have considerable long-term effects.(4) The simple measure of applying anthelminthic drugs can have an outsized effect on children's health and well-being.

Background

Schistosomiasis

Epidemiology

Schistosomiasis, also known as bilharzia, was first identified by *Theodor Bilharz*, a German professor of anatomy, in 1851.(11) The disease is caused by trematode worms found in tropical and subtropical regions.(12) Schistosomiasis, which affects over 200 billion people worldwide, is one of the NTDs with the highest impact on the global burden of disease.(13) The WHO estimates that in 2019 over 236 million individuals required preventive chemotherapy (Figure 1).(14)

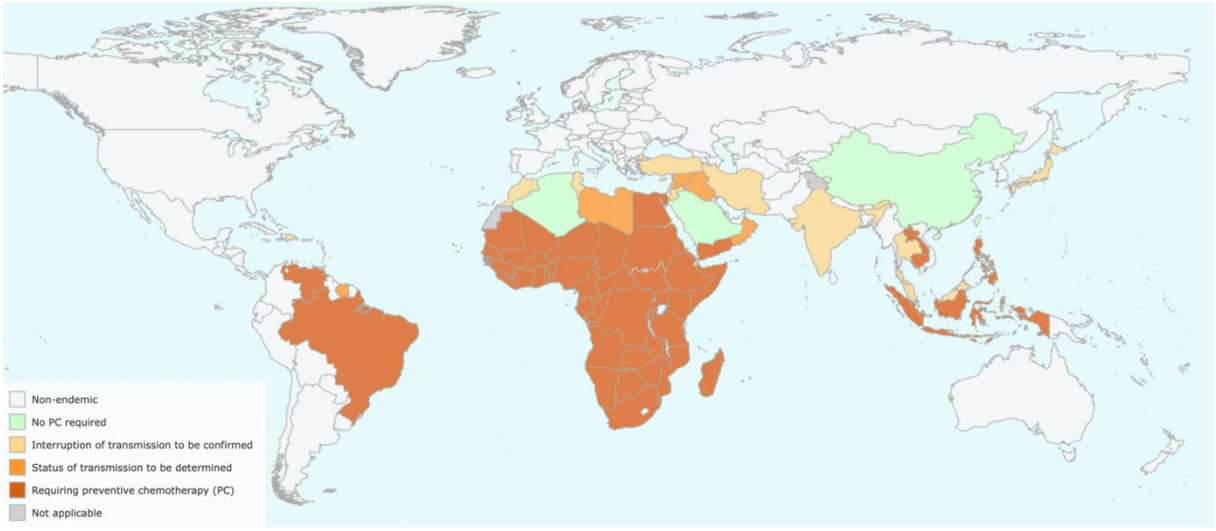

Figure 1: Status of Schistosomiasis endemic countries (WHO 2020). (15)

Aetiology

There are three species of schistosomes that cause the majority of infections in humans: S*chistosoma haematobium* (*S. haematobium*), S*chistosoma japonicum (S. japonicum)*, and S*chistosoma mansoni (S. mansoni*).(12) In sub-Saharan Africa, Schistosomiasis is mainly caused by *S. mansoni* and *S. haematobium*, which lead to intestinal and urogenital schistosomiasis, respectively.

Transmission occurs through contact with freshwater sources and predominantly takes place in areas with inadequate access to safe drinking water and sanitation. The schistosome lifecycle (Figure 2) starts when eggs contained in the faeces or urine of an infected individual come into contact with a freshwater source. If the conditions are favourable, miracidia will hatch from the eggs and infect their intermediate host: certain types of freshwater snails. In the host snail, the miracidia undergo asexual multiplication and are then released as cercariae. Cercariae must find a susceptible mammalian host within 48 hours. They penetrate intact skin, and shed their tails, thus becoming schistosomulae. The schistosomulae migrate first to the lungs, then the heart, and finally the liver, where they develop further.

The mature worms exit the liver via the portal veins, where they mate. Unlike most other trematodes, schistosomes are dioecious, meaning individuals of separate sexes. Adult worms then migrate to the mesenteric venules, where they will reside. The preference for certain sections of the mesenteric system seems to be species-specific. The female releases eggs, causing inflammation processes that lead to the development of granuloma around them.(16) The translocation of eggs to the intestines or bladder ensues, where they are finally eliminated with feces or urine.(12,17)

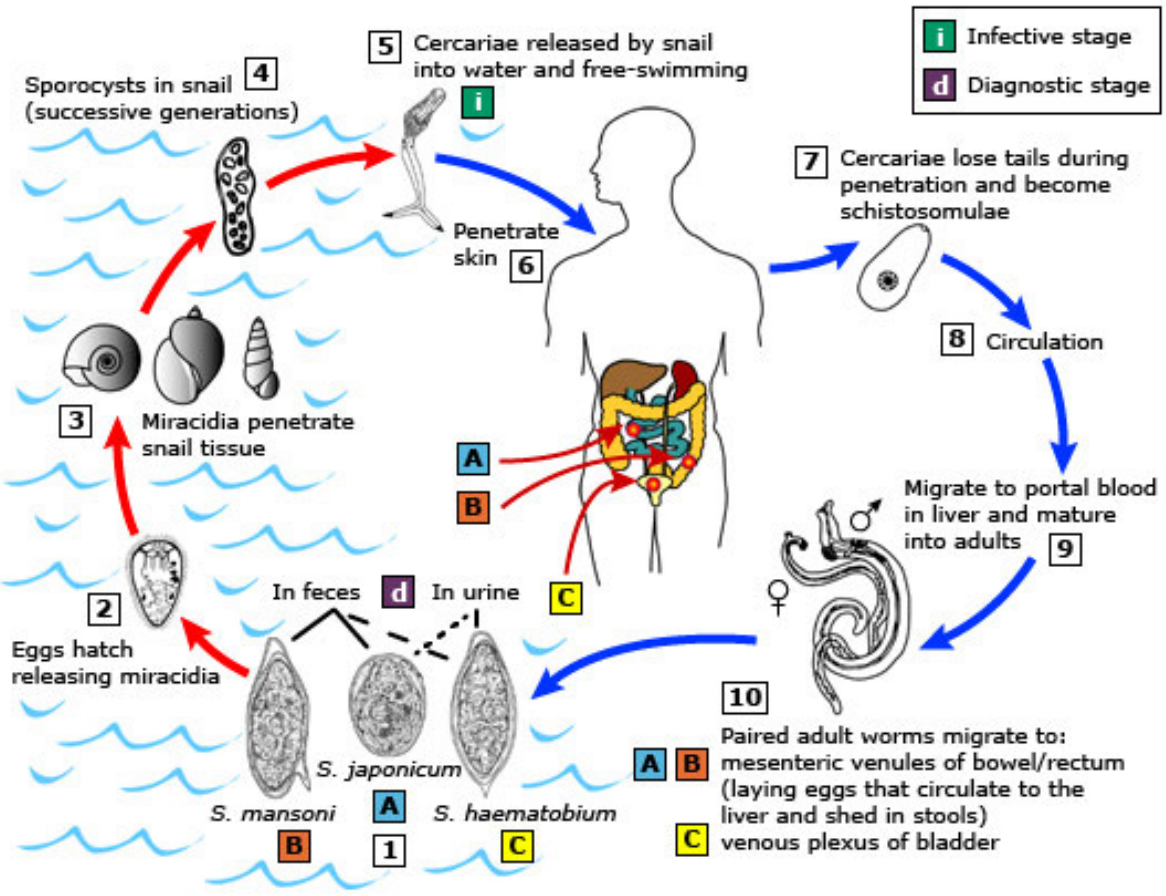

Figure 2: *Life cycle of Schistosome species (CDC 2019).* (17)

Clinical presentation

As the cercariae enter the skin, it may cause a local immune response. The so-called cercarial dermatitis or "swimmers itch" consists of maculopapular lesions that can persist for several days.(18) Acute Schistosomiasis is also called Katayama fever. It usually develops four to six weeks after an initial schistosome infection when the first cycle of egg deposition causes a systemic hypersensitivity reaction.(11,19) It almost exclusively occurs in non-immune individuals upon first contact with the parasite. (18) The symptoms are often unspecific, like fever, fatigue, myalgia, malaise, cough, and eosinophilia.

Infections with schistosomes can go unnoticed for many years, leading to a delay in diagnosis.(11) Schistosomes have evolved different strategies to evade their host's immune

system and may survive for years, continuing to produce eggs, which most likely is the cause of morbidity.(8)

Chronic infections with *S. mansoni* can lead to periportal fibrosis, which in turn may cause portal hypertension and gastrointestinal bleeding. Other types of morbidity or pathology include abdominal pain, hepatosplenomegaly, hematemesis and ascites.(11,20,21) Mortality is mostly caused by haematemesis or liver failure.(21)

The initial classic sign of *S. haematobium* infections is haematuria. Symptoms include cystitis, urethritis and genital lesions. In later stages, kidney failure and bladder cancer can be observed.(20,21) Furthermore, longer-term infections can have irreversible consequences, like infertility.(15) Studies show an association between *S. haematobium* infections and STIs, like HIV. Coinfection may increase the risk of acquiring and transmitting STIs and exacerbate morbidity.(22,23)

Diagnosis

For *S. mansoni,* the diagnostic gold standard is detecting eggs in a stool specimen, using the Kato Katz method and counting eggs under the microscope.(24) To detect infections with S. haematobium, a urine specimen needs to be filtrated, and eggs can be observed through microscopy.

S. haematobium and *S. mansoni* eggs can be well distinguished under a microscope (Figure 3).

The Circulating Cathodic Antigen (CCA) test is a point-of-care test that can be used in endemic areas.

In non-endemic areas, immunological or serological tests can determine whether the individual has been exposed to the parasite.

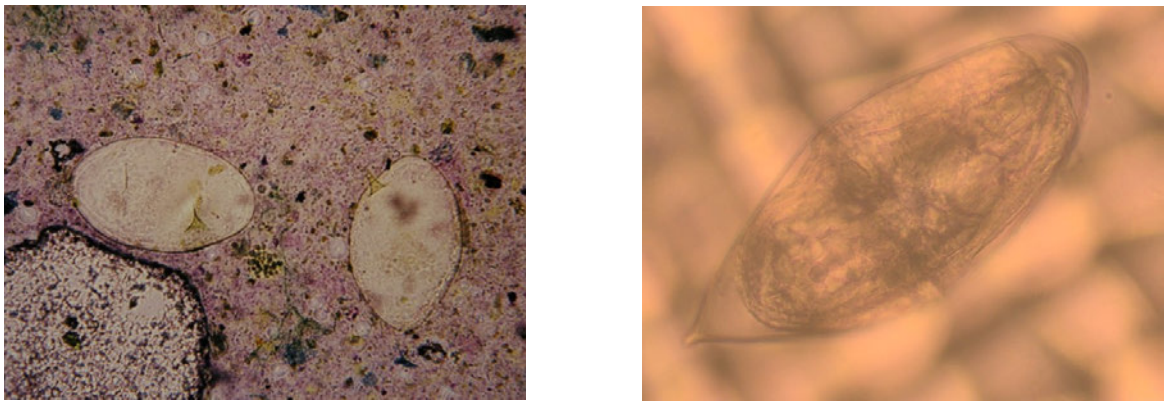

Figure 3: Two Schistosoma mansoni eggs as seen under the light microscope (left) and one Schistosoma haematobium egg on a nylon filter used for urine filtration (right).

Soil transmitted helminths

Epidemiology

Soil-transmitted helminths (STH) infections are among the most common infections worldwide, caused by different species of helminths.(25) Soil-transmitted helminthiasis predominantly occurs in regions with a warm and moist climate, where sanitation and hygiene are inadequate.(26) According to WHO, over 1.5 billion people, which amounts to almost one-fourth of the world's population, are infected with one or more STH.(25) Over 800 million children require preventive chemotherapy (Figure 4).(25)

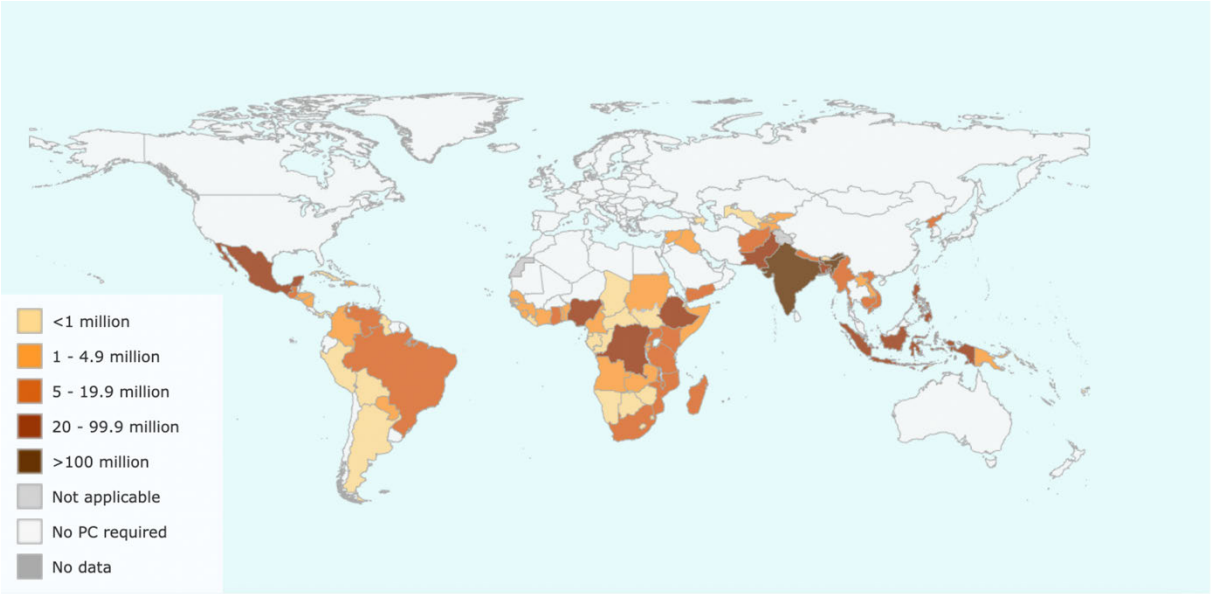

Figure 4: Number of children requiring preventive chemotherapy for soil transmitted helminthiasis (WHO 2020). (28)

Aetiology

The main species engendering infections in humans are *Ascaris lumbricoides (A.lumbricoides)*, hookworms *Necator americanus* and *Ancylostoma duodenale* and *Trichuris trichiura* (*T. trichiura*).

Infections spread through contact with parasite larvae and eggs. Of note, STH do not reproduce in their human host. Reinfections occur through contact with a contaminated environment.(25)

Clinical presentation

Adult worms can live in the human gastrointestinal tract for years, and female adult worms can produce thousands of eggs daily.(27,28) Individuals with low or moderate infections are often asymptomatic or show mild and unspecific symptoms.(27) Infections with *A. lumbricoides* can cause a variety of symptoms, depending upon the phase of the parasite's lifecycle. This includes eosinophilic pneumonia, upper gastrointestinal bleeding, acute pancreatitis, anaemia, and weight loss.(27) Hookworms can cause gastrointestinal symptoms,

blood loss, and anaemia.(29) the most common symptoms of infections with *T. trichiura* are abdominal pain, asthenia, diarrhoea and in severe cases, Trichuris dysentery syndrome.(27)

Diagnosis

STH are mostly diagnosed by analysis of stool samples for helminth eggs and larvae. The most common method is counting eggs per gram stool, using the Kato Katz method.(30) Furthermore, antigen- and antibody-detection assays can be used if fecal analysis methods are not available. Blood samples can be analyzed for eosinophilia, a common sign of infection with helminths.

Morbidity due to Schistosomes and STH

Morbidity due to helminth infections is proportional to the worm burden.(31) Most individuals will show light to moderate levels, while fewer will suffer from a heavy infection intensity. These heavily infected suffer the highest morbidity and are a major source of spreading the disease in the community.(31)

The initial infection with parasites often occurs at an early age.(32) Through repeated contact with a contaminated environment, reinfections may frequently occur. If left untreated, the worm burden will increase over the years. A peak in infection rates can be observed in school-age children (SAC).(8) In addition, chronic infections with STH or schistosomes exacerbate malnutrition, can impair physical growth, and diminish cognitive capacities. Especially SAC are at high risk for adverse effects, as they:

- have heightened nutritional needs as they are in a period of rapid physical growth.
- are expected to acquire basic skills and knowledge at school, and infections can adversely affect their cognitive capabilities.
- are usually less aware of the importance of hygiene and may, therefore, unknowingly perpetuate infections.(31)

Heavy infections are associated with impaired intellectual development leading to poor school performance in children and in adults with reduced work productivity in

adults.(5,6) Therefore, apart from causing suffering and reducing DALYs, helminth infections contribute to upholding poverty.(31)

Intestinal Protozoa

Intestinal protozoa are transmitted through ingesting food or water contaminated by protozoic cysts or oocysts.(33) Infections are especially common in tropic and subtropic regions, causing millions of cases of diarrhoea each year.(33)

The most important intestinal protozoan pathogens that cause enteric infections in humans include *Giardia intestinalis (G. intestinalis)* and *Entamoeba histolytica/dispar (E. histolytica/dispar)*. A high prevalence of *G. intestinalis* and *E. histolytica/dispar* are strongly associated with inadequate water, sanitation, and inadequate hygiene behaviour.(34) Therefore, infection rates with intestinal protozoa are a suitable indicator of estimated hygiene conditions. Especially among young children and elder people, infections with protozoa cause severe gastrointestinal symptoms that can lead to considerable malnutrition and mortality.(35)

Giardia intestinalis

G. intestinalis, also known as *G. lamblia* or *G. duodenalis*, is one of the most common intestinal parasites worldwide.(36) In some areas with inadequate hygiene conditions, a prevalence of up to 40% have been reported.(37)

Giardia cysts, which are the infectious stage of the parasite, can survive and remain infectious for several months in cool and damp areas.(37) Cysts ingested through contaminated food or water pass through the gastric system and develop into trophozoites (Figure 5).(38,39) Trophozoites absorb nutrients from their human host and eventually move to the colon, where they transform back into cysts.(40)

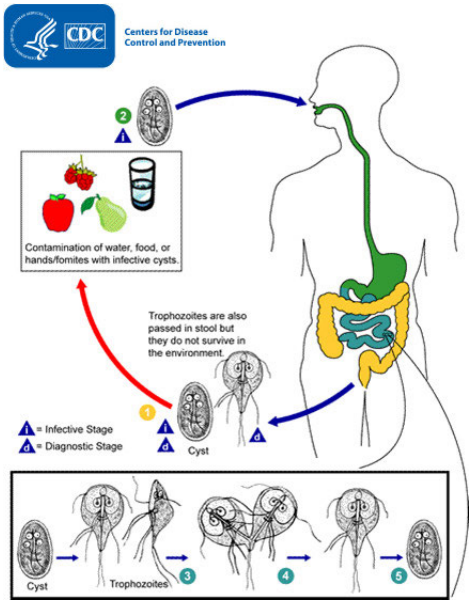

Figure 5: Life cycle of G. intestinalis (CDC 2021). (42)

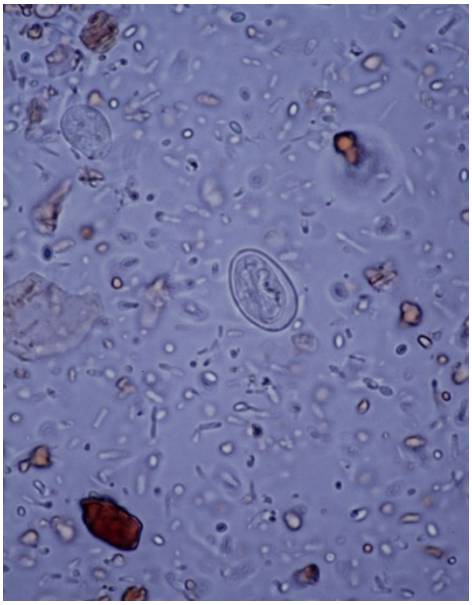

Figure 6: A Giardia lamblia cyst under a light microscope.

Both cysts and trophozoites can be found in the excretions of an infected individual (Figure 6).(40) Infections can be asymptomatic or cause symptoms like severe diarrhea, abdominal cramps, malaise, and malabsorption.(39) Even if giardiasis is a mostly self-limiting disease, in some cases, it can lead to the degradation of growth and the cognitive functions of infected children.(41)

Entamoeba histolytica and *dispar*

Amoebiasis is an intestinal infection caused by *E. histolytica*.(42) Up to 50 million individuals are estimated to be infected by *E. histolytica*, causing approximately 100,000 deaths annually, mostly in LMICs.(43) Several species of entamoeba are known to colonize humans, but not all are pathogenic.(44)

E. dispar infections occur more frequently, and the parasite is generally considered to be apathogenic. *E. histolytica* and *E. dispar* are morphologically indistinguishable, making identification of trophozoites and cysts in stool samples difficult.(42) Similar to *Giardia*, *Entamoeba* cysts and trophozoites are ingested through contaminated food or water (Figure 7). In the small intestine, excystation occurs and trophozoites migrate to the large intestine.

Trophozoites can invade the intestinal mucosa, causing intestinal diseases. They can also spread to other organs and cause extraintestinal diseases. Trophozoites and cysts are then excreted in the feces (Figure 8).(44)

Infections are mostly asymptomatic but can also manifest as severe dysentery. The most common extraintestinal manifestation is an amoebic liver abscess.(44)

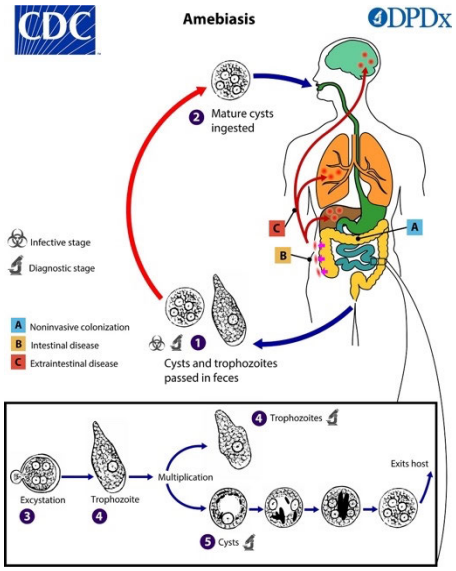

Figure 7: Life cycle of Entamoeba. (CDC 2019) (47)

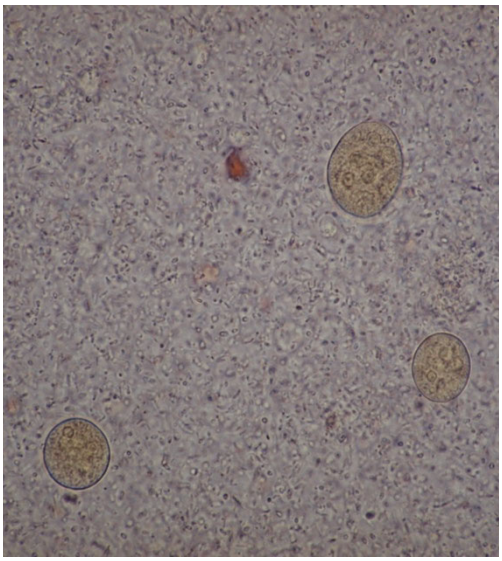

Figure 8: Two Entamoeba histolytica/dispar cysts next to a slightly bigger E. coli cyst.

Diagnosis

To confirm infection with protozoa, direct observation of cysts and trophozoites in stool specimens is used.(45) This method is time intensive and requires a certain level of skill and expertise. Furthermore, antigen-detection assays can be performed for most protozoa.

Mass drug administration

Mass drug administration (MDA) is defined as treating populations or sub-populations in high-prevalence settings with safe and inexpensive medication without necessarily requiring a diagnosis.(46) MDA aims to prevent or reduce morbidity and mortality as well as interrupt transmission cycles.

Mass drug administration with Albendazole and Praziquantel has been used for decades; it is considered safe, effective, and economical.(47,48) Both drugs are on the WHO List of essential medicines. Systematic reviews of past trials have shown no severe adverse events and only a few mild reversible events.(49) The charity evaluator GiveWell estimates the overall cost to deworm one child, including the cost of medication and staff time, at $0.79.(50) The WHO recommends treating all SAC in areas with a prevalence ≥ 50% of schistosomes and STH annually, respectively biannually.(31)

Mass drug administration campaigns often use the existing infrastructure of schools. This ensures that individuals at a critical stage of physical and cognitive development can be reached, and it helps keep this intervention cost-effective. However, some groups of children will be excluded, like street children or children who work to support their families. In addition, to entirely eliminate transmission, it is necessary to also include pre-SAC and adults in the MDA programs.(51) Mass drug administration campaigns must be repeated regularly, or infection rates usually return to pre-treatment levels within a few months.(31)

Water, Sanitation, and Hygiene (WASH)

To combat infectious diseases, it is important not only to treat the disease, but also to ensure that people have access to adequate water, sanitation, and hygiene. The WHO states that every year, over 800,000 people die from diarrhea as a result of unsafe drinking water, a lack of sanitation, and poor hygiene.(52)

MDA is a cost-effective and efficient way to tackle parasitic infections. However, to interrupt infection cycles and entirely eliminate the disease, it is crucial to also improve the quality of WASH.(51) Building an infrastructure for adequate WASH, combined with education programs, can effectively reduce parasite transmission and prevent deaths from diarrheal diseases.(51,52)

Methods

Ethics statement

Research clearance, certificate number CREC/344/2019, was obtained from the Catholic University of Health and Applied Sciences Bugando (CUHAS) (Appendix 4). No ethical clearance was required from Julius-Maximilians-Universität Würzburg.

Study area

Tanzania is a country with an exceptionally high prevalence of schistosomiasis. The WHO estimates that almost 15 million Tanzanians require preventive chemotherapy for schistosomiasis annually.(14)

Mwanza city was chosen as the study site due to the high prevalence of helminths and protozoa in the general population. The city is located on the shorelines of Lake Victoria, where especially high infection rates with schistosomes have been observed (Figure 9). Studies show infection rates of over 90% in SAC on the shores of Lake Victoria.(53) The lake is a natural habitat for the intermediate hosts for schistosomes, namely freshwater snails *Biomphalaria choanomphala* and *Biomphalaria sudanica*.(54) For many people in the region, Lake Victoria is the primary source of fresh water.

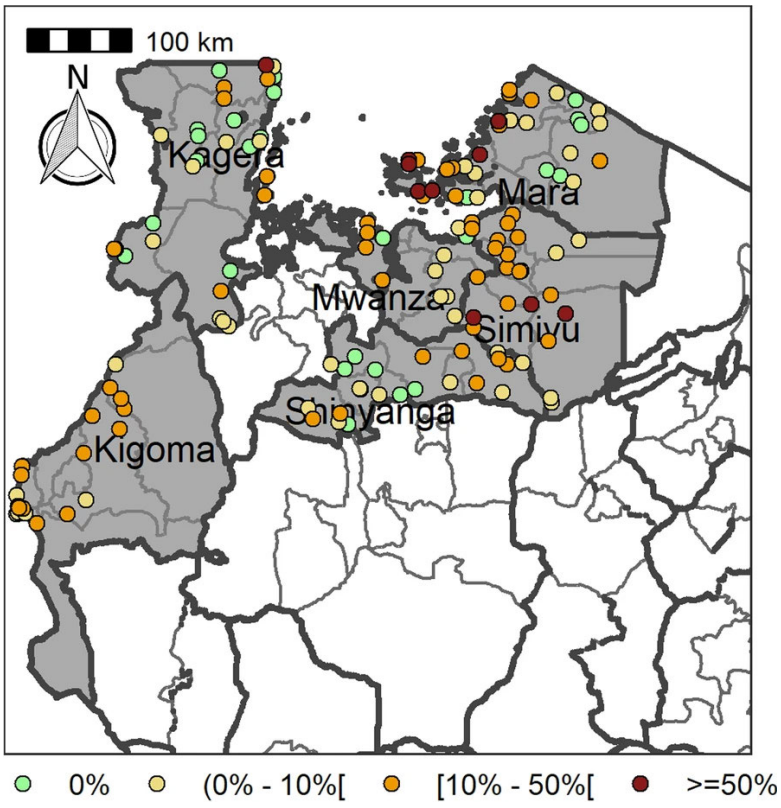

Figure 9: Prevalence of S. mansoni and S. haematobium as observed in different schools in north-western Tanzania. The map includes county and district boundaries (Mazigo et al. 2022).

Mwanza city is home to a very high number of orphans and street children. Railway children, a UK-based NGO, has identified 1,548 children living and working on the streets of Mwanza city during daytime and 738 during night-time in their headcount 2014.(22)

Study population and selection criteria

The cross-sectional study was conducted in March 2019. We included 144 orphans from four different orphanages (SOS, Fonelisco, Village of Hope, Wote Sawa). 70 children were male (44%) and 68 female (42.8%). In addition, 112 street children (100% male) were screened. Contact with street children was established with the help of the NGO "Tanzania Rural Health Movement". On three different days, the children could freely present themselves to be included in the study.

Study participants were included if they

i) were permanent inhabitants of Mwanza city.

ii) were between six and eighteen years old.

iii) agreed to participate in the study in the presence of a witness, after having received an oral briefing and provided written consent.

Sample size and sample procedure

The sample size was calculated using the following formula developed by Leslie Kish:

$$N = \frac{p(1-p)Z^2}{d^2}$$

With:

- N = required sample size
- Z = confidence level of 95% (standard value of 1.96)
- p = assumed prevalence intestinal Protozoa infections (0.20)
- d = margin error at 5% (standard value of 0.05)

To obtain significant results for all the parasites to be screened, we used the parasite with the lowest expected prevalence in our study region for p. For the study area, the prevalence of intestinal Protozoa was expected to be the lowest (about 20 %).(55) We used the standard level of confidence of 95% (1.95). For d, we used the standard value of 0.05.

Thus, a minimum sample size of 246 was calculated. To compensate for losses of samples and incomplete data, 307 children who met the inclusion requirements were included in the initial screening process. After accounting for dropouts and incomplete data, we obtained a sample size of 256.

Participation was voluntary, and participants could leave the study at any stage without stating a reason.

Informed consent procedure

All participants received an oral briefing on the study procedures. The children were given either an assent form (ages 6-17) (Appendix 12-13) or a consent form (ages >17) (Appendix

9-11). If necessary, the form was read to the child. Participants were able to ask questions. If the participant consented, the participant or their guardian signed the assent form.

Questionnaire

We used a standardized questionnaire to determine hygiene behaviour and the living conditions of the participants (Appendix 2 + Appendix 3). The study participants answered the questions with the help of the local study team, who read the questions to the children if needed.

First, demographic information was recorded: age, sex, height, and weight. The questionnaire consisted of ten questions on nutritional status, living conditions, water- and washing patterns, education, and hygiene conditions. It was furthermore recorded whether, and if so, when the study participant had received anthelminthic treatment.

Parasitological examination of stool and urine samples for helminths and protozoa infections on site

A single stool and urine samples were collected in two separate clean containers from every consenting study participant. On site, two Kato Katz thick smears were prepared from different sites of each stool sample, using a template of 41.7mg (Vestergaard Frandsen, Lausanne, Switzerland), following a standard protocol, described elsewhere (see Figure 10).(56) The Kato Katz smears were examined for the presence of *S. mansoni* and STH eggs (*A. lumbricoides* and *T. trichiura* and Hookworms) by two trained laboratory technicians. For quality assurance, a random sample of 10% of the negative and positive Kato Katz thick smears was re-examined.

Figure 10: Preparation of Kato Katz slides in the field laboratory.

Figure 11: Positive (S01, S04, S06), negative (S03, S05) and invalid (S02) CCA-POCT tests.

The stool samples were also conserved in formalin and ethanol. The samples were shipped to Germany for further processing and examination under a light microscope at the Medical Mission Institute. The sodium acetate-acetic acid-formalin method (SAF) uses highly inflammable liquids (ethyl ether), requiring an explosion-proof centrifuge, which was not available at the parasitology laboratory in Mwanza at the time.

All collected urine samples were examined for the presence of hematuria, using a urine dipstick test. They then underwent a urine filtration technique with Nuclepore® membrane filters (Whatman International Limited, Maidstone, England), according to WHO standards for the presence of *S. haematobium* eggs.(57)

In addition, all urine samples were tested with the *Schistosoma* Circulating Cathodic Antigens (CCA) Urine Cassette Assay (manufactured by Rapid Medical Diagnostics, Pretoria, South Africa) (see Figure 11).(58,59) Preparation and examination of urine samples for the CCA cassette were performed according to the manufacturer's instructions. The entire laboratory technician team participating in reading the CCA results was blinded for the Kato Katz parasitological results of the study participants.

Parasitological examination of conserved stool samples for helminths and protozoa infections at the Medical Mission Institute

At the Medical Mission Institute, the conserved stool samples were concentrated with the SAF method using an FPC kit. In the first step, three drops of Triton X-100 (a trademark of Room and Haas), a non-ionic surfactant and emulsifier, were added to each tube containing a fecal specimen to break up fecal debris and release any trapped eggs.(60) Then 3 ml of ethyl acetate was added, and the tubes were shaken for 30 seconds. Afterwards, the specimen was transferred into a 15 ml centrifuge tube, passing through a strainer that intercepts the larger parts of the fecal probe.

The centrifuge tubes were then centrifuged at 500 G for 10 minutes. Then the upper three layers containing debris and ethyl acetate were removed. The specimen could now be transferred to a slide using a pipette and covered with a coverslip (size: 22x32). The slides were subsequently examined under a light microscope systematically, first using a 10x and afterward a 40x objective.

Mass Drug Administration

After the examination and sample collection, all the children received a single 40 mg/kg dose of Praziquantel, according to WHO recommendations.(61) In addition to Praziquantel for the treatment of schistosomiasis, Albendazole in a 400 mg single dose was administered for the treatment of STH. To reduce the adverse effects of Praziquantel, a meal was provided for each study participant. After swallowing Praziquantel, the participants were asked to remain at the field data collection point for one to two hours so the research team could monitor and manage any possible adverse effects.

As there is no simple, cost-effective point-of-care test for protozoa, the results of protozoan infections were only available with some delay. As soon as the data were available, they were forwarded to Tanzania Rural Health Movement or the heads of the orphanages. The responsible authorities established contact with the infected children, whenever possible, to offer adequate medication.

The treatment for *Giardia*, as recommended by the Medical Letter 2013, is a daily dose of Metronidazole 35-50 mg/kg/d, divided into three doses15 mg/kg body weight for 5 days. For asymptomatic infections with *E. histolytica*, a daily dose of diloxanide furoate 20 mg/kg body weight, divided into three doses a day, is recommended. According to the study protocol, for symptomatic infections, the recommended treatment was a daily dose of Metronidazole, 35-50 mg/kg body weight, divided into three doses a day for 10 days, followed by a course of diloxanide furoate as stated above.

Ultrasonography and clinical examination

At chronic stages, *S. mansoni* infections are associated with hepatic and gastrointestinal symptoms such as hepatomegaly, splenomegaly, and periportal fibrosis. We used the simplified Niamey protocol proposed by the German Society for Tropical Medicine and International Health to classify organ abnormalities caused by long-term schistosome exposure. The participants were examined independently by two medical doctors with long-term experience in ultrasonography. First, a clinical examination was performed, which included palpating the liver and spleen. In cases where the organs were palpable, consistency and possible tenderness were determined.

The study participants were examined with a portable ultrasound machine in a supine position, lying on their backs with their legs stretched out on an examination table. The examining physicians were blinded to the participant's *S. mansoni* status. The liver image pattern was obtained through a subcostal, transhepatic view, a substernal transverse view, and sagittal scans. Spleen size, portal vein diameter, and occurrences of ascites and other abnormalities were also recorded.

Liver image patterns type A + B were regarded as normal.(62) Patterns C-F were classified as pathological. Various parameters for the liver, spleen, gall bladder, and portal vein were determined (see protocol in Appendix 4).

Data analysis

All data were double entered, using Excel with the final data set stored in a MySQL database. The data were checked for consistency and any errors were then cleaned. Statistical analysis was performed using IBM SPSS Statistics version 24 (SPSS Inc., Chicago, USA).

The data were analyzed using frequency tables, cross-tabulations and prevalence calculations. To compare the mean intensity of infection by sex, age, and group category, we used the t-test; the results were regarded as significant if $p<0.05$. To obtain the number of eggs per gram of feces, we multiplied the average number of eggs in each slide with 24.(64) According to the WHO progress report, infection intensity with *S. mansoni* of 1–99 eggs per gram (epg) is classified as light, 100–399 epg as moderate and ≥400 as heavy.

To compare the appearance of periportal fibrosis in either group, we used the chi-square test. Results were considered significant if $p<0.05$. Liver image patterns (LIP) types A+B were considered normal, C+D as mild, and E+F as severe patterns for periportal fibrosis.(64)

Results

Demographic information

144 orphans (70 (48.6%) males, 68 (47.2%) females, 6 (4,2%) sex not recorded) and 112 street children (100% male) took part in the study. The median age for orphans was 9 ± 3 years and for street children 13 ± 2 years. The median body mass index (BMI) in orphans was 16 ± 2.8 and in street children 17.15 ± 2. A lower BMI after regression for age and sex was significantly associated with infection status as determined through the CCA test ($p=0.029$).

Table 1: Age distribution of street children and orphans.

			Age (in years)							
.			unknown	6-7	8-9	10-11	12-13	14-15	>16	Total
Orphans		male	5	21	16	7	13	5	3	70
		female	1	23	14	11	10	8	1	68
		unknown	6	0	0	0	0	0	0	6
	Total		12	44	30	18	23	13	4	144
Street Children		male	7	0	2	13	38	36	13	109
		unknown	3	,00	0	0	0	0	0	3
	Total		10	,00	2	13	38	36	13	112
Total	Total		22	44	32	31	61	49	17	256

Questionnaire

26.8% (66) claimed they had received some form of anthelmintic treatment (22.8% of street children, 29.7% of orphans). 95.8% (138) of orphans stated they attended school regularly. Only 12.7% (13) of the street children attended regularly. While 100% of the orphans slept in orphanages, 14.9% (15) of the street children stayed with their families overnight. The remaining children had no fixed place to stay overnight and therefore slept in varying locations. All study participants expressed that they had received drinking water from safe sources, namely piped water or wells. Only 1.4% (2) of the orphans stated in the questionnaire that they used the lake to wash, whereas 97.1% (99) of the street children named the lake as at least one of their washing options. 83.3% (80) of the street children stated they do not regularly get food. The data show that orphans solely use flush toilets or latrines. Of the street children 81.4% (91) stated in the questionnaire that they used the "bushes" or "other" in addition to flush toilets or latrines.

Ultrasonography results

In only 4 of the participants (1.7%), the liver was palpable, and in 100% of these cases, the consistency was firm. One participant (0.4%) reported tenderness upon palpation. In four children (1.7%), the spleen was palpable, and in one of these cases, tenderness was reported. Overall, we observed normal LIPs A+B (98.1%), mild PPF patterns C+D (1.9%), and no severe PPF patterns E + F. 118 (98.4%) of orphans and 87 (97.8%) of street children showed patterns A + B. 2 (1.6%) of orphans and 2 (2.2%) of street children had patterns C + D.

No significant correlation between LIP and sex, age, or group category could be observed.

Prevalence and intensity of infections with S. mansoni and S. haematobium

The prevalence for *S. mansoni* determined by the POC-CCA-test was 65.9% (91) for orphans and 94.5% (103) for street children. After regressing for sex and group category, a higher age was significantly associated with infection status (p=0.014). No significant difference between males and females among the orphans sampled could be observed. Of the orphans, 19.2% tested positive for *S. mansoni* in Kato Katz (light = 64.6%, moderate = 17.7%, heavy = 17.7%). Of the street children, 77.1% showed positive test results in Kato-Katz (light = 29.8%, moderate = 27.1%, heavy = 43.1%). After regression for sex and age, the street children showed a significantly higher infection rate compared with orphans (p=0.003). None of the children tested positive for *S. haematobium*.

Prevalence of infections with Protozoa after SAF concentration

Microscopy after concentration with the SAF method showed positive results for *G. intestinalis* in 3.4% (5) and *E. histolytica/dispar* in 9.6% (14) of orphans. 5.4% (6) of the street children were positive for *G. intestinalis* and 22.3% (25) for *E. histolytica/dispar*. No significant correlation with sex, age, or group category could be observed.

Prevalence of infections with STH after SAF concentration

We found no infections with *A. lumbricoides.* Only one orphan (0.7%) and three street children (0.9%) had been infected with *T. trichiura*. Nine (8.1%) street children and none of the orphans were infected with Hookworms. Overall, being a street child is significantly associated with a greater likelihood of being infected with STH (p=0.013).

Discussion

Differences between street children and orphans

The study data show differences in living conditions, infection rates, and the morbidity of orphans and street children. We observed a significantly higher rate of infection with *S. mansoni* in street children. Most stated in the questionnaire that they use the lake to wash. The lack of access to safe water for washing and leisure activities results in street children frequently coming into contact with the water of Lake Victoria. This can result in frequent infection and reinfection. However, in all the orphanages included, the orphans seem to have

access to safe water for personal hygiene. Only a few stated in the questionnaire that they use the lake to wash. Furthermore, orphans may have more frequent access to the deworming programs offered in their schools or orphanages.

We did not find similar results for the infection rates with protozoa. This suggests that both groups may live in comparable hygienic standards. It is to note that mass drug administration programs usually treat only helminth infections but not infections with protozoa. Therefore, better accessibility to MDA programs for orphans as compared with street children would not influence the prevalence of protozoic infections.

Surprisingly, we observed a low prevalence of STH for all street-connected children. Given that these children spend a lot of time outside and often walk barefoot, we expected higher hookworm infection rates. This result may be influenced by the small sample size sensitivity level of the diagnostic methods. Furthermore, *A. lumbricoides* and *T. trichiura* eggs are more resistant than hookworm eggs. As the specimens were only analysed a few days after collection, we expected to see relatively fewer to no hookworm eggs.

On ultrasound, we found no severe LIPs of PPF. This is expected as, after the initial infection, it takes, on average, 5-15 years for advanced fibrosis to manifest.(65) However, some children already showed mild patterns. Given the high prevalence of schistosomes in our study group with, in some cases, very high worm loads, it is expected that many will develop PPF should they not receive regular interventions in the future.

Importance of a holistic approach to public health

Overall, we found that the general hygienic circumstances and access to healthcare of both groups can be substantially improved. As a first step, regular MDA campaigns specifically targeting neglected groups in a population should be implemented. Such a public health measure would ameliorate the situation of the treated individuals and play a part in interrupting the infection cycles. Furthermore, sanitation could be ameliorated by building public latrines and facilities to wash with safe water. These public health measures are economical and easy to implement. By interrupting infection cycles, these interventions could have an outsized positive impact on the health of the entire population.

The case for deworming

It is well established that many regions in sub-Saharan Africa suffer from high infection rates of schistosomiasis.(11,55,66) Although there is a large amount of data across populations, little information can be found on the prevalence in marginalized groups like street children and orphans.

Apart from the moral obligation to ameliorate the current situation for these children, there are also practical reasons. As with most public health issues, the problem of parasitic infections cannot be solved if certain groups of the population are excluded from interventions. The lack of access to adequate sanitation like latrines for street children is particularly concerning. Excretions of infected individuals not predisposed to receive adequate help maintain the schistosome lifecycle. The issue, therefore, not only presents a hazard for the health of street children but also for the rest of the population.

Limitations

There are some limitations to our study. We divided our study group into street children and orphans. However, it is difficult or even impossible to draw a clear line between both groups. Many street children have spent at least some time in an orphanage. Some are orphaned, some have run away from their families, while others spend the day on the streets but return to their families at night. Furthermore, in our study, we only included male street children. The lack of female street children seems to be a general phenomenon. It might be due to the fact that females are frequently forced into domestic or sex work; therefore, they disappear from the streets and run away from home less often.(67)

However, this complicates the possibility of finding significant differences in the study results. It is to note that street children sampled were, on average, four years older than the orphans. This could influence the results, for example, through differences in risk behaviour. Furthermore, for each question, the children only had 2-6 possible answers to choose from. The data may, therefore, not portray a nuanced picture of the living circumstances of our study group.

Summary

The present study investigates the infection rates of parasites, morbidity, and the living conditions of street children and orphans in Mwanza city, northern Tanzania. A high percentage of orphans and street children in Mwanza city is infected with one or more parasites. A significantly higher rate of infections with *S. mansoni* in street children as compared with orphans could be observed. The prevalence of *S. mansoni* determined by POC CCA test was 65.9% for orphans and 94.5% for street children. 19.2% of the orphans tested positive for *S. mansoni* in Kato Katz. Of the street children, 77.1% showed positive test results in Kato-Katz. Only 1.3% of the orphans stated in the questionnaire that they use the lake to wash, whereas 91.1% of the street children named the lake as at least one of their options for washing. Protozoal infections used as a marker for hygiene were at a comparable level for both groups. Microscopy showed positive results for *G. intestinalis* in 8.2% and for *E. histolytica/dispar* in 23% of orphans and 8.1% for *G. intestinalis,* and 23.8% for *E. histolytica/dispar* in street children. Through ultrasonography, we observed no signs of severe PPF and only a few mild PPF patterns. Most street children use the lake to wash and often do not have access to adequate sanitation. However, everyone in the study group indicated having access to safe drinking water. Overall, we found the general hygienic conditions for both groups to be inadequate. With the help of simple public health measures, like improve sanitation and regular mass drug administration, the overall situation would likely be considerably improved.

Zusammenfassung (Summary in German)

Die vorliegende Studie untersucht Infektionen mit verschiedenen Parasiten, die Morbidität und Lebensbedingungen von Straßenkindern und Waisen in Mwanza, einer Stadt im Norden Tansanias. Ein hoher Prozentsatz von Waisen und Straßenkindern in Mwanza leidet an Infektionen mit einem oder mehreren Parasiten. Es konnte eine signifikant höhere Rate von Infektionen mit *S. mansoni* bei Straßenkindern im Vergleich zu Waisen festgestellt werden. Die Prävalenz von Infektionen mit S. *mansoni,* ermittelt durch POC-CCA-Tests, betrug

65,9% bei Waisen und 94,5% bei Straßenkindern. 19,2% der Waisen waren im Kato-Katz-Test *S. mansoni* positiv. Bei den Straßenkindern zeigten 77,1% positive Testergebnisse im Kato-Katz-Test. Nur 1,3% der Waisen gaben in dem Fragebogen an, den See zum Waschen zu benutzen, während es 91,1% bei den Straßenkindern waren. Protozoeninfektionen, die als Marker für die Hygieneumstände, unter denen die Kinder leben verwendet wurden, waren bei beiden Gruppen auf vergleichbarem Niveau. Die Mikroskopie zeigte positive Ergebnisse für *G. intestinalis* bei 8,2% und für *E. histolytica/dispar* bei 23% der Waisen und bei 8,1% für *G. intestinalis* und 23,8% für *E. histolytica/dispar* bei den Straßenkindern. Durch Ultraschall konnten keine Anzeichen für schwere PPF festgestellt werden, und nur bei wenigen Kindern zeigten sich leichte PPF-Muster. Die meisten Straßenkinder benutzen den See um sich zu waschen und haben oft keinen Zugang zu angemessener Sanitärversorgung. Alle Teilnehmer der Studie gaben jedoch an, Zugang zu sicherem Trinkwasser zu haben. Insgesamt stellten wir fest, dass die allgemeinen hygienischen Bedingungen für beide Gruppen unzureichend sind. Mit Hilfe einfacher öffentlicher Gesundheitsmaßnahmen, wie bessere sanitäre Einrichtungen und regelmäßige Entwurmung, könnte die Gesamtsituation für Straßen- und Waisenkinder erheblich verbessert werden.

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Appendix

Appendix 1 List of abbreviations

A. lumbricoides	*Ascaris lumbricoides*
BMI	Body mass index
CCA	Circulating Cathodic Antigens
E. dispar	Entamoeba dispar
E. histolytica	*Entamoeba histolytica*
EPG	Eggs per gram
G. intestinalis	*Giardia intestinalis*
LIP	Liver image patterns
MDA	Mass drug administration
NTD	Neglected tropical disease
PPF	Periportal fibrosis
SAC	School-aged children
S. haematobium	*Schistosoma haematobium*
S. mansoni	*Schistosoma mansoni*
STH	Soil-transmitted helminths
T. trichiura	*Trichuris trichiura*
WHO	World Health Organization

Appendix 2 List of Figures

Figures: Acknowledgements

Figure 1: Reprinted from the WHO webpage: Schistosomiasis: Status of schistosomiasis endemic countries: 2021, available here: https://apps.who.int/neglected_diseases/ntddata/sch/sch.html, Copyright WHO 2022.
Figure 2: Reproduced from the CDC webpage, DPDx - Laboratory Identification of Parasites of Public Health Concern: Schistosomiasis, available here: https://www.cdc.gov/dpdx/schistosomiasis/index.html, Copyright CDC.
Figure 3: Copyright Andreas Müller and Anemone Franz
Figure 4: Reprinted from the WHO webpage: Number of children (pre-SAC and SAC) requiring preventative chemotherapy for soil-transmitted helminthiasis: 2021, available here: https://apps.who.int/neglected_diseases/ntddata/sth/sth.html, Copyright WHO 2022.
Figure 5: Reproduced from the CDC webpage, DPDx - Laboratory Identification of Parasites of Public Health Concern: Giardiasis, available here: https://www.cdc.gov/dpdx/giardiasis/index.html, Copyright CDC.
Figure 6: Copyright Andreas Müller
Figure 7: Reproduced from the CDC webpage, DPDx - Laboratory Identification of Parasites of Public Health Concern: Amebiasis, available here: https://www.cdc.gov/dpdx/amebiasis/index.html, Copyright CDC.

Figure 8: Copyright Andreas Müller

Figure 9: Reproduced from: Mazigo et al, "Precision and geographical prevalence mapping of schistosomiasis and soil-transmitted helminthiasis among school-aged children in selected districts of north-western Tanzania", 2022.

Figure 10: Copyright Anemone Franz

Figure 11: Copyright Anemone Franz

Disclaimer

Appendix 3 List of Tables

Appendix 4 Ethical Clearance

CATHOLIC UNIVERSITY OF HEALTH
AND ALLIED SCIENCES
BUGANDO

P.O. Box 1464 Phone: (255) 28-250-0881 Email: vc@bugando.ac.tz
Mwanza, Tanzania Fax: (255) 28-250-2678 Website: www.bugando.ac.tz

CUHAS/BMC RESEARCH & ETHICAL COMMITTEE (CREC)
ETHICAL CLEARANCE FORM

Date	12th March 2019
Research Clearance Certificate No	CREC/344/2019
Name of researchers/PI and Institution	▪ Anemone Franz ▪ Univesity of Würzburg, Germany
Purpose of the research	Award of Doctor of Medicine at the University of Würzburg, Germany
Title of the Research	Determining the prevalence and morbidity of Schistosoma mansoni, soil-transmitted–helminths and intestinal Protozoa in Orphans and street children in Mwanza City, North Tanzania
Budget and Sponsor (s)	▪ € 8.330 ▪ University of Würzburg
Research period	March 2019 to February 2020

Ethical clearance is hereby granted.

A progress report shall be submitted to the relevant Directorate every 6 months.

CREC Chairperson

CREC Secretary

Appendix 5 Physical examination form

A) Identification

CODE	
ORPHANAGE	

B) Examination results

Height	
Weight	
Upper-arm-width	

Appendix 6 Questionnaire

A) Identification

CODE	
ORPHANAGE (if any)	

B) Socio-demographic characteristics of children

NO:	**QUESTIONS AND FILTERS**	**CODING CATEGORIES**
1	Sex of respondent	A) Female B) Male
2	Age	
3	Have you received treatment for parasitic infections in the last 6 months ?	A) Yes B) No
4	Where do you sleep?	A) Family B) Friends C) Orphanage D) Varying
5	How often do you attend school?	A) Always B) Often C) Sometimes D) Never
6	What is your main source of drinking water?	A) Piped water B) Well C) River/stream water D) Lake/ Pond water E) Rain water F) Bottled water
7	Where do you wash?	A) Lake B) Piped water C) River

		D) Other
8	Where do you get your food from?	A) Family B) Friends C) Orphanage D) Other E) I don't regularly get food
9	What kind of toilet facilities do you use?	A) Flush toilet B) Latrine C) Bush D) Other
10	Do you ever stay at an orphanage?	A) Often B) Sometimes C) I´ve never stayed at an orphanage

Appendix 7 Ultrasound report form

Ultrasound Report form for *Schistosoma mansoni* ***Code No.***

_____

Name sonographer:……..

S/no	variables	Codes	Select box
1	Liver image patterns	A Normal	
		B Diffuse echogenic foci ('starry sky'); minimal evidence of wall thickening around portal and subsegmental branches	
		C Ring echoes around vessels in cross-section; pipe-stems parallel with portal vessels	
		D Echogenic ruff around portal bifurcation and mainstem; thickening of walls of main portal branches	
		E Hyperechoic patches expanding into parenchyma	
		F Echogenic bands and streaks expanding from main portal vein and its bifurcation to liver surface, where they retract organ surface	
		X Cirrhosis	

		Y Fatty liver	
		U Unknown; indeterminate	
2	Other abnormalities detected	Specify:	
3	Size of left liver lobe (Liver PSL) (in cm)	_____cm	
4	Size of right liver lobe (Liver AAL) (in cm)	_____cm	
5	Portal vein diameter (in mm)	_____mm (quiet respiration)	
8	Spleen size	Spleen size (longitudinal diameter) in mm _____	
11	Gall bladder wall thickness?	0= normal (thickness < 4mm 1= Increased (thickness ≥4mm)	
12	Ascites	0 = Not present 1= Detected	

Appendix 8 Laboratory report form

Laboratory report form, page No. 1 **Code:_____**

CCA-Test	positive □	negative □
Urine dipstick test		
Haemoglobin	positive □	negative □
Protein	positive □	negative □
Urine Filtration	done □	not done □
Urine filtration	positive □	negative □

S. haematobium Egg count

Kato –Katz-Smears

Slide 1	S. mansoni	positive □	negative □	Egg count
	Other helminth eggs:			
Slide 2	S. mansoni	positive □	negative □	Egg count
	Other helminth eggs:			

Laboratory report form, page No. 2 Code:_____

Faecal Parasite Concentration Technique

Helminth eggs	positive □	negative □
Helminth species:	A) Schistosoma mansoni □	
	B) Schistosoma haematobium □	
	C) Ascaris □	
	D: Hookworm □	
	E) Trichuris □	
	F: Strongyloides larvae	
	G: Taena spec. eggs	
	H: Others	
Please specify “others”:		
Cysts of pathogenic Protoza	positive □	negative □
Giardia intestinalis cysts	positive □	negative □
Entamoeba dispar / histolytca	positive □	negative □

Appendix 9 Consent form English long version

Introduction

I am **Anemone Franz**, a medical student at Julius-Maximilian-University, Würzburg, conducting a study on "**Determining the prevalence and morbidity of *Schistosoma*, soil-transmitted-helminths and intestinal Protozoa in orphans and street children in Mwanza city, Northern Tanzania**".

Purpose of the research study

Schistosomiasis, caused by either *schistosoma mansoni* or *schistosoma haematobium* and soil-transmitted helminths, including *ascaris lumbricoides*, *trichuris trichiura* and hookworms, are among the neglected tropical diseases, which cause a significant burden of morbidities and unaccounted mortalities in Sub-Saharan Africa. Left untreated, most helminthic infections lead to chronic inflammations, cause anemia and malnutrition and thus have a constant effect on the health status of the affected individual. The simple measure of applying anthelminthic drugs has a crucial benefit on children's health and quality of life.

Apart from helminths, infections with intestinal protozoa are also highly frequent in Sub-Saharan Africa. Especially among young children, protozoa cause severe gastrointestinal symptoms and lead to considerable malnutrition and mortality.

Procedures

If you choose (or allow your child) to participate in the study, a stool and urine specimen will be obtained for laboratory analysis. The stool will be examined for signs of helminths and protozoa. The urine sample will be analyzed for schistosoma haematobium, hematuria and proteinuria. Moreover, the results will be anonymously published in a dissertation book and/or scientific journals.

Risks, Discomfort, and Benefits

You will not feel any discomfort, and there is no risk (when the specimen is being taken). You will not incur any direct costs as a result of participating in the study. If you are found to be positive wfor these worms, you will be treated as per the soil-transmitted helminths treatment that WHO recommendations.

Confidentiality

Information related to you (your child) will be treated in strict confidence to the extent provided by law. Your identity (your child's identity) will be coded and not be associated with any published results.

RIGHTS AS A PARTICIPANT

Your (your child's) participation in this study is voluntary, and you may withdraw at any time if you wish. Declining to participate shall not affect medical treatment (your child's medical treatment) from any health facility in any way nor your relationship with CUHAS Bugando. Should you at any time have any queries pertaining this research in regard to your personal rights (child's rights), you may contact the principal investigator, Anemone Franz,

on phone number +255 622 661 673 or Chairman of the CUHAS/BMC Ethics and Research Committee of CUHAS Bugando on +255282500881.

VOLUNTARY CONSENT

This information has been explained to me, and all my current questions have been answered to my satisfaction. If I have some more questions to ask, I will contact Anemone Franz on the phone: number +255 622 661 673.

My signature below indicates that I have volunteered voluntarily to participate (or voluntarily allowed my children to participate) in this research study.

_____ _____

Name of Participant (Parent/Guardian) Signature of Participant (Parent/guardian). Date. Phone No.

_____ _____

Name of Person Obtaining Consent Signature of Person Obtaining Consent

(PI or Designee) (PI or Designee) and Date

_____

Witness

Appendix 10 Consent form English short version

Consent form for the study

(English version)

"Determining the prevalence and morbidity of *Schistosoma*, soil-transmitted helminths and intestinal Protozoa in orphans and street children in Mwanza city, Northern Tanzania"

Name of participant: _____
Date of birth: _____
Study No.: _____
Name of counselor: _____

I have been counselled about the aim of the study and the investigations that will be done with the samples (stool and urine) I have to provide to participate. Furthermore, I was counselled about the ultrasound examination that will show if my abdominal organs are affected.

I understand that my participation is absolutely voluntary, and I will not get any payment for participation.

I was counselled about the medication that will be offered and I understand that I can refuse to take the tablets although they are strongly recommended. I was told that there might be minor side effects like nausea or stomach pain, which is most likely related to killing of the worms.

All my questions were answered, and I am willing to participate in the study.

Date: _____

Signature of participant / legal guardian:_____(if possible)

Signature of Counsellor: _____

Appendix 11 Consent from Swahili

FOMU YA RIDHAA YA WATOTO

KICHWA CHA HABARI: Uchunguzi wa kiasi cha Ugonjwa wa Kichocho, minyoo ya tumbo na protozoa kwa watoto wa mitaani Katika Jiji la Mwanza, Kaskazini mashariki mwa Tanzania.

WATAFITI: Anemone Franz, Dr. Andreas Müller, Dr Deodatus Ruganuza

Fomu hii ya idhini ni sehemu tu ya kuomba ridhaa imelenga kukupa taarifa ya msingi kuhusu maana ya utafiti na ni kitu kitahusika endapo mtoto wako atashiriki. Kama utahitaji maelezo zaidi kuhusu mambo yaliyoelezwa au ambayo hayajaelezwa humu usisite kuuliza. Soma vizuri kwa utaratibu fomu hii na utapewa fomu hii kwa ajili ya kimbukiumbu zako.

UTANGULIZI

Mimi ninaitwa Anemone Franz ni Mwanafunzi wa Udaktari kutoka Chuo kikuu cha Julius Maxmillian , Wurzburg na nifanya utafiti kuhusu "**Uchunguzi wa kiasi cha Ugonjwa wa Kichocho, minyoo ya tumbo na protozoa kwa watoto wa mitaani Katika Jiji la Mwanza, Kaskazini mashariki mwa Tanzania.**"

LENGO LA UTAFITI

Kichocho ni ugonjwa unaosababishwa na minyoo iitwayo Schistosoma mansoni au Schistosoma haematobium, minyoo ya tumbo ni magonwa yasiyopewa kipaumbele ya kitropiki yanashambulia watu wengi na kusababisha vifo ambavyo havihesabiwi katika Africa kusini mwa Jangwa la Sahara. Yasipotibiwa maonjwa haya husababisha upungufu wa damu na utapiamlo hivyo kufanya afya ya mgojwa kuwa mbaya. Njia rahisi ya tiba ni

kutumia dawa za minyoo ambazo zimethibitishwa kutibu ugonjwa na kufanya afya kuimarika.

Mbali na minyoo, vijidudu aina ya protozoa hushambulia watu wengi Africa kusini mwa Jangwa la Sahara na kusababisha dalili za ugonjwa wa tumbo na wakati mwingine hata vifo.

MTOTO WAKO ANATAKIWA KUFANYA NINI?

Ukimruhusu mwanao kushiriki kwenye utafiti huu tutachukua taarifa zake kama jina umri na mahali anapoishi na tutaomba atupatie choo pamoja na mkojo kwenye chombo tutakavyompatia. Tutakipima choo hicho kuangalia mayai ya minyoo wa tumbo pamoja na protozoa halafu tutamtibu kama ana minyoo na tutatibu protozoa tutakaowaona kwenye choo. Tutapima mkojo kuangalia protini au damu.

JE KUNA HATARI YEYOTE?

Kuna hatari ndogo sana ni sawa na hakuna hatari yeyote ya kushiriki na kutupatia sampuli , taarifa za mtoto tutakazochukua ni siri na choo na mkojo kitachukuliwa baada ya mtoto kujisaidia mwenyewe. Kadhia ndogondogo huweza kujitokeza nazo ni kutapika tumbo kuumwa na kichwa kuuma na kizunguzungu baada ya kutumia dawa ya minyoo. Hizi huweza kutokea hata anapotumia dawa nyingine yeyote. Hatutaachia taarifa inayoweza kumtambua mtoto mmoja mmoja kwenye utafiti huu.

JE TAARIFA ZA MTOTO WANGU ZITATUNZWA KWA USIRI

Taarifa za mtoto wako zitatunzwa kwa usiri ambapo mtafiti mkuu tu atakuwa na uwezo wa kuziona taarifa hizo, taarifa zote zinawekwa kwenye kompyuta yenye neno la siri/ ufunguo na na kompyuta itafungwa kwenye kabati kwa kufuli na ufunguo. Taarifa ambazo hazina majina ya washiriki zinaweza kutumika na watafiti wengine kwa ajili ya utafiti zaidi. Utafiti wa siku za usoni kwa kutumia taarifa tutakazokusanya utahitaji ridhaa ya bodi ya maadili ya utafiti

KAMA MTOTO AKIPATA MADHARA YANAYOKANA NA KUSHIRIKI UTAFITI JE NITAFIDIWA?

Ikitokea mtoto wako akapata madhara kwa sababu ya utafiti hakuna fidia yoyoye itakayotolewa na watafiti. Bado unabaki na haki zako za kisheria za kudai fidia ikiwa utapata madhara.

HAKI ZA MSHIRIKI

Kushiriki kwenye utafiti huu ni kwa hiari unaweza kusitisha ushiriki wako kwenye utafiti huu muda wowote ambao unaona ni sawa kuacha kushiriki. Kama utakataa kushiriki kwenye utafiti huu haitaathiri matibabu utayohiyaji kutoka vituo vya afya . Kama una maswali kama mshiriki unaweza kuwasiliana na mtafiti mkuu Anemone Franz on phone number +255 622 661 673 or Mwenyekiti CUHAS/BMC kamati ya maadili ya utafiti CUHAS +255282500881.

SAHIHI

Sahihi yako kwenye fomu hii ni uthibitisho kuwa umesoma na umeelewa taarifa kuhusu ushiriki wa mtoto wako kwenye utafiti huu na unaridhia ushiriki wake. Hii haiondoi haki zake za kisheria au kuondoa wajibu wa kisheria au kitaaluma wa watafiti na taasisi wanazotoka.

Jina la Mzazi/ Mlezi	Sahihi na Tarehe
Jina ka Mtoto	Sahihi na Tarehe
Jina la Mtafiti	Sahihi na Tarehe
Jina la Shahidi	Sahihi na Tarehe

Appendix 12 Assent form

Assent for Younger Child (6-17 years old)

TITLE: **Determining the prevalence and morbidity of *Schistosoma*, soil-transmitted-helminths and intestinal Protozoa in orphans and street children in Mwanza city, Northern Tanzania**

INVESTIGATORS: Anemone Franz, Dr. Andreas Müller, Deo Ruganuza

We want to tell you about a research study we are doing. A research study is a way to learn more about something. We want to find out how many children are infected with parasites. You are being asked to join the study because at your age many children are infected.

If you agree to join this study, you will be asked to give some demographic information about yourself (age and residence) and answer questions about whether you have taken medicine to treat worms in the last 6 months and then you will be asked to give a stool and urine sample, you will get treated with Albendazole and Praziquantel.

This study has very minimal risks as we will only take information like age and residence which will not be disclosed to any other party or presented in a manner that can personally identify you, the history of taking medication to treat worms and ask for a sample of stool and urine.

It is up to you if you want to join the study or not. You can say okay or you can say no It's OK if you say okay and then you change your mind later. If you want to stop, then all you have to do is tell us you want to stop. No one will be mad at you if you don't want to be in the study or if you say yes now then want to stop later.

Before you say yes or no to being in this study, we will answer any questions you have. If you join the study, you can ask questions at any time. Just tell the researcher that you have a question.

We will also talk to your parents about this study. You can talk this over with them before you decide.

Anemone Franz +255622 661 673

Would you like to be in this research study?

◯ Yes, I want to be in this research study. ◯ No, I don't want to do this.

_____	_____	_____
Child's name	Signature of the child	Date

_____	_____	_____
Person who received assent	Signature	Date

The CUHAS/BMC joint Institutional Ethics Review Board has approved this research study. A signed copy of this assent form has been given to you to keep.

Appendix 13 Assent form children Swahili

Fomu ya ruhusa (6-17 years old)

KICHWA CHA HABARI: **Kuchunguza kiasi na Ugonjwa usababishwa na Schistosoma minyoo ya tumbo na Protozoa wa tumbo kwa yatima na watoto wa mitaani ndani ya jiji la Mwanza, Kasakazini Mashariki mwa Tanzania.**

Watafiti: Anemone Franz, Dr. Andreas Müller, Dr Deodatus Ruganuza

Tunataka kukueleza kuhusu utafiti tunaofanya, utafiti ni njia ya kujifinza kuhusu magonjwa. Tunataka kujua watoto wangapi wanaugua ugojwa wa minyoo na protozoa wat umbo. Tunakuomba ujiunge na utafiti huu kwasababu watoto wengi wa umri wako wanaugua.

Ukikubali kuingia kwenye utafiti huu tutaomba taarifa kukuhusu wewe mahali unapoishi na umri halafu tutapenda kujua kama umemeza dawa za minyoo ndani ya miezi sita iliyopita. Pia tutaomba utupatie sampuli ya choo na mkojo halafu tutakutibu kwa kutumia dawa ya Albendazole na Praziquantel.

Utafiti huu hauna hatari kwako maana tarrifa kukuhusu hazitatolewa kwa mtu yeyote katika hali ambayo inaweza kukutambua wewe. Ni juu yako kuamua kama unataka kushiriki kwenye utafiti huu. Unaweza pia kubadili mawazo kuhusu kushiriki baafda ya kuwa umeshakubali kushiriki. Hakuna mtu atakayekukasirikia kama utakataa kushiriki. Pia kabla hujakubali kushiriki tungependa uulize maswali, au pia muda wowote ukiwa ndani ya ushiriki wa utafiti.

Tutazungumza na mzazi au mlezi kuhusu utafiti huu, unaweza kujadili nao kuhusu maamuzi ya kushiriki.

Anemone Franz +255622 661 673

Je utapenda kushiriki kwenye utafiti huu?

_____ Ndio nataka kushiriki _____ Hapana sitaki.

_____ _____ _____

Jina la mtoto Sahihi ya mtoto Tarehe

_____ _____ _____

Jina la aliyepokea ruhusa Sahihi Tarehe

Bodi ya Maadili ya utafiti ya CUHAS/BMC imethibitisha huu utafiti this research. Nakala ya Ruhusa hii umepewa kwa ajili ya kumbukumbu.

Appendix 14 Danksagung

Ich möchte mich hiermit bei Dr. Andreas Müller bedanken, der mir die Möglichkeit gegeben hat, an diesem spannenden Thema unter seiner Leitung zu arbeiten. Ich bedanke mich für die kontinuierliche geduldige Beratung und Unterstützung seit Projektbeginn vor mehr als drei Jahren. Prof. Dr. August Stich und Prof. Dr. Klaus Brehm danke ich besonders für ihre Bereitschaft als Referenten für diese Arbeit zu fungieren. Auch für die mühevolle Arbeit des Korrekturlesens und die wertvollen Anregungen möchte ich mich herzlich bedanken. Schließlich gilt mein Dank Dr. Anje Fuss, die mich bei vielen Schritten der Projektplanung und -durchführung tatkräftig unterstützt hat.