Original Research Article

Transmission of parasitosis in a community and treatment option

Comment [DI1]: Transmission and treatment options regarding helminthosis in a community

Abstract

Infections caused by parasites and mainly helminths affect more than a billion people worldwide, causing anemia,and having a significant social and economic impact. To alleviate this burden, the population resorts to massive administration of antiparasiticswithout worrying aboutimproving the condition of the habitat, water and hygiene, an obvious transmission channel for helminths in the populations.In this epidemiological study different epidemiological characteristics of the habitat.We receivedwe received responses from 7,014 households regarding on the disease risk factors,and from 283 pharmacieson available treatments. It appears from our analysis that most plots of land were cleared and dry but sometimes covered with plants and grasses.An average of four households, six children over fifteen years, and four children under five years old, as well as two toilets were observed per plot of land. Quality of toilets, sources of water supply, misuse of toilet pots for children under five years old as well as variations in weather conditions were the elements of the transmission ofhelminthosis in Kolwezi. Affected people presented with varied signs, feeling of vomiting, fatigue and nocturnal cough. Laboratory tests which, moreover, were able to observe moreHookwormand*Ascaris lumbricoides* eggs. Self-medication involved mostlymebendazole, herbal teas and palm kernel oils while pharmaciesin the area dispensedAlbemedazoles morefrequently.Urgent advocacy and health on epidemiology of helminthosis is necessary in the study area.

Comment [DI2]: Parasitic helminths

Comment [DI3]: with

Comment [DI4]: affected

Comment [DI5]: antihelminths

Comment [DI6]: improvements in the factors that aid in spreading helminthosis

Comment [DI7]: community

Comment [DI8]: we used questionnaires, oral interviews and direct observations to determine risk factors and treatment options for the disease in two communities of Kolwezi in Democratic Republic of Congo.

Comment [DI9]: Altogether,

Comment [DI10]: It was observed

Comment [DI11]: by infants

Comment [DI12]: the major risk factors for

Comment [DI13]: Dominant symptoms of helminthosis in the community were

Comment [DI14]: Occasional stool examination revealed mainly

Comment [DI15]: Mebendazole®

Keywords: Helminthosis, transmission, risk factors, antihelminths, Kolwezi

Introduction

Intestinal parasitosis is a major public health problem that affects the health of primary school children in low- and middle-income countries where living, water, sanitation, and hygiene conditions are precarious [1]. It is one of the commonly perceived and often observed serious

problems in children, leading to high mortality[2]. Faecal-oral transmission is a common way of transmitting a parasite.

Comment [DI16]: helminthosis

Comment [DI17]: soil-transmitted helminth parasites

Soil-transmitted helminth are a group of parasites that cause gastrointestinal infections in humans and require soil to grow into their infectious [3]. Ecological factors such as soil temperature, soil pH and rainfall patterns are, however, important determinants for the successful transmission of soil helminths, as they play a major role in their abundance and survival of STHs in soil before they can be transmitted to the human host [4].

Comment [DI18]: parasites

Comment [DI19]: develop into their infective stages

Comment [DI20]: development,

The purpose of the study is to study the ecological factors influencing the transmission of soil-transmitted helminthiasis in the study area,

Comment [DI21]: was

Comment [DI22]: determine

Comment [DI23]: helminthosis

Comment [DI24]: Kolwezi, Lualaba Province in the Democratic Republic of Congo.

Methodology

Study sites.

Comment [DI25]: Study area

The study was conducted in the two communities, Manika and Dilala in the city of Kolwezi (Latitude: -10.7, Longitude: 25.6667 , 10° 42′ 0″ South, 25° 40′ 0″ East), with an area of 21,300 hectares at an altitude of 1,264m above sea level, and having a humid subtropical climate comprising hot summers and dry winters [5].over the year, the average temperature in Kolwezi is 22.4°C while the average rainfall is 512.7mm.The boundary of Manika and Dilalaare notclearly

Comment [DI26]: Either you give the accurate geographical co-ordinates in Latitudes (North of Equator) and Longitudes (East of Greenwich Meridian) OR you Sketch the map of the study area

Comment [DI27]: Average annual

delineated, so many residents freely commuteacross the two communities as part of their daily activities.

Questionnaire and survey procedure

The questionnaire elicited questions onlocation and composition of households, environment, typesand usage of toilets, and sources of water supply. Oral interviews required participants to describe how parasitic infections had affected them. Response to themix of closed and open questionnaire was designed to last between 10-15 minutes. The questionnaire was pre-tested in Lubumbashi to ascertain its validation.

Participation was voluntary and participants were free to opt out of the survey at any time or skip questions they did not wish to answer. Further consent or ethical approval was therefore needed for the study.

The research was conducted within the duration of 300 Level Parasitology Course for medical studentsin the Faculty of Medicine, University of Kolwezi.Two groups of the investigation team conducted the interview - One groupconducted in French forparticipantsfluent in Frenchwhile the second group conducted the interview through a translator fluent in Swahili, the main vernacular of the people. All responses were imputed into laptop computers using theGoogle form questionnaire.

Survey analysis.

Comment [DI28]: Study design

This is a cross-sectional study among the inhabitants of the city of Kolwezi on the transmission of helminthic diseases. A total of 7014 households and 283 pharmacies were visited and the results received were analyzed using Epi info 7.3 and Office Excel 2013 and are presented in the form of Tables, Pie charts and histograms.

Comment [DI29]: Delete since All Pie charts were not clear and have been converted to Bar Charts

Comment [DI30]: Bar charts

Results and Discussion

Comment [DI31]: Adequate subheads have been added for effective presentation and discussion of results

Characteristics of the study area

A Total of 7014 households from Kolwezi were visited: 59.2% or 4155 households were from the commune of Manika and 40.8% or 2859 were from Dilala. These households had plots characterized by a clean yard (48.1%), dry (61.4%), humid (17.26%) covered by trees in 34.0% of cases, with the presence of grass 23.42% and a flow of water not controlled in 15.52% cases. The plots had on average: 4 households with 6 children over 15 and 4 under 5 and two toilets (Table 1).

Comment [DI32]: See Corrected Table 1 and use the frequency percentages to present and discuss your results

Table 1: Description of the environment and composition of households

Comment [DI33]: Delete this Table and replace with the properly formatted Table 1 below

Household by municipality	***NOT***
Manika	4155
Dilala	2859
household environment	***NOT***
Humidity	1211
Covered by trees	2389
Not covered	2171
Dried	4311
Own	3379
Presence of water flows	1089
Presence of herbs	1643

Household composition	*Average*
Number of households	4
Number of adults (Age≥15 Years)	6
Number of children (age ≤5 years)	4
Number of toilets	2

Table 1: Characteristics of the study area

Study sites	Characteristics	Frequency (Number)	Frequency (Percentage)
Communities with households	Manika	4155	59.2
	Dilala	2859	40.8
	Total frequency	**7014**	**100.0**
Characteristics of households	Humid environment	1211	7.5
	Land covered by plants	2389	14.8
	Land not covered by plants/trees	2171	13.4
	Dry land	4311	26.6
	Own	3379	20.9
	Presence of surface flowing water	1089	6.7
	Presence of herbs	1643	10.1
	Total frequency	**16193**	**100.0**
Average numberin plot of land	Households	4	
	Adults (Age≥15 Years)	6	
	Children (age ≤5 years)	4	
	Toilets	2	

Comment [DI34]: What is this? Clarify

Types and quality of toilets

About 45.8% of the toilets in the house holds were of the Turkish type; 38.5% were seated and 15.7% were makeshift toilets. The roof was present on 58.16% of the toilets, 62.12% of them had a door and 57.6% were of fired brick construction (Table 2).

Table 2: Types and quality of toilets

Comment [DI35]: This Table is not well-formatted and confusing. Delete and replace it with the corrected Table 2 below

Kind toilets	No.	**%**	**roof**	NOT	**Door**	NOT	**Types of construction**	NOT
Turkish	3213	45.8	Without roof	1132	Without door	971	adobe brick	470
Seat	2701	38.5	With roof	4080	With door	4357	Baked bricks	4038
unclassified	1100	15.7	N / A	N / A	N / A	N / A	N / A	?HAS
Total	7014	100						

Table 2: Types and quality of toilets

Quality of toilets	Variables	No.	%
Kind of toilets	Turkish	3213	45.8
	Seat	2701	38.5
	Unclassified (Make-shift)	1100	15.7
	All toilets	**7014**	**100.0**

Roof	Without roof	1132	16.1
	With roof	4080	58.2
	Unclassified	1802	25.7
	All toilets	**7014**	**100.0**
Door	Without door	971	13.84
	With Door	4357	62.12
	Unclassified	1686	24.04
	All toilets	**7014**	**100.0**
Types of construction	Adobe brick	470	6.7
	Baked bricks	4038	57.6
	Unclassified	2506	35.7
	All toilets	**7014**	**100.0**

Environmental conditions near toilets and locations of water sources

The environment of the toilets is shown in Table 3.Frequency of those shaded was 48.65%, humid (27.13%), presence of grass (25.69%) and trees (17.40%),and presence of un-emptied toilet pots for children under 15 (37.16%). The water source was either private by drilling (45.89%), public (40.97%), manually dug closedwells (12.27%),manually dug open wells (5.48%), lakes (0.38%), rivers(1.65%) or Kishimpo (4.93%). Frequency of water sources placed far from toilets and trees was 75.36%, near toilets (11.04%) and near a tree (13.58%).

Table 3: Environment around the toilet and location of the water source

Environment around the toilet	Number	Water source	Number	Location of water source	Number
Humid	1903	public	2874	Near the toilet	775
Shady	3413	Drilling	3219	Near a tree (including banana and sugar cane)	953
Presence of toilet potties for children under 5 years old	2607	Open well	385	Far from toilets and trees	5286
Presence of herbs	1802	Closed well	861		
Presence of trees (banana and sugar cane included)	1221	River	116		
		Lake	27		
		Kishimpo	346		

Table 3: Environmental conditions near toilets and locations of water sources

Characteristics	Variables	Frequency (No.)	Frequency (%)
Environment near toilets	Humid	1903	17.4
	Shady	3413	31.2
	Presence of toilet potties infants	2607	23.8

Comment [DI36]: Use the data in the corrected Table 3 to present and discuss your results (replace the values in RED

Comment [DI37]: 5 years

Comment [DI38]: This Table does not show the frequency percentages you are reporting. It was not well-formatted and therefore confusing. Delete and replace it with the corrected Table 3 below

	Presence of herbs	1802	16.4
	Presence of plants (e.g., banana, sugar cane)	1221	11.2
	Total frequency	**10946**	**100.0**
Environment nearwater sources	Public	2874	36.7
	Drilling	3219	41.1
	Open well	385	4.9
	Closed well	861	11.0
	River	116	1.5
	Lake	27	0.4
	Kishimpo	346	4.4
	Total frequency	**10946**	**100.0**
Environment nearlocation of water sources	Near the toilet	775	11.0
	Near trees (e.g., banana and sugar cane)	953	13.6
	Far from toilets and trees	5286	75.4
	Total frequency	**7014**	**100.0**

It is a known fact that the development of soil-transmitted helminthiasis in the soil depends on several factors that create favorable environmental conditions for the survival of nematode eggs [5]. Studies carried out in other tropical and subtropical areas also reported that these factors significantly favor the survival and development of soil helminth stages [7, 8].

Rainfall not only provides essential moisture for the development of ovules to infective larval stages, but also aids in the dispersal of ovules and the migration of larvae throughout the environment [9].It has been shown that there are more soil-transmitted helminths during the rainy months than during the dry months in Croatia[10], Cameroon[11] and Nigeria [8], where infection rates were significantly higher during the rainy season than during the dry season. The effect of rain on the dispersal of larvae is important, sincerain-drops can transport the larvae to about 90 cm from the manure. Several authors have reported migration of larvae up to 15 cm deep in the soil and up to 40 cm from the center of the faecal mass but the soil type can have a major effect on the ability of larvae to migrate [12].

Comment [DI39]: ova

Comment [DI40]: ova

Comment [DI41]: wet than dry seasons

Comment [DI42]: contaminated

Although the collection of data was made during the intermediate period between the rainy season and the dry season, it is known that the ova of Ascaris lumbricoides record the highest occurrence during the dry months because of the greater resistance of the eggs of *A. lumbricoides* to extreme environmental conditions and can remain viable in the soil for several months due to aestivation which explains their survival in strange and harsh weather conditions, such as extremely hot and dry weather [13].

Comment [DI43]: Always italicize Scientific names like *Ascaris lumbricoides*

Also, an inverse relationship between soil conductivity and occurrence of soil-transmitted helminths was found by in Cameroon and Bandung [14], and in Indonesia [15]. Thus, the availability and abundance of soil-transmitted helminths are independent of the conductivity of their environment, and no correlation was found between the parameter and the prevalence of helminth larvae and ova.

The presence of trees and grasses in the plots provides the soil with abundant quantities of organic matter; one would have thought that it would increase the survivability and viability of helminths

in the soil. Indeed, studies conducted in Egypt indicated that there was an increase in the abundance of STHs with increasing total organic matter [16,17]. However, Strongyloides stercoralis showed a negative correlation with total soil organic matter. It was reported that a high amount of total organic carbon, which is a major constituent of total organic matter, does not seem to favor the survival of Strongyloides larvae in the environment [18].

Figure 1 shows that the monthly weatherforecasts for the city of Kolwezi for 2023. Temperatures vary between the fork of 16°C and 24°C.

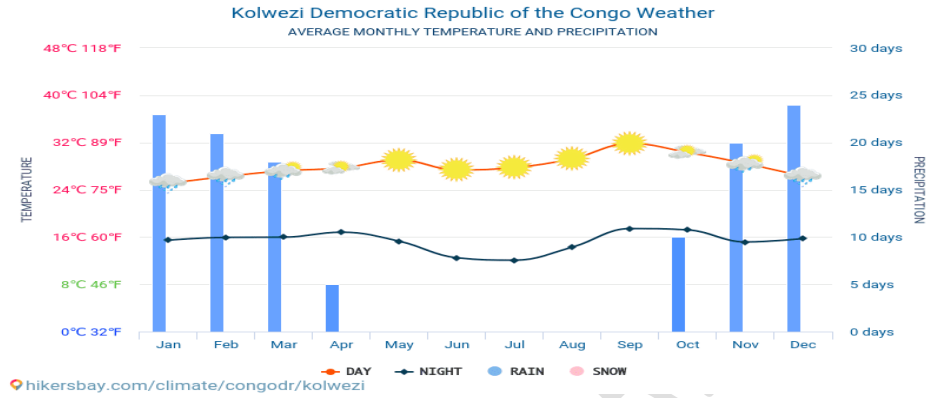

Fig. 1: Distribution of temperature forecasts in Kolwezi in 2023

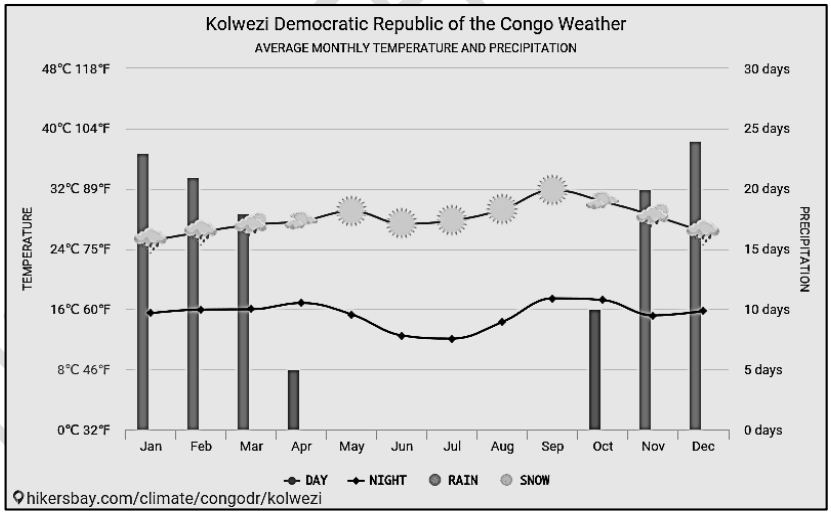

Figure 1: Monthly temperature and rainfall forecasts in Kolwezi in 2023

The World Health Organization has reported that hookworm and other soil helminths can tolerate a pH range of 4.6 to 9.4 and would still be able to hatch and grow to stages infectious [19,20] . A. duodenale and *S. stercoralis* larvae showed a significant negative correlation with observed soil temperature range. The ovules of *Ascaris*spp. and *A. duodenale* also showed a significant positive correlation with soil conductivity. This shows that the presence of salt ions in the soil favored egg survival and viability, already reported by some authors [12].

Comment [DI44]: Italicize this

Comment [DI45]: This figure is not clear. Replace it with the Clearer Figure 1 below

Comment [DI46]: *Ancylostoma duodenale*

In the environment,survival is favored at moderate temperatures (0 to 20°C). Humidity affects the survival of *Tænia* spp. eggs more than temperature.eggs are commonly found on vegetables (0.9-30%) and in soil and water samples (0-43%), their presence posing a risk to the consumer[21]. Invertebrates can function as transport hosts, transferring infection to an intermediate host, but the importance of this route of transmission is still questionable. Contamination of food, soil and water can increase the risk of helminth infectionsin humans and other intermediate hosts [22,23]. It can also bespreadby invertebrates and wind [24, 25] as presence of eggs has been detected in soil and water samples [26,27].

Helminthosis in households: use of toilet pots and laboratory tests for STHs

From Figure 2, we see that 65.9% of households use potties for the toilet of children under 5 years old. About 73.4% acknowledge having suffered from parasitosis while only 48.4% have had to pass laboratory tests for diagnosis.The overturning of toilet pots for children under five, the age group carrying parasites, provides the soil with eggs and larvae. Indeed, the soil remains the main reservoir of the infectious stages of soil-transmitted helminthiasis and serves as an important medium for determining the level of susceptibility of a population to soil-transmitted helminthiasis. The results of the study showed that soil-transmitted helminth infections in endemic areas are not only due to unsanitary and poor living conditions, but also to ecological factors favoring the dispersal and development of the infective stages of STHs[28].

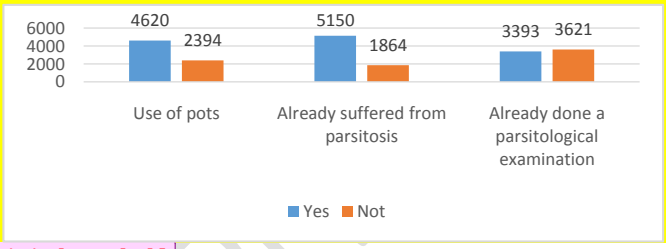

Fig. 2: Parasitosis in households

Comment [DI47]: This figure does not reflect the percentages being reported. Delete and replace it with re-formatted Figure 2 that shows the correct values in percentages

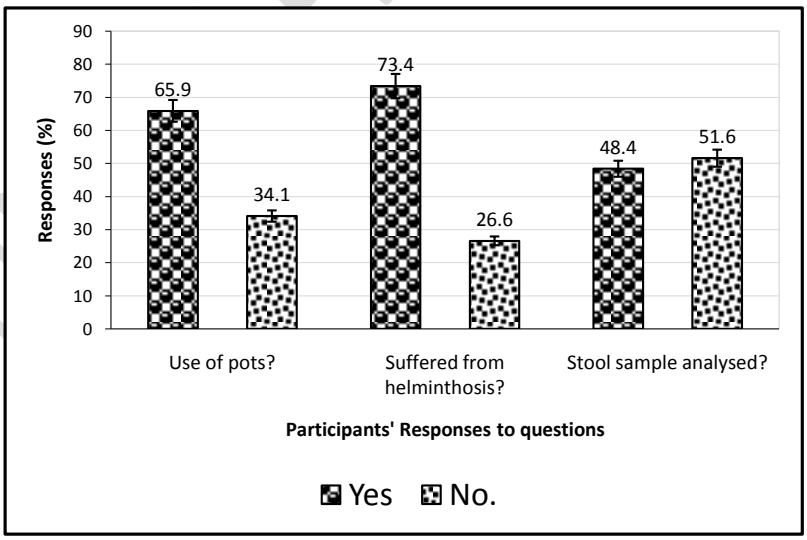

Figure 2: Helminthosis in households:use of toilet pots and laboratory tests for STHs

Frequency of symptoms of helminthosis experienced in the community

Symptoms include deterioration of the intestines, toxic effects, blood loss, diarrhea, malnutrition, and anemia. Some helminths eat away at the intestinal wall causing bleeding while secreting an anticoagulant. The damage caused by inflammation and the wounds they open generate tumors and growths. Additionally, helminths can block the ducts or cause intestinal obstruction and perforation of the digestive tract causing peritonitis [29].

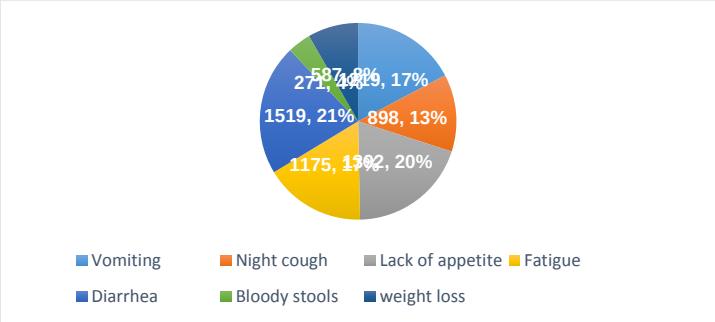

Fig. 3: Breakdown of temperature forecasts in Kolwezi in 2023

Comment [DI48]: Delete this Pie Chart. The title of this figure is misleading. The Pie Chart is not clear and has been replaced with a Bar Chart (Figure 3 below) showing the frequencies of symptoms of helminthosis experienced in the community

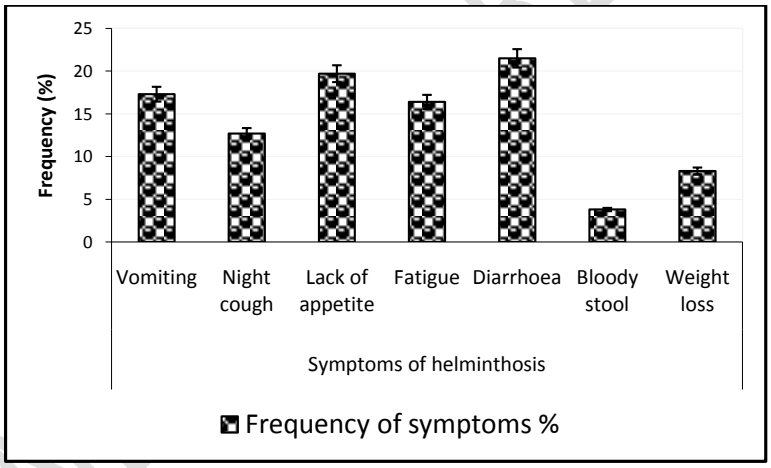

Figure 3: Frequencies of symptoms of helminthosis experienced in the community

Helminthiasis can lead to serious collateral effects limiting the physical and mental development of children, especially when repeated infections occur between 5 and 15 years of age. An estimated 182 million preschool children are infected, about 33% of those living in developing countries [30]. These children show lower height and weight due to undernourishment compared to well-nourished children living in a healthy environment. At the same time, malnutrition leads to poor academic performance and a lower intelligence quotient [31]. Other effects, such as epileptic seizures, violent headaches, dizziness, local paralysis, vomiting, and optical and physical disturbances, have been reported [32].

Relative distributions of helminth parasites in the community

Distribution of parasites in the community is shown in Figure 4. It was observed that distribution of *Ascaris lumbricoides*and Hookworm eggsmore frequent than other helminth species in the community.

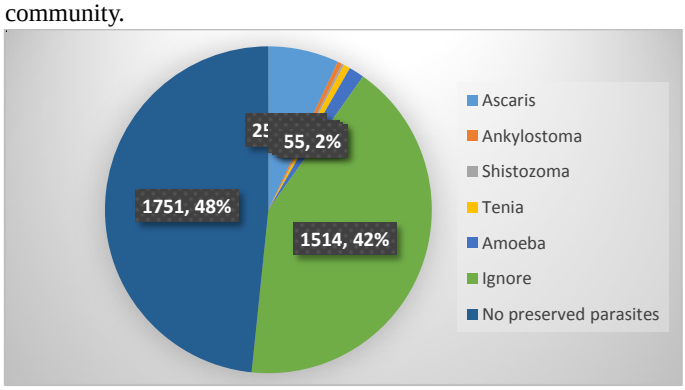

Fig. 4: Distribution of parasites diagnosed in the community.

Comment [DI49]: Delete this Pie Chart. Replaced it with the Bar Chart (Figure 4 below) showing the relative distributions of parasites.

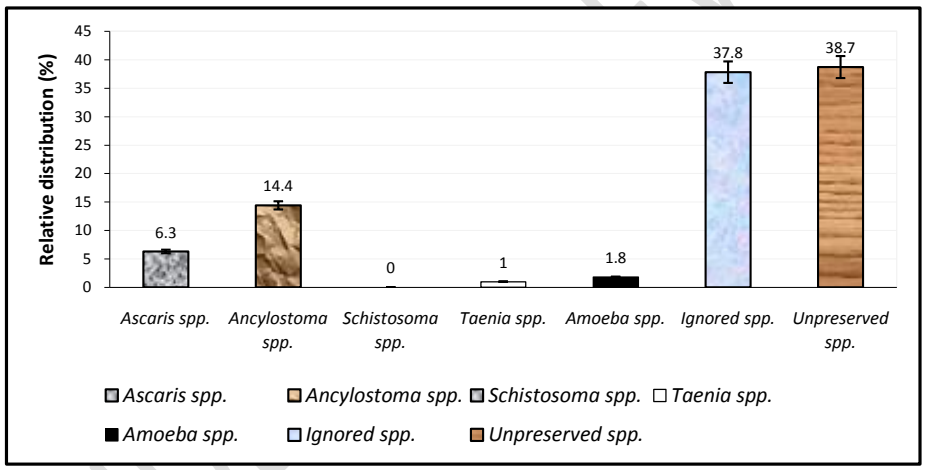

Figure 4: Relative distributions of parasites in the community

Parasitic helminths are transmitted to humans via their infective eggs, and they are the most resistant biological structures to inactivation in the field of environmental engineering [33]. Most helminths are transmitted by direct contact with contaminated soil, crops, or sewage (e.g., *Ascaris lumbricoides*, *Trichuris trichiura*, and *hookworms*), but some require the presence of intermediate hosts like garden snails inaquatic environment, in the case of schistosomiasis [34]. The main species that infect humans are roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*) and hookworms (*Necator americanus* and *Ancylostoma duodenale*)[35]. Concerns about their presence are related to their extremely low infectious dose, their high survival rate in the environment for prolonged periods (up to several years, compared to weeks for other pathogens) and their high resistance to conventional disinfection processes [36].Helminth eggs pose a particular health threat when sanitary conditions are poor, polluted water is used for irrigation, or when excrement or untreated sludge is disposed indiscriminately. They cause a group of diseases

called “helminthosis” but specific names are given depending on the genus concerned, for example, Ascarosis for the genus *Ascaris*, Ancylostomosis for the genus*Ancylostoma*[37].

Treatment of Helminthosis in the study community

Preparations used for the treatment of helminthosis in the study community are shown in Figure 5. Mebendazole® is the most administered antiparasitic in the communityand the most available in pharmacieswhileAlbendazole is second in terms of consumption, also being regularly prescribed and available in pharmacies. Herbal teas and palm oils are also highly patronized in the community for treatment against parasites.

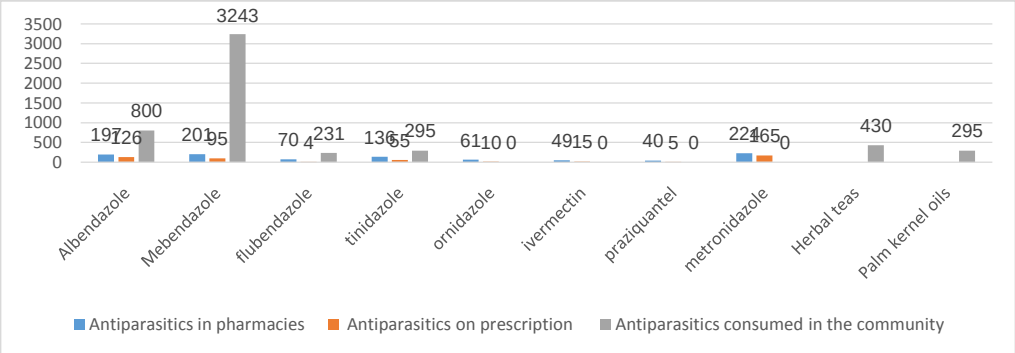

Fig. 5: Supply situation, prescription of antiparasitic and their consumption in the community

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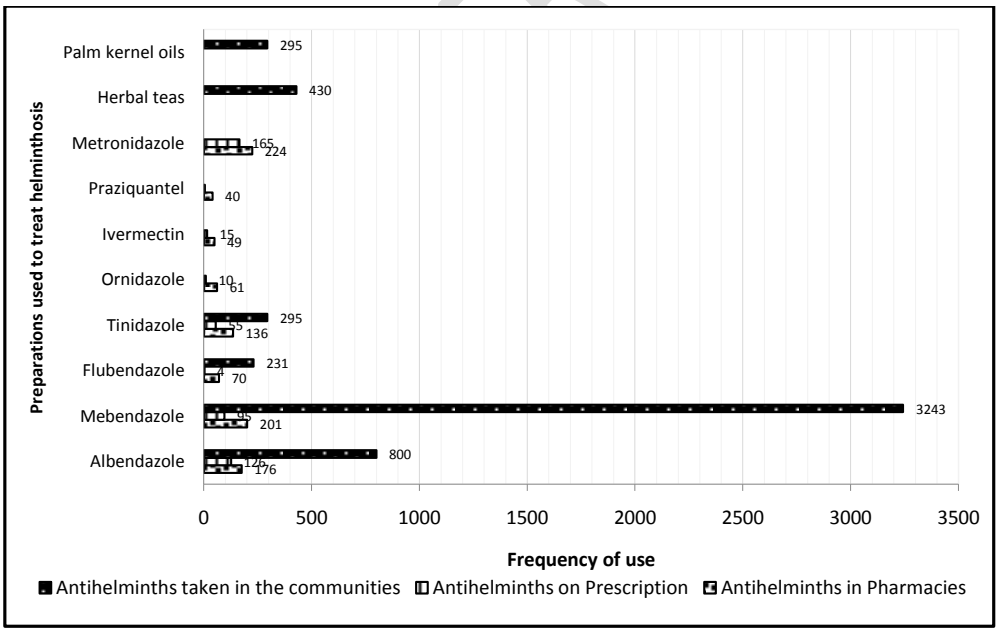

Figure 5: Preparations used for the treatment of helminthosis in the study community

Mebendazole are donated to national ministries of health through the World Health Organization (WHO) in all endemic countries for the treatment of all school-aged children. Generic ivermectin for *Strongyloides stercoralis* control has been available at an affordable price since 2021[38]. For treatment, WHO recommends Albendazole (400 mg) and mebendazole (500 mg), antiparasitic that

are effective, inexpensive, and easy to administer by non-medical personnel (e.g., teachers). They have undergone extensive safety testing and have been used in millions of people with few minor side effects [39]. Albendazole is an anthelmintic antiparasitic. It is a Benz imidazole carbamate. It acts on nematodes, cestodes and certain protozoa. It acts on the cytoskeleton of helminths by inhibiting the polymerization of tubulins and their incorporation into microtubules, thus blocking the uptake of glucose by the parasites, and causing their death. It also has activity on *Giardia intestinalis* (or *duodenalis*). It exerts an irreversible action targeted on the ventral disc of the trophozoite by effect on the polymerization of tubulin and giardin, resulting in disorganization of the cytoskeleton and micro ribbons. The ability to adhere to enterocytes is diminished, resulting in inhibition of parasite growth and multiplication [40].

Conclusion

Environmental factors that affect temperature, soil moisture, and atmospheric humidity influence the survival rate and development of hookworm larvae, thereby affecting transmission [57]. In this study, increased vegetation and elevation were associated with increased risk of infection as well as increased intensity of infection.Access to a handwashing facility with soap and water in the household was also observed to be associated with lower risk and intensity of infection.The transmission of parasitic diseases is a fact in Kolwezi, it is carried by the level of housing and sanitation of plots, access to water, the load of children under five in households. important not to neglect the role of flies which function as an important mechanical vector of infectious parasitic forms, which proliferate due to the non-discharge of children's toilet pots having been used as excrement. The fruits and vegetables produced in the area function as vehicles for the parasites, constituting a risk factor associated with transmission due to the marketing of these agricultural products in other areas. This transmission is also favored by geographical, climatic, and meteorological conditions.

Comment [DI51]: Conclude from your findings only. Do not cite author (s) in conclusion.

It is therefore essential to educate the population to modify habits that could be considered risk factors, while improving adequate environmental sanitation, emphasizing socio-cultural and educational aspects, as well as hygienic practices. public health. These interventions must combine technical and socio-economic actions that guarantee public health, including environmental sanitation in general, and the elimination of other factors that affect the dispersal and transmission of intestinal parasites, such as faecal contamination of soil and water.

References

Comment [DI52]: Ensure that you comply strictly with the Journals style of referencing

1. Aschale A, Adane M, Getachew M, Faris K, Gebretsadik D, Sisay T, Dewau R, Chanie MG, Muche A, Zerga AA, Lingerew M, Gebrehiwot M, Berhanu L, Ademas A, Abebe M, Ketema G, Yirsaw M , Bogale K, Ayele FY, Melaku MS, Amsalu ET, Bitew G, Keleb A, Berihun G, Natnael T, Hassen S, Yenuss M, Dagne M, Feleke A, Kloos H. Water, sanitation, and hygiene conditions and prevalence of intestinal parasitosis among primary school children in Dessie City, Ethiopia.PLoS One. 2021 Feb 3;16(2):e0245463. doi: 10.1371/journal.pone.0245463. PMID: 33534792; PMC ID: PMC7857601.
2. Khadka S, Sapkota S, Adhikari S, Dubey AK, Thapa A, Bashyal R, Bhusal H. Intestinal Parasitoses among Chepang and Musahar Community People of Makwanpur and Nawalparasi Districts of Nepal. Acta Parasitol. 2021 Mar;66(1):146-154. doi: 10.1007/s11686-020-00269-0. Epub 2020 Aug 23. PMID: 32829473.
3. Hassan AA, Oyebamiji DA (2018) Intensity of soil transmitted helminths in relation to soil profile in selected public schools in Ibadan metropolis. Biom Biostat Int J 7(5):413–417Return to ref 2018 in article

4. Jansen F, Dorny P, Gabriël S, Dermauw V, Johansen MV, Trevisan C. The survival and dispersal of Taenia eggs in the environment: what are the implications for transmission? A systematic review. Parasite Vectors. 2021 Jan 29;14(1):88. doi: 10.1186/s13071-021-04589-6. PMID: 33514421; PMC ID: PMC7845101.
5. What Are the 5 Koppen Climate Classification Types?LIFE SCIENCE | NATURAL ENVIRONMENT,Updated on May 12, 2022
6. Tchakounté BN, Nkouayep VR, Poné JW (2018) Soil contamination rate, prevalence, intensity of infection of geohelminths and associated risk factors among residents in Bazou (West Cameroon). Ethiopian J Health Sci 28(1):63–72
7. Salam S, Azam S (2017) Prevalence and distribution of soil transmitted helminth infections in India. BMC Public Health 17:201
8. Hassan AA, Oyebamiji DA (2018) Intensity of soil transmitted helminths in relation to soil profile in selected public schools in Ibadan metropolis. Biom Biostat Int J 7(5):413–417
9. Oyebamiji DA, Ebisike AN, Egede JO, Hassan AA (2018) Knowledge, attitude, and practice in respect to soil contamination by soil-transmitted helminths in Ibadan, Southwestern Nigeria. Paras Epidemiol Cont Parepi 3:e00075
10. Stojcevic D, Susic V, Lucinger S (2010) Contamination of soil and sand with parasite elements as a risk factor for human health in public parks and playgrounds in Pula. Veterinarsky Arch 80(6):733–742
11. Nkouayep VR, Tchakounté BN, Poné JW (2017) Profile of geohelminth eggs, cysts, and oocysts of protozoans contaminating the soils of ten primary schools in Dschang, West Cameroon. J Parasitol Res Article ID 1534675
12. Amadi EC, Uttah EC (2010) Bionomics of geohelminth nematodes in contaminated foci in parts of Abua Communities, Niger Delta, Nigeria. J Appl Sci Environ Manag 14(2):61–64
13. Oyewole, OE, Simon-Oke, IA Ecological risk factors of soil-transmitted helminths infections in Ifedore district, Southwest Nigeria. Bull Natl Res Cent 46, 13 (2022). https://doi.org/10.1186/s42269-022-00700-8
14. Letah Nzouebet WA, Kengne Noumsi IM, Rechenburg A (2016) Prevalence and diversity of intestinal helminth eggs in pit latrine sludge of a tropical urban area. J Water Sanit Hyg Dev 6(4):622–630
15. Muntalif BS, Firdayati M, Lesmono FD, Siregar AS, Notodarmojo PA, Fathuna IS (2020). Helminth eggs assessment of fecal sludge in urban area of Bandung, Indonesia. In: E3S web of conferences, vol 48. EDP Sci, p 4002
16. Oyewole, OE, Simon-Oke, IA Ecological risk factors of soil-transmitted helminths infections in Ifedore district, Southwest Nigeria. Bull Natl Res Cent 46, 13 (2022). https://doi.org/10.1186/s42269-022-00700-8
17. Khieu V, Schär F, Forrer A, Hattendorf J, Marti H, Duong S, Vounatsou P, Muth S, Odermatt P. High prevalence, and spatial distribution of Strongyloides stercoralis in rural Cambodia. PLoS Negl Too Dis. 2014 Jun 12;8(6):e2854. doi: 10.1371/journal.pntd.0002854. PMID: 24921627; PMCID: PMC4055527.
18. Anegagrie M, Lanfri S, Aramendia AA, Scavuzzo CM, Herrador Z, Benito A, Periago MV. Environmental characteristics around the household and their association with hookworm infection in rural communities from Bahir Dar, Amhara Region, Ethiopia. PLoS Negl Too Dis. 2021 Jun 22;15(6):e0009466. doi: 10.1371/journal.pntd.0009466. PMID: 34157019; PMCID: PMC8219153.
19. Dalu T, Barson M, Nhiwatiwa T. Impact of intestinal microorganisms and protozoan parasites on drinking water quality in Harare. Zimbabwe. J Water Sanit Hyg Develop. 2011;3:153–163. doi: 10.2166/washdev.2011.049. [CrossRef] [Google Scholar]

20. Papajova I, Pipikova J, Papaj J, Cizmar A. Parasitic contamination of urban and rural environments in the Slovak Republic: dog's excrement as a source. Helminthologia. 2014;51:273–280. doi: 10.2478/s11687-014-0241-8. [CrossRef] [Google Scholar]
21. Jansen F, Dorny P, Gabriël S, Dermauw V, Johansen MV, Trevisan C. The survival and dispersal of Taenia eggs in the environment: what are the implications for transmission? A systematic review. Parasite Vectors. 2021 Jan 29;14(1):88. doi: 10.1186/s13071-021-04589-6. PMID: 33514421; PMC ID: PMC7845101.
22. Aghaindum AG, Landry FKA. Dissemination of the resistant forms of intestinal worms in the marshy areas of the city of Yaounde (Cameroon): importance of some abiotic factors of the medium. Appl Water Sci. 2019;9:19. doi: 10.1007/s13201-019-0895-y. [CrossRef] [Google
23. Chaoua S, Boussaa S, Khadra A, Boumezzough A. Efficiency of two sewage treatment systems (activated sludge and natural lagoons) for helminth egg removal in Morocco. J Infect Public Health. 2018;11:197–202. doi: 10.1016/j.jiph.2017.07.026. [PubMed] [CrossRef] [Google Scholar]
24. Amoah ID, Singh G, Stenström TA, Reddy P. Detection and quantification of soil-transmitted helminths in environmental samples: A review of current state-of-the-art and future perspectives. Act Too. 2017 May;169:187-201. doi: 10.1016/j.actatropica.2017.02.014. Epub 2017 Feb 15. PMID: 28214519.
25. Maikai BV, Umoh JU, Ajanusi OJ, Ajogi I. Public health implications of soil contaminated with helminth eggs in the metropolis of Kadanu. Nigeria. J Helminthol. 2008;82:113–118. doi: 10.1017/S0022149X07874220. [PubMed] [CrossRef] [Google Scholar]
26. Pray IW, Gamboa R, Elizalde M, Gomez LA, Vilchez P, Muro C, et al. Detection of Taenia eggs in soil after mass anti-helminthic treatment: results from a community-wide soil sampling in Northern Peru. Am Soc Trop Med Hyg. 2018;486:153. [Google Scholar]
27. World Health Organization. Ending the neglect to attain the Sustainable Development Goals—a road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization; 2020.
28. WHO.soil-transmitted-helminth-infections, © 2023 WHO
29. Gripper LB, Welburn SC. The causal relationship between neurocysticercosis infection and the development of epilepsy—a systematic review. Infect Dis Poverty. 2017;6:31. doi: 10.1186/s40249-017-0245-y. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
30. Laranjo-González M, Devleesschauwer B, Gabriël S, Dorny P, Allepuz A. Epidemiology, impact and control of bovine cysticercosis in Europe: a systematic review. Pests Vectors. 2016;9:81. doi: 10.1186/s13071-016-1362-3. [PMC free article] [PubMed] [CrossRef] [Google Scholar]
31. World Health Organization. Ending the neglect to attain the Sustainable Development Goals—a road map for neglected tropical diseases 2021–2030. Geneva: World Health Organization; 2020.
32. Vaz Nery S, Clarke NE, Richardson A, Traub R, McCarthy JS, Gray DJ, Vallely AJ, Williams GM, Andrews RM, Campbell SJ, Clements ACA. Risk factors for infection with soil-transmitted helminths during an integrated community level water, sanitation, and hygiene and deworming intervention in Timor-Leste. Int J Parasitol. 2019 Apr;49(5):389-396. doi: 10.1016/j.ijpara.2018.12.006. Epub 2019 Feb 22. PMID: 30802450.
33. Tefera E, Belay T, Mekonnen SK, Zeynudin A, Belachew T. Prevalence and intensity of soil transmitted helminths among school children of Mendera Elementary School, Jimma, Southwest Ethiopia. Pan Afr Med J. 2017 Jun 6;27:88. doi: 10.11604/pamj.2017.27.88.8817. PMID: 28819509; PMC ID: PMC5554658.

34. Jiménez B, Maya C, Barrios JA, et al. (2017) Helminths and their Role in Environmental Engineering. Human Helminthiasis. InTech. DOI: 10.5772/64878.
35. Caldrer S, Ursini T, Santucci B, Motta L, Angheben A. Soil-Transmitted Helminths and Anaemia: A Neglected Association Outside the Tropics. Microorganisms. 2022; 10(5):1027. https://doi.org/10.3390/microorganisms10051027
36. Ravindran VB, Soni SK, Ball AS. A Review on the Current Knowledge and Prospects for the Development of Improved Detection Methods for Soil-Transmitted Helminth Ova for the Safe Reuse of Wastewater and Mitigation of Public Health Risks. Water. 2019; 11(6):1212. https://doi.org/10.3390/w11061212
37. Maya C, Pérez M, Velásquez G, Barrios JA, Román A, Jiménez B. Quick incubation process to determine inactivation of Ascaris and Toxocara eggs. Water Sci Technol. 2019 Dec;80(12):2328-2337. doi: 10.2166/wst.2020.062. PMID: 32245924.
38. Bisanzio D, Montresor A, French M, Reithinger R, Rodari P, Bisoffi Z, Buonfrate D. Preventive chemotherapy for the control of strongyloidiasis in school-age children: Estimating the ivermectin need. PLoS Negl Too Dis. 2021 Apr 15;15(4):e0009314. doi: 10.1371/journal.pntd.0009314. PMID: 33857134; PMCID: PMC8078808.
39. Chai JY, Jung BK, Hong SJ. Albendazole and Mebendazole as Anti-Parasitic and Anti-Cancer Agents: an Update. Korean J Parasitol. 2021 Jun;59(3):189-225. doi: 10.3347/kjp.2021.59.3.189. Epub 2021 Jun 21. PMID: 34218593; PMCID: PMC8255490.
40. Campbell S, Soman-Faulkner K. Antiparasitic drugs. [Updated May 29, 2023]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available at: https://www.ncbi.nlm.nih.gov/books/NBK544251/