Journal Homepage: - www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/22471
DOI URL: http://dx.doi.org/10.21474/IJAR01/22471

*RESEARCH ARTICLE*

# PREVALENCE OF GEOHELMINTHIASIS IN CHILDREN AGED 5 TO 15 YEARS IN THE DEPARTMENT OF MAYO-LEMIE, MAYO-KEBBI EAST PROVINCE, CHAD

**Vourchakbe Joel[1], Karbo Keudaye Tao[2], Mahamat Bechir[3] and Ousmane Issa Abdel Djalil[1]**

1. Department of Science Biology, Faculty of Exact and Applied Sciences, University of Moundou, PO Box 206, Moundou, Chad.
2. Department of Science Biology, Faculty of Exact and Applied Sciences, University of N'Djamena, Chad.
3. Faculty of Human Health Sciences, University of N'Djamena, Chad.

## *Manuscript Info*

***Manuscript History***
Received: 14 October 2025
Final Accepted: 16 November 2025
Published: December 2025

***Key words***
Prevalence, Geohelminthiasis, Department, Mayo-Lemie, Chad.

## *Abstract*

Geohelminths are roundworms transmitted by soil contaminated with feces.They constitute a serious public health problem in Chad.This stud y aimed to determine the prevalence and risk factors for geohelminthias is among children aged 5 to 15 years in the Mayo-Lemie Department of Chad. Stool samples were collected from these children and the Kato-Katz concentration technique was used to identify the parasite. An overall prevalence of 23.29% was obtained, with 79% for Ascaris lumbricoides, 18% for Trichuris trichiura, and 6% for hookworms. Males were more infected (78.43%) than females (21.57%). The [12-15] age group was the most infected (47.06%), followed by the [5-8] age group (29.41%) and the [9-11] age group (23.53%). Guelendeng Hospital had the highest infection rate (31.37%), followed by Bere Health Center (27.45%), Nanguigoto Health Center (23.53%), and Sanang Health Center (17.65%). The risk factors are: ignorance of previous cases (OR=0.765 at 95% CI [0.711 - 0.824] and lack of awareness of geohelminths (OR=4.745 at 95% CI [1.784 - 12.618]. This study showed a high prevalence of geohelminthiasis among children aged 5 to 15 years in the Mayo-Lemie Department of Chad. Hygiene practices should be reinforced in order to reduce the risk associated with these parasites.



## Introduction

Geohelminths refer to a group of roundworms transmitted through soil contaminated with fecal matter. The three main groups of geohelminths are roundworms (Ascaris lumbricoides), whipworms (Trichuris trichiura), and hookworms (Necator americanus and Ancylostoma duodenalae) (Sastry and Bhat, 2018). Soil-transmitted helminth infections (STH) particularly affect the poorest and most disadvantaged communities, who have limited access to safe drinking water, sanitation, and hygiene. Preschool-aged children, school-aged children, and women of childbearing age are the groups at highest risk (WHO, 2021). The highest burden is found in school-aged children (5 to 14 years old) (WHO, 2024). Approximately 24% of the global population, or 1.5 billion people, are infected with

**Corresponding Author:** Vourchakbe Joel
**Address:** Department of Science Biology, Faculty of Exact and Applied Sciences, University of Moundou, PO Box 206, Moundou, Chad.

STIs, with a high prevalence among children and women of childbearing age, who are at the highest risk of STI-related morbidity (Montresor et al., 2020; Sartorius et al., 2021). The most affected populations are found in China, sub-Saharan Africa, East Asia, and the Americas (Pullan et al., 2014; WHO, 2022). In sub-Saharan Africa, soil-transmitted helminths (STH) affect more than 11% of the population (Sartorius et al., 2021). However, the burden of STH varies considerably between countries on the African continent, but also within the same country (Sartorius et al., 2021; WHO, 2022). In 2016, it was estimated that 40% of the population in Africa was exposed to geohelminthiasis, which remains a major public health problem in endemic countries such as Chad (Kemba et al., 2022).

Thus, Chad, being a subtropical country with bioclimatic biodiversity, favors the development of numerous human parasites, including geohelminths (WHO, 2017). Geohelminthiasis is a waterborne disease that poses a serious health problem in hot regions (Dankoni and Tchuente, 2014). In this context, the risk of contamination is a real problem in the Mayo-Lemie Department, Mayo-Kebbi East Region, Chad. In this department, a large part of the population does not have access to drinking water and depends on rivers and wells. Despite all this information, the diagnosis of these parasitic worms is not carried out regularly and systematically, especially since, to our knowledge, this is the first study conducted in the Mayo-Lemie Department. We believe it is useful to assess the health status of the population with regard to geohelminthiasis in children aged between 5 and 15 in the Mayo-Lemie Department. The aim of this study is to describe the epidemiological aspects and risk factors of geohelminthiasis in the Mayo-Lemie Department of the Mayo-Kebbi-Est Province in Chad.

## Materials and Methods:-

### Study sites

This is a descriptive cross-sectional study with an analytical focus, conducted over a two-month period from July 14, 2025, to August 14, 2025, to investigate the epidemiology and factors contributing to the occurrence of geohelminthiasis in children aged 5 to 15 years. This study was conducted in Chad, a Central African country with an area of 1,284,000 km², specifically in the department of Mayo-Lemie, Mayo-Kebbi-Est Province, in the Guelendeng Health District. Samples were collected from four public health facilities: the Dictict Hospital in Guelendeng and the health centers in Bere, Nanguigoto, and Sanang.

**The Guelendeng Health District is located 153 km from N'Djamena and 82 km from Bongor, the provincial capital, and is bordered:**

- To the north by the Mandalia Health District;
- To the west by the Katoa Health District;
- To the south by the Moulkou Health District.
- To the east by the Bailli Health District.

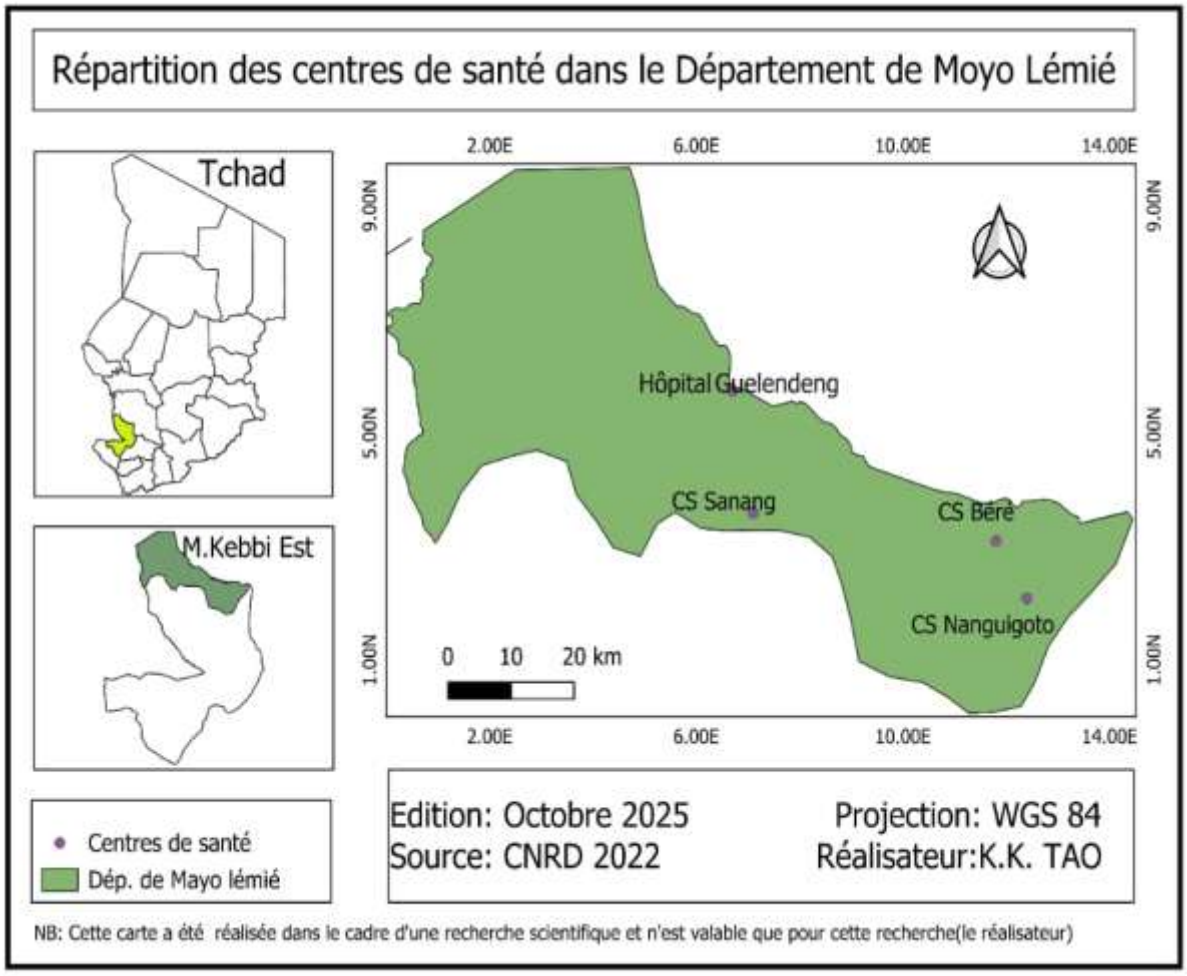


**Figure 1: Map of the study area**

## Methodology:-

**Selection criteria**

- **Inclusion criteria**
  Only consenting patients seen in consultation with specific clinical signs are included in this study;
  All children aged between 5 and 15 inclusive;
  All children who have lived in the study area for at least 3 months;
  Any patient who had not had a bowel movement on the day of the examination;
- **Exclusion criteria**
  Patients who refused to participate in the study;
  Any child aged 5 to 15 years who had received anthelmintic treatment.
  .

**Study population:**

Our study was conducted on a sample of 220 children aged 5 to 15 years with clinical suspicion of intestinal parasitosis (generally digestive symptoms) or undergoing a health check-up. The subjects concerned were outpatients consulting in the clinical departments of Guelendeng Hospital and the health centers of Bere, Nanguigoto, and Sanang. As the children were unable to respond to us, the survey was conducted among the mothers/guardians who had brought their children for treatment. These children constitute an easily mobilized population that is particularly exposed to this condition.

**Study framework :**

The competent authorities of the Mayo-Lemie Department (mayor of the town, village chiefs) were contacted one month in advance and a request was made to the administrative authorities of the University of N'Djamena and the Guelendeng district hospital in the province of Mayo-Kebbi-Est, with a view to obtaining authorization for the

survey and analysis. Children aged 5 to 15 were chosen for the following reasons: this age group is the most affected; individuals in this age group are less reluctant to undergo mass screening; and it was possible to compare our results with those of previous studies, most of which were conducted on school populations. The parasitological examination was carried out at the Distique de Guelendeng Hospital in the Mayo-Lemie Department.

**Collection of stool samples:**

After receiving the children who met the inclusion criteria, the consent form was explained to each parent before sampling. Children aged 10 years and older were asked to answer the questionnaire directly, while children under 10 years of age were assisted by their parents in answering the questions. The questionnaire submitted to participants consisted of two parts. The first part focused on sociodemographic data (age, gender, education level, neighborhood, and religion), and the second part focused on risk factors (knowledge, hand and food hygiene, and type of water consumed). After completing the questionnaires, participants were given a sterile, transparent plastic collection jar with a wide opening and a capacity of 60 ml to collect their entire stool sample, along with instructions on how to collect the samples (first stool of the morning, collect a large amount to avoid contact with the ground). The samples collected at the health centers (Bere, Nanguigoto, and Sanang centers) were labeled, formalized at 10%, and sealed to preserve the parasitic forms. After collection, the samples were sent to the laboratory of the Guelendeng District Hospital in the province of Mayo-Kebbi-Est for parasitological analysis.

**Copro-parasitological techniques**

- **Routine techniques for parasite detection**

Each stool sample underwent macroscopic examination and direct microscopic examination after concentration.
Macroscopic examination of fresh samples allowed us to determine: stool appearance, consistency (formed, pasty, liquid), color (yellowish, brownish, greenish, whitish), and odor.
We also noted:

- ✓ The presence of non-parasitic elements: blood, slime, mucus, pus, food residue.
- ✓ The possible presence of certain parasites:

Nematodes: adult pinworms and roundworms
Cestodes: Taenia segments; Trematodes: adult flukes

- **Direct examinations after concentration**

This technique allows the identification and quantification of intestinal helminth eggs present in stool samples. It concentrates helminth eggs in a considerable amount of sieved fecal matter. Kato's solution clarifies these eggs thanks to the glycerin it contains and colors non-parasitic elements green through the action of malachite green (Sartorius and 2021). Using a flat-edged spatula, a small amount of stool is collected and placed on a clean plate. A fine-mesh sieve (0.2 mm) is used to retain large particles in the stool. A template that can hold 41.7 mg of stool is placed on a microscope slide and filled with the sieved fecal matter. The template is then carefully removed; the fecal matter is covered with a small strip of cellophane soaked for at least 24 hours in Kato's solution (a mixture of 100 ml of mineral water, 100 ml of glycerin, and 1 ml of 3% malachite green). The slide is turned over and the preparation is pressed against the cellophane on a smooth surface to spread it evenly. Excess glycerin is wiped off with a piece of toilet paper.
The prepared slide is examined under an optical microscope at 10x magnification. The eggs observed are counted and the results are recorded on a collection form.

- **Criteria for judgment**

Only the detection of geohelminths in their various forms (eggs, larvae, adults) through parasitological examination of stool samples is considered a positive result.

## Data Analysis:

Statistical analysis of the collected data was performed using Word 2019, Excel 2019, and SPSS 22 software. The data were expressed as numbers of individuals and percentages. A multivariate logistic regression analysis was performed to identify the main risk factors. The Chi-square independence test was used to test the association between the various risk factors for geohelminths. A p-value $< 0.05$ with an odds ratio $> 1$ was considered statistically significant at 95% confidence intervals.

## Results:-

**Overall prevalence**

The results obtained show that of the 219 samples taken, 51 tested positives for various geohelminths, representing an overall infestation rate of 23.29%, while 168 tested negative, representing a rate of 76.71%. In our study, the types of geohelminths found in the department were Ascaris lumbricoides, T. trichiura, and hookworms (Ancylostoma duodenaale and Necator americanus). These parasites were distributed as follows:

- Ascaris lumbricoides was the most common parasite in the study, with a prevalence of 76% (39 cases detected).
- Trichirus trichiura came next with 9 cases detected, or 18%.
- Hookworms (Ancylostoma duodonale and Necator americanus) were the least common species, with 3 cases, or 6%

**Distribution of geohelminthiasis according to healthcare facilities**

It should be noted that patients living in the town of Guelendeng accounted for the highest number of consultations (64 patients), representing 29.22% of the total number of patients. The frequency of parasitized patients within this healthcare facility was also the highest, reaching 31.37%. At the Bere health center, the total number of patients examined was 55 children, representing 25.11% of the population and a frequency of 27.45%. At the Nanguigoto and Sanang health centers, 22.83% of the total population was seen for a parasitological examination. The frequency in this case is 23.53% and 17.65%, respectively.

**Table 1: Distribution of geohelminthiasis according to health facilities**

| Healthcare facility | NE | Result (%) | | $\chi^2$ | P – value |
|---|---|---|---|---|---|
| | | Positive | Negative | | |
| Guelendeng Hospital | 64 | 16 (25) | 48 (75) | 1,046 | 0,790 |
| Bere Health Center | 55 | 14 (25,45) | 41 (74,55) | | |
| Nanguigoto Health Center | 50 | 12 (24) | 38 (76) | | |
| Sanang Health Center | 50 | 9 (18) | 41 (82) | | |
| **Total** | **219** | **51 (23,28)** | **168 (76,71)** | | |

**Analysis of the relationship between the factors implicated and the persistence of geohelminths**

- **Gender**

  The results shown in this table indicate that 31.75% of male respondents and 11.83% of female respondents who tested positive stated that geohelminthiasis is persistent.

  The calculated OR is 0.373 and its 95% CI is (0.202 <OR<0.686). The difference observed is statistically significant. We can therefore confirm the hypothesis that gender influences the persistence of geohelminthiasis.

**Table 2: Distribution of respondents according to geohelminth risk factors by gender**

| Sex | NE | Result (%) | | OR | IC à 95% |
|---|---|---|---|---|---|
| | | Positive | Negative | | |
| Feminine | 93 | 11 (11,83) | 82 (88,17) | 0,373 | [0,202; 0,686] |
| Masculine | 126 | 40 (31,75) | 86 (68,25) | | |
| **Total** | **219** | **51 (23,29)** | **168 (76,71)** | | |

**NE : Number examined**

- **Age**

Our study shows that among those who tested positive, those aged between 12 and 15 (31.58%) were most exposed; whereas children aged 5 to 8 (16.48%) and 9 to 11 (23.08%) were less exposed to geohelminthiasis.

The calculated chi-square and its p-value ($\chi 2 = 5.284$; P= 0.071). The differences observed are not statistically significant; they are due to chance. We can therefore reject the hypothesis that age is a risk factor for geohelminthiasis.

**Table 3: Distribution of respondents by age group based on responses regarding risk factors for geohelminths in their households**

| Age group | NE | Resultat (%) | | $\chi^2$ | P-value |
|---|---|---|---|---|---|
| | | Positif | Negatif | | |
| [5 to 8 years old] | 91 | 15 (16,48) | 76 (83,52) | **5,284** | **0,071** |
| [9 to 11 years old] | 52 | 12 (23,08) | 40 (76,92) | | |
| [12 to 15 years old] | 76 | 24 (31,58) | 52 (72,22) | | |
| **Total** | **219** | **51 (23,28)** | **168 (76,71)** | | |

**NE : Number examined**

**Use of healthcare facilities**

The results in this table show that of the 23.29% of respondents who tested positive, 31.11% did not use healthcare facilities for treatment against geohelminthiasis in 21.26% of cases. The calculated OR is 1.463 and its 95% CI is (0.870<OR<2.462). The differences observed are not statistically significant. We can therefore reject the hypothesis that not using healthcare facilities is a risk factor for geohelminthiasis.

**Table 4: Distribution of respondents according to risk factors for geohelminthiasis based on use of healthcare facilities in the event of signs of geohelminthiasis**

| Non-use of healthcare facilities | NE | Result (%) | | OR | IC à 95% |
|---|---|---|---|---|---|
| | | Positive | Negative | | |
| No | 45 | 14 (31,11%) | 31 (69,69%) | 1,463 | [0,870; 2,462] |
| Yes | 174 | 37 (21,26%) | 137 (78,74%) | | |
| **Total** | **219** | **51 (23,28)** | **168 (76,71)** | | |

**Awareness of geohelminthiasis**

The results in the table below show that 30.13% of respondents who tested positive are not aware of the fight against geohelminthiasis, compared to 6.5% of those who are aware. The calculated OR is 0.16 and its 95% CI is (0.04<OR<0.58). The differences observed are not statistically significant. We can therefore reject the hypothesis that not using healthcare facilities influences the persistence of geohelminthiasis.

**Table 5: Breakdown of respondents according to persistence of geohelminthiasis based on awareness of measures to combat these diseases**

| Lack of awareness about the fight against GH | NE | Result (%) | | OR | IC à 95% |
|---|---|---|---|---|---|
| | | Positive | Negative | | |
| No | 156 | 47 (30,1) | 109 (69,87%) | 4,745 | [1,784; 12,618] |
| Yes | 63 | 4 (6,3) | 59 (93,65%) | | |
| **Total** | **219** | **51 (23,28)** | **6,71) 168** | | |

## Discussion

This study involved children aged 5 to 15 years in four health facilities in the Mayo-Lemie Department of the Mayo-Kebbi-Est Region in Chad. Two hundred and nineteen (219) children selected for the study came from several localities. The results of this cross-sectional study showed a high prevalence of geohelminth infection, at 23.29%.

Although several studies of this type have been conducted in Chad, this is the first to analyze geohelminth infection in the Mayo-Lemie Department. The prevalence found in this study corroborates the results of a previous study conducted by Noumedem et al. (2023) in Moundou, which found a prevalence of 16.52% of geohelminth infection among children aged 5 to 15 years. The result is similar to those from the town of Butajira in south-central Ethiopia (23.3%) (Shumbej et al., 2015), Gamo Gofa in southern Ethiopia (23.5%) (Asfaw et al., 2020), and Cameroon (24.1%) (Tchuem Tchuente et al., 2012). A study conducted among schoolchildren in Dembecha, Ethiopia, by Al-Tamceani et al. (2020) found that the prevalence of soil-transmitted helminth infection was 21.5%. However, the result differs from that of a study conducted by Hamit et al. (2008) in N'Djamena, which found a prevalence of 51% of geohelminth infections in subjects aged 0 to 70 years. Flaure et al. (2020) conducted a study in Douala among children aged 5 to 15 years; a prevalence of 41% was found. This difference is due to higher rainfall in the city of Douala than in the Mayo-Lemie Department and Douala's geographical location near the coast. This variation could be due to differences in topography and study period, during which communities improved their standard of living and personal and environmental hygiene over time.

Similar results were also found in a study conducted in Niamey, Niger, among school-aged children, with results of 49.5% for males and 50.5% for females (Soumana, 2016). The results of our study show that the highest contamination rate was observed in the 12-15 age group, at 47.06%. Those aged between 5 and 8 accounted for 29.41%, while those aged between 9 and 11 accounted for only 23.53%. These results are consistent with data found among children in Kekem (western Cameroon), where the most affected age group was 11 to 14 years old, accounting for 75% (Nabarrro et al., 2021). Several studies have found that children aged 5 to 15 were more exposed (Ndaguimana et al., 2014; Ruth et al., 2021). However, another study reported that children under 6 years of age were more likely to be carriers of soil-transmitted helminth infections than children over 6 years of age (Weldesenbet et al., 2019). This difference could be due to the delayed schooling of children in this department, as is the case in semi-rural towns, as confirmed by certain studies carried out in developing countries (El-Kettani and Azzouzi, 2006).

With regard to place of residence, the risk of developing a geohelminth infection was higher among study participants residing in the town of Guelendeng (31.37%) than among those residing in other villages. Similar results have been reported at Sekela Primary School in western Ethiopia (Tolera et al., 2020) and in Brazil (Carneiro et al., 2002), and they agree that rural populations were more affected than those living in urban areas. This high prevalence among health facilities could be explained by the fact that, although the area is part of the city, it is located on the banks of the Chari River and is therefore frequently flooded. The inhabitants suffer from a lack of sanitation, are poor, and have poor personal hygiene.

The geohelminth species encountered in this study were Ascaris lumbricoides (76%), Trichuris trichiura (18%), and hookworms (Ancylostoma duodenale and Necator americanus) (6%). Awano-Ambene et al. (2020) found a high frequency of Ascaris lumbricoides in their study. A. lumbricoides had the highest parasite load, with a significant proportion of moderate infections, particularly in all four health facilities. This could be explained by the high level of environmental contamination resulting from the large number of infected individuals, the durability of A. lumbricoides eggs in varying environmental conditions, and their high fertility (O'lorcain et al., 2000) and the sticky nature of A. lumbricoides egg shells (Quilès, 2006), which promote their attachment to human hands, fruit, and vegetables. These results confirm previous studies showing that A. lumbricoides tends to induce higher parasite loads than others (Bethony et al., 2006; WHO, 2020). These results are similar to those of Almaw (2020), who in 2019 in Indonesia found a prevalence of hookworms of 3.4% in children aged 5 to 15. The high prevalence of Ascaris lumbricoides and Trichuris trichiura could be explained by the fact that these two species of helminths have a common mode of transmission and are much more resistant to climatic factors, unlike hookworms, which are transmitted transcutaneously and are much more closely linked to water.

Factors contributing to the occurrence of geohelminthiasis in the Mayo-Lemie department among children aged 5 to 15 years. Our results show that in households with more than six (6) people, there is a significant influence on the occurrence of GH in children aged 5-15, with an OR of 0.497 and a 95% CI = (0.271; 0.912).

The results of our study converge with those of Nabarro et al. (2014), who found that household size significantly influences the occurrence of GH in Orang Asli (OR = 2.65 and 95% CI = [1.24-5.70]) and differ from those found in Malaysia, where household size does not influence the OR of 1.88 and its 95% CI (0.78-4.51) (Menzies et al., 2014).

The educational level of the population in our study shows that the risk of geohelminth infections was significantly higher among children whose parents had a primary school education ($\chi 2 = 16.35$) and $p = < 0.0001$. The risk of

developing geohelminth infections was 4.7 (95% CI: 1.410, 15.59) times higher among respondents whose mothers were illiterate than among their counterparts. This result is consistent with the findings of Tolera and Dufon (2018) in Kenya (McClure et al., 2014) and Mexico (Quihui et al., 2006). This could be due to educated mothers who know that their children practice personal hygiene, do not allow them to play with dirt, and wash their hands before meals and after defecation.

The results of our investigation into types of geohelminthiasis showed that no previous cases of geohelminthiasis were detected in children aged 5 to 15 years in households (00%) compared to (23.50%) confirmed cases. The lack of previous infections is significant. This result contradicts that of Vernier, whose study in Ngozi shows that for children aged 9 to 14, the overall prevalence of geohelminthiasis obtained using the Kato-Katz technique was 52.4%. More specifically, the most common helminth was T. trichiura (36.5%). Hookworms and A. lumbricoides were less common, with a prevalence of 17.2% and 12.4%, respectively (Vernier, 2014).

Use of healthcare facilities In our study, we found that 31.11% of our respondents do not use healthcare facilities in the event of a parasitic infection. These results contradict those of Sidibe (2010), who found that 85.5% of respondents said they would go to a healthcare center in the event of an infestation. In the same series, in 2015, Kamariza (2010) found in a survey in Burundi that 79.01% of respondents used healthcare facilities. This situation could be explained by parental poverty, ignorance among the population, and distance from healthcare facilities.

With regard to awareness of geohelminthiasis, the majority of our participants whose children are infected with geohelminths (30.13%) stated that they had not been made aware of geohelminthiasis. These results are similar to those of Kouame (2025), where 55.55% of respondents stated that they had not been made aware of geohelminthiasis. The results show that the main channels for raising awareness are essentially rare.

## Conclusion:-

The overall prevalence of geohelminthiasis infection was 23.29% among children in the Mayo-Lemie Department. This study assessed the association between potential risk factors and the prevalence of infection. Educational level, the population's failure to treat drinking water, the absence of latrines in households, not washing hands with clean water and soap, ignorance among the population, lack of awareness, and age group were found to be statistically significant risk factors for geohelminthiasis infection among children in this study. Surveillance of geohelminthiasis and hygiene measures should be strengthened in order to reduce the pathological risk associated with these parasites in Chad. However, it will be important to extend the study to other departments of the country.

**Authors' declaration**

The authors declare that there are no conflicts of interest regarding the data.

**Ethical considerations**

This study was conducted in an academic setting after obtaining authorization from academic and administrative authorities. Before conducting the survey, a request for authorization was submitted to the administrative authorities of the University of N'Djamena and the Guelendeng District Hospital in the province of Mayo-Kebbi-Est. Each participant was informed of the rationale for the survey and told that their participation in the study was voluntary and that they could withdraw at any time. The information collected was used solely for the purposes of the study and was kept confidential.

## References :-

1. Montresor A., Mupfasoni D., Mikhailov A., Mwinzi P., Lucianez A., Jams heed M., et al., (2020). The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030, PLos Negl Trop Dis; 14(8): 0008505. https://doi.org/10.1371/journal.pntd.0008505 PMID: 32776942.
2. WHO, (2021). Schistosomiasis and soiltransmitted helminthiases: progress report, 2020. Wkly Epidemiol Rec; 96.
3. WHO, (2024). Soil-transmitted helminthiases: eliminating as public health problem soil-transmitted helminthiases in children: progress report 2001–2010 and strategic plan 2011-2020; Available from: https:// iris.who.int/handle/10665/44804. Cited 2024 Jun 19.
4. Montresor A., Mupfasoni D., Mikhailov A., Mwinzi P., Lucianez A., Jams heed M., et al. (2020). The global progress of soil-transmitted helminthiases control in 2020 and World Health Organization targets for 2030, PLos Negl Trop Dis; 14(8): 0008505. https://doi.org/10.1371/journal.pntd.0008505 PMID: 32776942.

5. Sartorius B., Cano J., Simpson H., Tusting L., Marczak L ., Miller-Petrie M.et al. (2021). Prevalence and inten sity of soil-transmitted helminth infections of children in sub-Saharan Africa. Geospatial anal ysis. The Lancet Global Health; 9(1): 52–60. https://doi.org/10.1016/S2214-109X (20)30398-3 PMID: 33338459.
6. Pullan, R. L., Smith, J. L., Jasrasaria, R. & Brooker, S. J. (2014. Global numbers of infection and disease burden of soil transmitted helminth infections in 2010). Parasite Vectors 7: 37. Doi: 10.1186/1756-3305-7-37.
7. WHO, 2022. Soil-transmitted helminth infections. Accessed: May 2022. Online. Available from: https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth infections.
8. Kemba S. A.B, Nack J.C, Oyono M.G. A.D, Hamit M.A et Bilong Bilong C.F. (2022). Intestinal Helminthiases among School Children in the Sahelian and Sudanian Zones of Chad: Prevalence and Risk Factors.26 p
9. OMS, (2017). Geneva Geohelminthiasis and Schistosomiasis. WHO, Jan-2017.
10. Dankoni E.N et Tchuente L.T., 2014. Epidemiology of schistosomiasis and geohelminthiasis in the Kekem District (West Cameroon). Int. J. Innov. Appl. Goujon; 8(4):1782. 10.1016/j.parepi. 2023. e00319
11. Sartorius B., Cano J., Simpson H., Tusting L., Marczak L., Miller-Petrie M.et al. (2021). Prevalence and inten sity of soil-transmitted helminth infections of children in sub-Saharan Africa. Geospatial anal ysis. The Lancet Global Health; 9(1): 52–60. https://doi.org/10.1016/S2214-109X (20)30398-3 PMID: 33338459.
12. Noumedem A.C., Adia., Yamssi C., Adam M.I., Simeni N.S., Gamago N.G. (2023). Prevalence and risk factors for geohelminths among children aged 5 to 15 years in primary schools in the city of Moundou, southwestern Chad.
13. Shumbej T., Belay T., Mekonnen Z., Tefera T., Zemene E. (2015). Soil-transmitted helminths and associated factors among preschool children in Butajira town, south-central Ethiopia: a community-based cross-sectional study. PLoS One. 10:0136342. Doi: 10.1371/journal.pone.0136342.
14. Tchuem Tchuente L.A., Kamwa Ngassam R.I. et Sumo L. (2012). Mapping of schistosomiasis and geohelminthiasis in central, eastern, and western Cameroon. PLoS Negl Trop Dis ; 6 :1553. Doi: 10.1371/journal.pntd.0001553.
15. Al-Tameemi K et Kabakli R. (2020). Ascaris lumbricoides: epidemiology, diagnosis, treatment, and control. Asian journal of pharmaceutical and clinical research, 8–11. http://dx.doi.org/10.22159/ajpcr.2020.v13i4.36930.
16. Hamit M., Tidjani M., Bilong B.F.C. (2008). Recent data on the prevalence of intestinal parasites in N'Djamena, Republic of Chad. Afr. J. Environ. Sci. Technol. 2(12): 407–411. ISSN 1991-637X © 2008 Academic Journals.
17. Flaure Edith., Heunga Tchapda., Asaah Smith., Kamga Henri. et Lucien Fouamno. (2020). Geohelminth among Public School Children in Douala Metropolis: Prevalence, Perception and Associated Risk Factors. Am. J. Tchapda, Bonaventure Tientche. Epidemiol. Infect. Dis. 8(2) doi: 10.12691/8-2-2.
18. Soumana A., Saidou D., Dima H., Daouda B. et Guero T. (2016). Intestinal parasitic infections in children under 5 years of age in Niamey, Niger. Original article. Mali Medical 2016. Volume xxx1 No. 4, 20 p.
19. Nabarro L., Morris-Jones S. et Moore D.A. (2020). Infections Acquired Through the Gastrointestinal Tract. In Peter's Atlas of Tropical Medicine and Parasitology (Seventh Edition); Nabarro, L., Morris-Jones, S., Moore, D. A. J., Eds.; Elsevier: London; pp 165–243.
20. Ndaguimana D. (2014). Contribution to the study of Batwa knowledge, attitudes, and practices in the fight against malaria. Bujumbura, INSP. Public health thesis, 66P.
21. Ruth M.M.R., Cedric Y., Malla M.E., Nadia N.A.C., Aime T.N., Leonelle M., Payne V.K. (2021). Intestinal helminth infections and associated risk factors among school-aged children of Bamendjou Community, West Region of Cameroon. J. Parasitol. Res. 2021; doi: 10.1155/2021/6665586.
22. Weldesenbet H., Worku A. et Shumbej T. (2019). Prevalence, intensity of infection, and factors associated with geohelminthiasis among primary school children in the Gurage zone, south-central Ethiopia: a cross-sectional study. BMC Res Notes. 12: 231.
23. El-Kettani and Azzouzi EL.M. (2006). Prevalence of helminthes in a rural population using waste water for agricultural purposes at Settat Morocco. Sante, 16 (4): 245-251. Doi: 10.1684/san.2007.0046.
24. Tolera A., Dufera M. (2020). Prevalence of geohelminthiasis and associated risk factors among primary school students in Sekela, western Ethiopia. J Parasitol Res. 2020: 1-7. Doi: 10.1684/san.2007.0046.
25. Carneiro F.F., Cifuentes E., Tellez-Rojo M.M. et Romieu I. (2002). The risk of Ascaris lumbricoides infection in children as an environmental health indicator to guide preventive activities in Caparaó and Alto Caparaó, Brazil. Bull World Health Organ. 80:40-46. Doi: 10.1590/S0042-96862002000100008.
26. Awono-Ambene H.P., Njieyap L.D., Ntonga P.A., Etang J.D., Antonio-Nkondjio C. and Ndo Njiokou F. (2020). Soil-transmitted protozoans and helminths from market gardening sites of Yaounde, Cameroon. J. Environ. Sci. Public Health. 4(2):61–70. Doi: 10.26502/jesph.96120085
27. O'Lorcain P et Holland CV. (2000). The importance of Ascaris lumbricoides for public health. Parasitology.121 : S51-S71.

28. Bethony J., Brooker S., Albonico M., Geiger SM., Loukas A., Diemert D. et al. (2006). Soil-transmitted helminth infections: ascariasis, trichuriasis, and hook worm. The Lancet. 367:1521–1532. Doi: 10.1017/s0031182000006442.
29. Almaw G. (2020). Comparative Cross-Sectional Study, North West Ethiopia; Woreda: Prevalence and Associated Factors of Soil Transmitted Helmenthiasis among School Age Children in Wetland and Non-Wetland Areas of Fogera.
30. Nabarro L., Morris-Jones S. et Moore D.A. (2020). Infections Acquired Through the Gastrointestinal Tract. In Peter's Atlas of Tropical Medicine and Parasitology (Seventh Edition); Nabarro, L., Morris-Jones, S., Moore, D. A. J., Eds.; Elsevier: London; pp 165–243. Doi: 10.1016/B978-0-7020-4061-0.00003-0
31. Menzies SK., Rodriguez A., Chico M., Sandoval C., Broncano N., Guadalupe I. et al. (2014). Risk Factors for Soil-Transmitted Helminth Infections during the First 3 Years of Life in the Tropics; Findings from a Birth Cohort. PLoS Negl Trop Dis.8(2). https://doi.org/10.1371/journal.pntd.0002718 PMid : 24587469 PMCid : PMC393727439.
32. Tolera A., Dufera M. (2020). Prevalence of geohelminthiasis and associated risk factors among primary school students in Sekela, western Ethiopia. J Parasitol Res. 2020: https://doi.org/10.5897/JPVB2014.0159
33. McClure E.M., Meshnick S.R., Mungai P., Malhotra I., King C.L., Goldenberg R.L., Hudgens M.G., Siega-Riz A.M. et Dent A.E. (2014). Association between parasitic infections during pregnancy and maternal and fetal anemia: a cohort study on the Kenyan coast. PLoS Negl Trop Dis. 8: 2724. Doi: 10.1371/journal.pntd.0002724.
34. Quihui L., Valencia M.E., Crompton D.W., Hagan P., Morales G. et Diaz-Camacho S.P. (2006). Role of employment status and education of mothers in the prevalence of intestinal parasitic infections among rural Mexican schoolchildren. BMC Public Health. 6: 225-228. Doi: 10.1186/1471-2458-6-225.
35. Vernier I. (2014). Epidemiology and control of water-related diseases in the context of a water and sanitation project in Ngozi, Basel. University of Basel, Master's thesis in Epidemiology. 71p: 20-26.
36. Sidibe Y. (2010). Study of basic malaria indicators (MIS), Knowledge, Attitudes, and Practices regarding Schistosomiasis and Geohelminthiasis in the Senegal River Basin (Kayes-Mali Circle), Bamako. University of Bamako, doctoral thesis in Medicine. 103p: 68.
37. Kamariza M. (2015). Study of factors contributing to the persistence of geohelminthiasis in rural areas: The case of Kirundo Province. Cross-sectional analytical study. Burundi National Institute of Public Health, Master's thesis, 88p.
38. Kouame N.A., Bar M., Kouadio J.N., Toure S., Keiser J. et Coulibaly J.T. (2025). Prevalence and risk factors of soiltransmitted helminths in humans and domestic animals in southern Cote d'Ivoire. BMC Infectious Diseases 25 (1), 983, https://doi.org/10.1186/s12879-025-11099-8.