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OPHTHALMOLOGY | RESEARCH ARTICLE

Relationship between tropical endemic limbo-conjunctivitis and intestinal helminths in a population of Cameroonian children

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Abstract: *Background:* Tropical endemic limbo-conjunctivitis (TELC) is an allergic limbo-conjunctivitis, very common in children of tropical areas, and often characterized by ocular morbidity. Several studies were devoted to the study of the epidemiological and clinical aspects of TELC in Africa but in Cameroon, no study has ever been conducted on its association with intestinal helminths. The objective of our work was to investigate the association between TELC and intestinal helminths in pupils of Njombe-Cameroon. *Methods:* We conducted a cross-sectional study from January to September 2014. Random consecutive sampling was carried out. Selected pupils underwent a comprehensive eye examination, and their stool sample was examined using the KATO-KATZ technic to search for helminths eggs. Statistical tests were used for data analysis (p -value <0.05). *Results:* Two hundred and fifty-three students were enrolled. Thirty-six (14.2%) were affected by TELC. The average age of children with TELC was 9 ± 2 years (range: 4–13 years) with a male predominance ($p = 0.001$). Conjunctival hyperemia (88.9%) was the major clinical sign with a predominance of limbic clinical form (58.4%). The prevalence of intestinal helminths was 28.1% in

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Our research is especially oriented on the relationship between infectious diseases and the eye and on blindness/visual impairment related to infectious diseases in our environment. We have actually more than 25 publications and communications on the topic (*Helicobacter pylori*, *Toxoplasma gondii*, *Taenia solium*, HIV, ...). Our goal is to improve knowledge on these etiologies of ocular morbidity and to contribute to tackle these causes of blindness. Tropical endemic limbo-conjunctivitis is known as common disease with an ocular morbidity. Helminthiasis is also recognized as a public health issue. However, a work on the relationship between these two diseases have not been carried out in our environment. Therefore, this paper brings an overview on this relationship and gives evidence useful for the community and for scientists.

PUBLIC INTEREST STATEMENT

Tropical endemic limbo-conjunctivitis (TELC) is a chronic allergic eye disease, very common in children of tropical areas, and often characterized by severe ocular complications. Several studies were devoted to the study of different aspects of TELC in Africa.

This paper aims to give an overview on the relationship between this chronic conjunctivitis and helminths. Although these two diseases are frequent in Cameroon, any research on their association has never been carried out. The goal of our study was therefore to determine if there was a relationship between them.

According to our results, the prevalence of TELC (14.2%) is low in the area of Njombe-Cameroon. Male sex was associated to TELC. The overall frequency of intestinal helminth infection was 28.1% and the one amongst patients with TELC was 33.3%. Despite the presence of intestinal helminth infection in our population, it was not associated with TELC.

the general population vs. 33.3% in participants with TELC. TELC was not associated with intestinal helminths. *Conclusion:* The prevalence of TELC (14.2%) is low in our study. Male sex was associated to TELC. The overall frequency of intestinal helminth infection was 28.1% and the one amongst patients with TELC was 33.3%. Despite the presence of intestinal helminth infection in our population, it was not associated with TELC.

Subjects: Parasitology; Public Health Policy and Practice; Medicine, Dentistry, Nursing & Allied Health

Keywords: tropics; limbo-conjunctivitis; helminths; allergy; child; Cameroon

1. Introduction

Tropical endemic limbo-conjunctivitis (TELC) is a chronic keratoconjunctivitis of allergic etiology. According to Diallo (1976), this is an autonomous pathological entity, close to the vernal keratoconjunctivitis that occurs in temperate countries, particularly in Europe. TELC is the prerogative of hot, humid and dusty areas and particularly takes place in tropical Africa. It represents a major cause of consultation in ophthalmology, mainly among children and adolescents because of its morbidity (Mbuh, Ntonifor, & Ojong, 2012; Ojha, Jaide, Jinawath, Rotjanapapan, & Baral, 2014; Omgbwa, Bella, Owono, Mbome, & Ebana, 2009; Tabbara, 1999).

The study of Omgbwa et al. (2009), at the Gynecology/Obstetrics and Pediatric Hospital in Yaoundé, revealed a prevalence of 17.8% among children aged between 6 and 15; it represented the second pathology at that age after refractive errors. In Northern Cameroon, Koki et al. (2011), reported a rate of 33.5% for children aged between 4 months and 15 years.

It is characterized by its frequency, its clinical expression essentially limbal and corneal, and its evolution that is more chronic than seasonal. Its evolution is punctuated by relapses until the post-pubertal period that is marked by the cure to the expense of many sequelae (Diallo, 1976).

Intestinal helminths are a real public health problem throughout the world, with children being the most infected (Ojha et al., 2014). They are especially prevalent in sub-Saharan Africa, Asia and South America (Hotez et al., 2004, 2008). These infections are sources of morbidity and mortality. In Cameroon, despite a government policy that aims at eradicating worm infections and schistosomiasis, they remain prevalent with variable frequencies in different regions of Cameroon (Mbuh et al., 2012; Tchuem Tchuente et al., 2012, 2013). Helminths have an effect on the immune system of the host (Ojha et al., 2014). Several authors, in Asia and America, have reported a modulation of the cellular immune response in case of parasites with a variable impact on systemic allergic reactions (Hamid et al., 2011; Rujeni, Taylor, & Mutapi, 2012; Smits, Everts, Hartgers, & Yazdanbakhsh, 2010; Supali et al., 2010; Wördemann et al., 2008).

In Cameroon, to our knowledge, studies have only covered the epidemiological and clinical aspects of TELC and very few authors have addressed these factors specifically associated to parasitic origin.

The aim of our study was to determine the clinical profile of TELC and investigate the association between this disease and infestation with intestinal helminths among children in Njombe health area (Littoral region, Cameroon).

2. Material and methods

2.1. Type of study

This was a cross-sectional study.

2.2. Time and duration of the study

The study extended from January to July 2014 (a seven-month period).

Data collection (end of the long dry season and beginning of the short rainy season) and the clinical examination were performed at the study site, in the Njombé health area and analysis of biological samples was completed at the IMPM (Institut de Recherche Médicale et d'Etudes des Plantes Médicinales) laboratory of parasitology in Yaoundé.

2.3. Study site

The town of Njombé is part of the district of Njombé-Penja, Mungo Division (Nkongsamba), Littoral Region of Cameroon. It is located 73.5 km from the city of Douala, between the districts of Mbanga and Loum, on the national road No. 5 that runs from Douala to Bafoussam. The population of Njombé-Penja was estimated at about 31,792 inhabitants, in 2005. Economic activities are mostly limited to agriculture (especially banana) and trade.

This Health area was chosen because it is a rural area where most of the active population works in agriculture and its health district is recognized as a highly endemic focus for soil-transmitted helminths, *Schistosoma mansoni* and *Schistosoma haematobium* represents a prime target of PNLs (Programme National de Lutte contre la schistosomiase) (Tchuem Tchuente et al., 2013).

For reasons of convenience, our survey frame was made of schools with the largest enrollments within, such as: Njombé Bilingual High School (English and French section), school group "Les tisserins" (primary and secondary level) and Njombé public schools group I and group II.

2.4. Ethical considerations

The study was conducted in strict compliance with ethical principles of the Declaration of Helsinki. Therefore, authorizations for administrative and health authorities as well as the ethical approval (No 2014/64/UdM/PR/CAB/CIE of the Institutional Ethics Committee of Université des Montagnes) were obtained. An informed consent form was read and signed by parents or legal guardians of the students, and the assent obtained from children.

2.5. Sample

Our target population was composed of children under 15 years old, of both sexes, regularly enrolled in primary or secondary institutions in the health area of Njombé. We recruited consecutively all children meeting our inclusion criteria.

2.5.1. Inclusion criteria

- Participants under 15 years old living on the study site for at least 6 months, who have given their consent and whose parents or legal guardians gave their consent.

2.5.2. Exclusion criteria

- Children who took an antiparasitic treatment during the preceding month;
- Participants unable of emitting stools;
- Withdrawal of parental consent.

2.6. Procedure

Our study was conducted in two major stages, ophthalmological examination and collecting samples of feces on the study site for all participants, then the analysis of the biological samples at the IMPM laboratory of parasitology of Nkomo-Yaoundé.

2.6.1. Phase 1–Clinical examination and sampling

- *Information phase:* After the presentation of the various authorizations to the schools' principal, we had a meeting with teachers to present the study and its interest. Afterwards, in presence of their teachers, pupils were informed, through oral communication, on the validity of the study and the practical arrangements. Information letters and informed consent to be signed by parents or legal guardians were also distributed.
- *Sampling phase of biological material (stool):* Within a range of 24–48 h, we proceed to the recovery and counting of consent forms; to each of the children whose parents had given their consent, we gave him a container for stool collection, toilet paper and sampling techniques were explained to them. Samples of stool brought were immediately stored in a cooler with a 10 L block of ice in it.
- *Clinical examination phase:* A semi-structured interview was conducted with each child for socio-demographic characteristics, history of allergies, complaints akin to those of TELC was led by the investigator.

A complete ophthalmological clinical examination including, especially, evaluation of uncorrected far visual acuity on the E Snellen or Monoyer chart, a microscopic examination using a portable slit lamp in search of conjunctival hyperemia, pigmentation of the bulbar conjunctiva, tearing, conjunctival papillae, Trantas nodules, and a color test with fluoresce in search of corneal ulceration was achieved. The TELC was defined according to clinical signs in palpebral, limbal or mixed form and according to the evolutionary stages of the classification of Diallo (1976). All these variables were collected on pretested data collection chart.

- *Phase of preservation and transportation of stool samples:* Once emitted into plastic container, then labeled and packaged immediately in a cooler, samples were transported by the end of the day at the laboratory of Saint Jean de Malte de Njombé (HSJM) Hospital where they were kept in a refrigerator between 4 and 8°C for a period of 10 to 14 days before their transfer to the laboratory of Parasitology of IMPM.

2.6.2. Phase 2–Parasitological tests

At the parasitology laboratory of IMPM, stool samples were examined using the Kato-Katz method. The count of eggs of the various helminths was made as well as the sum of each species in order to determine the number of helminth eggs to 1/24th of a gram of feces.

Calculation of the parasite load: Parasite load (PL) was indirectly estimated by multiplying the number of eggs counted on a Kato-Katz blade by 24, considering that a brick of stool corresponds to 1/24 of a gram. Let X be the number of eggs on a blade $CP = X \cdot 24$.

Mean parasite load (MPL) was also evaluated [MPL = Sum of PL/Number of exams].

2.7. Variable analysis

The following parameters were recorded on a pretested data sheet, were analyzed thereafter:

- Socio-demographic characteristics: age, sex, place of residence, history of allergy and functional symptoms resembling those of TELC;
- Functional signs of TELC: tearing, photophobia, itching, foreign body sensation, pain, secretions, sticky, factors potential worsening the functional signs of TELC such as dust, sun, smoke, wind, light bright, warm climate;
- Clinical signs of TELC: visual acuity, clinical forms, stages according to Diallo;

Parasitological data: the time since the last deworming, helminths, type of helminths found, its parasite load;

Associations between the TELC and the infestation with intestinal helminths.

Statistical analysis was performed using SPSS Version 18. Statistical tests used were the χ^2 -test for the analysis of qualitative variables, ANOVA for comparison of averages and logistic regression for the influence of different parameters on TELC. The confidence limit was 95% and a p -value <0.05 was considered statistically significant for all analyzes.

3. Results

3.1. Sociodemographic data

In the study, 253 participants were recruited. The age of participants ranged from 4–14 years old, with a mean age of 10 ± 2 years. The most represented age group was 6–10 years (54.2%). Overall, 160 (63.3%) were female and 93 (36.7%) male, with a sex-ratio boys/girls of 0.58 (Figure 1).

3.2. Ophthalmologic data

Amongst the 253 children examined, 36 were suffering from TELC (14.2%). The average age of children with TELC was 9 ± 2 years old, with a range of 4–13 years.

The age group most affected by the TELC was the one that included the children aged of less than 5 years old, with a decrease with age (Table 1).

TELC was more common amongst boys (23.7%) than girls (8.8%).

Figure 1. Distribution of the study population by age and gender.

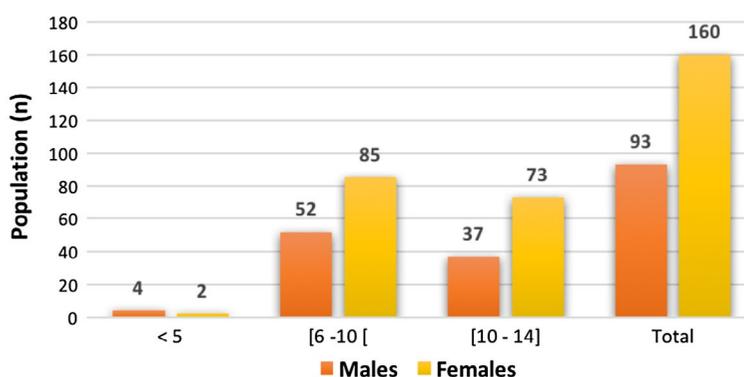


Table 1. Distribution of patients diagnosed with TELC according to their age

Age groups	Population (n)	Participants with LCET (n)	Percentage (%)	p-value
<5	6	4	4/6 (66.7)	0.001
[5-10[137	22	22/137 (16.1)	
[10-14]	110	10	10/100 (9.1)	
Total	253	36	36/253 (14.2)	

Table 2. Distribution of TELC according to gender

Gender	Population (n)	Participants with LCET (n)	Percentage (%)	p-value
Male	93	22	22/93 (23.7)	0.001
Female	160	14	14/160 (8.8)	
Total	253	36	36/253 (14.2)	

Figure 2. Distribution of symptoms in patients with TELC.

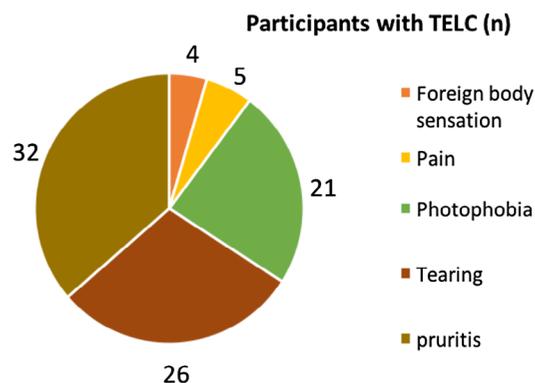
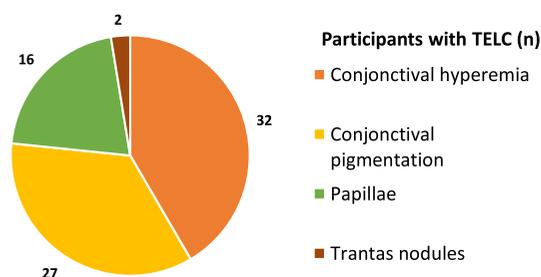


Figure 3. Distribution of clinical signs amongst patients with TELC.



Of children with TELC, there were 22/36 (61.1%) male, and 14/36 (39.8%) females, with a sex-ratio M/F of 1.57 (Table 2).

Eye pruritus (88.9%) was the most encountered complaint and could be isolated or associated in the same patient (Figure 2).

From observations made during ophthalmological examination amongst patients with TELC, the main one was conjunctival hyperemia (88.9%) (Figure 3).

The distribution of participants according to the classification of Diallo was: stade I, 75% ($n = 27$), stade II, 19.4% ($n = 7$), stade III, 5.6% ($n = 2$). There was no participant in stade IV.

Clinical forms of TELC found were limbal ($n = 21$; 58.4%), palpebral ($n = 4$; 11.1%) and mixed ($n = 11$; 30.6%).

3.3. Parasitological data

The average duration between the time of inclusion and the last deworming was 11 months, within the extremes of 2–82 months. The average age of infested children was 10 ± 3 years, with extreme ages of 5–14 years. The prevalence of intestinal helminth infection was 28.1% (71/253). The most parasitized age group was the one with the children aged between 0 and 5 years 33.3% (Table 3). We found 27 males and 44 females, which represents 0.61 as the sex ratio boys/girls ($p = 0.794$) (Table 4). The distribution of intestinal helminths according to age groups and gender did not differ ($p = 0.310$ according to age groups; $p = 0.794$ according to the gender).

Among those who were infected, mono-infected children represented 90.1% and those co-infected 9.9% (Table 5). Regarding the infestation by intestinal helminth species, the frequency of *Ascaris lumbricoides*, *Trichuris trichura*, et *Schistosoma mansoni* was respectively 4.35% (11/253), 3.95% (10/253) and 23.32% (59/253).

Table 3. Distribution of intestinal helminth infection according to age groups

Age groups	Population (n)	Participants with helminths (n)	Percentage (%)	p-value
<5	6	2	33.3	0.310
[5–10[137	33	24.1	
[10–14]	110	36	32.8	
Total	253	71	28.1	

Table 4. Distribution of intestinal helminth according to gender

Gender	Population (n)	Participants with helminths (n)	Percentage (%)	p-value
Male	93	27	29.1	0.794
Female	160	44	27.5	
Total	253	71	28.1	

Table 5. Distribution of mono and co-intestinal helminth infections amongst the participants

Population (n)		Infected participants (n)		Percentage (%)
Mono infections	A.l	7	71	9.9
	T.t	4	71	5.6
	S.m	53	71	74.6
	Total	64	71	90.1
Co infections	A.l et T.t	1	71	1.4
	A.l et S.m	1	71	1.4
	T.t et S.m	3	71	3.2
	A.l, T.t et S.m	2	71	2.8
	Total	7	71	9.9

Notes: A.l: *Ascaris Lumbricoides*; T.t: *Trichuri trichiuris*; S.m: *Schistosoma mansoni*.

Table 6. Frequency of intestinal helminths amongst patients with TELC

Presence of helminths	Population with TELC		Population without TELC	
	Number (n)	Frequency (%)	Number (n)	Frequency (%)
Yes	12	33.3	59	27.2
No	24	66.7	158	72.8
Total	36	100.0	217	100.0

3.4. Associations between intestinal helminths and TELC

The frequency of intestinal helminths within the population with TELC was 33.3%. On the other hand, it was 27.2% for the population without TELC ($p = 0.447$) (Table 6).

The intestinal helminths found amongst patients suffering from TELC were: *S. mansoni* ($n = 10$), *T. trichura* ($n = 3$) and *A. lumbricoides* (16.7%, $n = 2$).

MPL of *T. trichiura* within the population presenting TELC (336 eggs per gram) was higher than MPL of the group that did not show TELC (66 eggs per gram) ($p = 0.018$) (Table 7).

The absence of association between helminths and TELC was found: *S. mansoni* (OR = 0.990; $p = 0.197$; Confidence Interval = 0.97–1.00), *T. trichura* (OR = 1.015; $p = 0.07$; Confidence Interval = 0.99–1.03) and *A. lumbricoides* (OR = 0.999; $p = 0.55$; Confidence Interval = 0.99–1.00).

Table 7. MPL depending on the status of TELC and helminth species amongst participants

MPL (epg)			
Helminths species	MPL of participants without LCET	MPL of participants with LCET	p-value
<i>A. lumbricoïdes</i>	1,456	939	0.630
<i>T. trichiura</i>	336	66	0.018
<i>S. mansoni</i>	9	42	0.310

Notes: MPL: mean parasite load; epg: egg per gram.

4. Discussion

4.1. Sociodemographic and ophthalmological data

TELC occurs in hot climates (Ayena, Banla, Agbo, Gneni, & Balo, 2008; Banla et al., 2013; Chenge, Makumyamviri, & Kaimbo wa Kaimbo, 2003; De Smedt et al., 2011; Diallo, 1976; Everaerts & Doutetien, 1993; Koki et al., 2011; Maneh et al., 2005; Mc Moli & Asonganyi, 1991; Nyolo, Mc Moli, & Ndombo, 1993). However, its prevalence is variable. The prevalence found in our study is low (14.2%) and close to the one found by Ayena et al. (2008) (12.2% in Togo), unlike those reported in other regions of Cameroon and Central Africa [Koki et al. (2011): 31,55% in North Cameroon; Omgbwa et al. (2009), Maneh et al. (2015): 21.4%; Chenge et al. (2003): 32.9%].

4.2. Sociodemography

TELC is described as a disease of the young child. In our series, our participants were being recruited amongst children of school ages already able to express themselves (that is over 4 years). This could explain the low prevalence of TELC. This may also justify that the average age of children with TELC in our study is higher than the one recorded by other authors (Chenge et al., 2003; Koki et al., 2011; Maneh et al., 2005).

However, our average age is close to the one of Mc Moli and Asonganyi (1991), whose study was carried out in the Central Region (10,3 years old).

The average age of our participants could also be the result of the environment which is highly immunogenic because of poly-parasitism in younger children in rural areas and which, therefore, would provide greater immunomodulatory effects (Banla et al., 2013; De Smedt et al., 2011; Oliveira et al., 2009; Reddy & Fried, 2008; Smits et al., 2010). As a result, this would increase the age of the condition's outbreak. A further comparative study based on the association between intestinal helminths and TELC with an urban and rural population would provide clarification.

TELC is the prerogative of hot and dusty regions and is more frequent in case of air pollution (De Smedt et al., 2011; Evarest & Doutetien, 1993; Koki et al., 2011; Maneh et al., 2005; Obeng, Hartgers, Boakye, & Yazdanbakhsh, 2008). The epidemiology of TELC suggests a hereditary predisposition and many patients have another associated atopy as describes by other authors (Banla et al., 2013).

For many authors, TELC is a common condition for the young boy, as prevalence range from 55–81.9% (Ayena et al., 2008; Koki et al., 2011). In our series, male subjects were the most affected (61.1%), which is in accordance with the findings of authors cited above. The predominance of male in the TELC may be explained by the greater freedom given to boys compared to girls in our outdoor activities. Indeed, this allows them to spend more time playing outside than girls, and thereby, expose them to the dust and photosensitization that conditions the onset and severity of the condition. However, other African studies have shown that there is no difference between the prevalence of TELC in boys and girls (Ajaiyeoba, 2005; Chenge et al., 2003; De Smedt et al., 2011; Maneh et al., 2005).

4.3. Clinical features

Eye pruritis was the most common complaint in our series (88.9%). The work of the other authors corroborates our findings (Maneh et al. (2005), 58.8%; Koki et al. (2011) 60.9%; Chenge et al. (2003) 86%). This symptom was very often associated with other functional signs.

The most common clinical stage among children with TELC was Stage I (75%). On the other hand, there were no children with stage IV. Many other authors have also found stage I to be the most frequent (Ayena et al., 2008; Nyolo et al., 1993), unlike Maneh who found out that to stage II was the most frequent form in a study conducted in Togo (Maneh et al., 2005).

Clinical forms found were in descending order, the palpebral form (58%), the mixed form (38%) and the bulbar form (3%). Our results are superimposable to those of other authors who have found the palpebral form as the predominant form (Chenge et al., 2003; Koki et al., 2011; Nyolo et al., 1993).

4.4. Intestinal helminths

In our study, we noted that while parasite infestation was 28.1%, the one by *S. mansoni* was the most frequent (23.32%), followed by *A. lumbricoides* (4.35%) and *T. trichiuris* (3.95%).

According to Tchuem Tchuente et al. (2012, 2013), helminthiasis prevalence varied between 10.49% (West Cameroon) and 52.8% (South Cameroon). According to species, intestinal helminths prevalence varied for *A. lumbricoides*, between 11.48 and 19.5%, for *T. trichiuris* between 18.22 and 18.9% and for *Schistosomiasis* between 7.31 and 7.40.

In the South-West Cameroon region, the overall prevalence of helminth infections was 31% with 47.2 and 21% in rural and urban areas respectively, with a predominance of infestation amongst 6–12 years old (41.4%). In addition, the prevalence of *A. lumbricoides* and *T. trichiuris* was 19.3 and 11.8% respectively (Nyolo et al., 1993).

It should be noted that the prevalence of helminthiasis in our study is superimposable to the values found in Cameroon, although slightly higher than those found by Tchuem Tchuente et al. (2013) in the Littoral region. This can be explained by the high prevalence of schistosomiasis which is found in our participants in comparison with those found in the work of other Cameroonian authors. Schistosomiasis has been identified in several regions of Cameroon with recommendations for mass campaigns based on Praziquantel (Tchuem Tchuente et al., 2012, 2013). Our results are corroborated by national data which considers Njombé as a hyperendemic area of *S. Mansoni* (Tchuem Tchuente et al., 2013).

On the other hand, we note that the prevalence of *A. lumbricoides* and *T. trichiuris* in our study is lower than those reported by other authors. This decrease can be explained by the success of measures taken by the Ministry of Public Health of Cameroon in favor of mass campaigns based on Mebendazole in the community (Tchuem Tchuente et al., 2012, 2013).

4.5. Association TELC and helminths

According to many authors, polyparasitism has an effect on atopic predisposition. Thus, chronic parasite infestation would be associated with a decrease in allergic manifestations by suppression of the cellular immune response (Obeng et al., 2008; Smits et al., 2010). While acute parasitic infections exacerbate allergic manifestations, there is a decline in susceptibility to atopy as the infection progresses to chronicity (Reddy & Fried, 2008). However, there is no established association between atopic disorders and geohelminths. According to Wordemann, the modulation of systemic allergic manifestations depends on the type of parasite (Wördemann et al., 2008).

In our study, our results showed that there is no difference between the prevalence of intestinal helminth infection in patients with TELC and those without TELC. Moreover, no association was

found between Helminths and TELC. However, it should be noted that *T. trichiuris* parasite load was higher in LCET carriers compared to children without LCET, in our study.

The results reported in the literature are contradictory. Indeed, Ajaiyeoba's (2005) work in Nigeria (case-control study) reported that participants with TELC were 1.68 times more likely to have a helminth infection. Deworming appeared beneficial for participants with TELC. However, there was no association between helminth infections and TELC. In Banla et al. (2011), in a study based on parasitological analysis of feces in 109 TELC patients, found 47.7% positive helminth examinations, in Togo. After deworming, 13.5% of the positive cases returned to an interval between 1 and 4 years, while 28.1% of the non-decontaminated children presented for relapse within the same period. Thus, deworming would also have had a favorable effect on the stabilization of the disease. In contrast, according to Mc Moli and Asonganyi (1991), intestinal parasitosis is not a risk factor for the occurrence or aggravation of TELC. Next to him De Smedt et al. (2011), in Rwanda, reported that no association existed between TELC and intestinal parasitic infections, but rather blamed high socio-economic status as a risk factor.

It should be noted that although no clear causal relationship had been established between geohelminths and atopic predisposition, acute parasitic infections would exacerbate allergic manifestations while chronic infections would decrease them (Oliveira et al., 2009; Reddy & Fried, 2008; Rujeni et al., 2012). Furthermore, it is currently established that *S. mansoni* infections are responsible for inhibiting the antiparasitic immune response in order to promote parasite survival in the host. This immunomodulation action would also extend to other autoimmune pathologies (Oliveira et al., 2009; Rujeni et al., 2012).

Further studies would be suggested to shed light on the potential action of *S. mansoni* on TELC.

5. Conclusion

In our study, the frequency of TELC was 14.2% and predominated amongst male participants. The overall frequency of intestinal helminth infection was 28.1% and the one amongst affected patients by TELC was 33.3%. Age and sex were associated with TELC. On the other hand, there was no association between TELC and the intestinal helminth infection.

Author's contributions

All authors contributed to all parts of the study, provided information from literature and critically revised the manuscript. All authors read and approved the final version of the manuscript.

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Competing Interests

The authors declare no competing interest.

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