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Assessment of the evolution of malaria and intestinal helminthes infections from 1983 to 2014 in the Hevecam agroindustrial complex, south region of Cameroon

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Man-made development projects have usually been pointed to significantly influence the epidemiological features of communicable parasitic diseases in sub-Saharan countries as a result of anthropogenic environmental changes. This study aimed to assess the current health status of dwellers of the Hevecam agroindustrial complex established after rainforest deforestation in Southern Cameroon, and to monitor its evolution compared to data collected 31 years ago. A prospective cross-sectional study was carried out in 2014 in the same four villages which were previously investigated 31 years ago in the Hevecam area. Assessment focused on prevalence of malaria and soil-transmitted helminthiasis, and the risk factors of these diseases. Present data were then compared with those collected in 1983. Data from four villages investigated indicated that malaria and soil-transmitted helminthiasis were mesoendemic and hypoendemic, respectively in the area. The malaria endemicity level was similar in either study village according to both parasitological results and spleen index. *Plasmodium falciparum* and *Plasmodium malariae* caused 98.8 and 1.2% of malaria cases recorded. *P. falciparum* parasites loads ranged from light to heavy. Prevalence rates of *Plasmodium* carriage were significantly influenced by sex, age and occupation. Intestinal helminths parasites occurred in 14.1% subjects. The main infective agents were *Ascaris lumbricoides* and *Trichuris trichiura*, found either as monospecfic or mixed infections. *A. lumbricoides* infections were the most frequent. Helminths intensities of infections were predominantly light. Prevalence significantly varied with villages, age, occupation and regular deworming status. Mixed infections by malaria and helminths parasites were recorded in some subjects. Comparing current to previous data, malaria and intestinal helminthiasis have evolved significantly in divergent ways in 31 years within the Hevecam villages. Malaria infections increased from hypoendemic to mesoendemic, while intestinal helminth infections decreased from hyperendemic to hypoendemic. Evolution of these diseases indicated a need for health facilities located in Hevecam to improve specific control measures for malaria and sustained helminth control tools.

Key words: Malaria, intestinal helminthiasis, prevalence, evolution, Hevecam.

INTRODUCTION

In most rural and urban countries of sub-Saharan Africa, anthropogenic environmental changes for implementation of development projects have usually been demonstrated to influence the epidemiological profile of communicable diseases through changing the transmission pattern of existing diseases and importation of new pathologies by immigrants (Hunter et al., 1993; Keiser et al., 2005; Ripert et al., 1979). In fact, the functioning of the manmade projects need a manpower which is usually made of non-indigenous workers and their families attracted by the new job opportunities. In this situation, people were sometimes deported from other regions and resettled in the project area leading to creation of cluster settlements made of villages whose inhabitants were mostly immigrants.

Creation of development projects therefore influences greatly the dynamics of parasitic and other communicable diseases by introduction of new diseases and/or new parasites strains in the development site, and also through changes in environmental conditions favourable to vectors development and changing in human being habits. These observations have been a rule concerning dams construction and hydroagricultural projects which usually lead in many countries of sub-Saharan Africa, and other continents to a sustainable increase of prevalence rates of waterborne and vector borne parasitic diseases namely malaria, schistosomiasis, lymphatic filariasis and other filariasis in Africa (Hunter et al., 1994; Keiser et al., 2005; Ripert et al. 1979). Like waterborne and vector diseases, epidemiology of other communicable diseases like soil-transmitted helminth infections (STHs), intestinal protozoan, sexually transmitted diseases is likely to be influenced by the project. Like water-related development projects, other manmade environmental changes such as deforestation and changes in land use can be potential causes of dynamic changes in communicable diseases risk in absence of an adequate safeguard for disease surveillance.

Beyond such health negative impact of development projects there was a lack in implementation of an adequate safeguard for disease surveillance (Parent et al., 1997). A major prerequisite to build development projects in diseases endemic areas is implementation of health impact assessments to be followed by creation of an adequate safeguard for disease tracking system or prevent transmission according to country directorates of national disease control program. However, when such studies are done, results are not often used to design adequate scheme to prevent health negative impact of the project.

Malaria and intestinal helminthiasis are controllable, and recommended control tools are largely implemented in Cameroon through specific national control programs of the country Public Health Ministry. Infection with soil-transmitted helminth is intimately connected with poverty, with the highest prevalence rates observed in low- and middle-income countries where hygiene is poor, access to safe and clean water is lacking, and sanitation is absent or inadequate (Brooker, 2010; WHO, 2002, 2012, 2006; Hotez et al., 2006). The morbidity caused by intestinal helminth is most commonly associated with infections of heavy intensity (Hotez et al., 2006; Hotez et al., 2006). Anaemia and other morbidities (example, reduced physical and cognitive development) are the main reasons for this large global burden (Brooker et al., 2006; Partnership for Child Development, 1998). People are infected after ingesting eggs from contaminated soil or food (*Ascaris lumbricoides* and *Trichuris trichiura*), or through active penetration of the skin by infective larval stages present in contaminated soil such as hookworm (Brooker et al., 2006; Bethony et al., 2006). More than half of the Cameroon population is thought to be affected by soil-transmitted helminthiasis (Brooker, 2010).

Improving access to sanitation, safe water and hygiene practices (WHO, 2002, 2006, 2012; Utzinger and Keiser, 2004; Horton, 2003) together with annual mass drug administration of anti-helmintic drugs (WHO, 2012; Bartram and Cairncross, 2010; Ziegelbauer et al., 2012; Strunz et al., 2014) are affordable and simple measures to be implemented for a sustainable control of intestinal parasitic diseases under public health importance. Strategic plans have been so far lunched in order to eliminate soil-transmitted helminthiasis (STH) related morbidity in children by 2020 through school-based deworming (WHO, 2012). The World Health Organization (WHO) guidelines for STH control generally focus on routine mass drug administration for school-aged children, aiming primarily to reduce the prevalence of high to moderate-intensity infections by achieving in endemic countries a minimum target of regular deworming of at least 75% and up to 100% of school-aged children and other groups at risk of morbidity by 2010 (WHO, 2002, 2006). Cameroon Ministry of Public Health adopted the annual nationwide school-based mass deworming strategic plan for the control of schistosomiasis and STH in 2004 with its completion in 2007 (Tchuem and N'goran, 2009; Tchuem et al., 2013). Implementation of school-based annual deworming from 2007 to 2010 showed a 73% decrease of STH infections in school age children in all health districts of the Centre region of Cameroon (Tchuem et al., 2012).

Since 2005, a target was set for the reduction of malaria cases and deaths by 75% by 2015 (WHO, 2014). Such achievements could be attained in endemic countries only after wide implementation of WHO recommended malaria control guidelines to endemic countries mainly based large scale use of insecticide-

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treated mosquito nets (ITNs) in households, indoor residual spraying, intermittent preventive treatment in pregnancy (IPTp), proper management of diagnosed cases complemented with a tracking system as recommended in the T3: Test. Treat. Track Initiative (WHO, 2012, 2013, 2014). It was estimated that the only ownership and proper use of ITNs reduce the incidence of malaria cases by 50% in a variety of settings, this also reduce malaria mortality rates by 55% in children under 5 years of age in sub-Saharan Africa, as well reducing maternal anaemia, placental infection and low birth weight (WHO, 2013, 2014).

The Hevecam agro-industrial society was established in 1975 at Niete neighbourhood in southern Cameroon following an important deforestation of the evergreen forest. A previous assessment of the health status of the employees and their families undergone in 1983 showed an hyperendemic level of intestinal helminthiasis whereas malaria was hypoendemic (Moyou et al., 1984). Considering the ecological and human habits changes in the area, the morbidity of these diseases could likely change in absence of adequate control measures. This study aimed to assess the present endemicity levels of malaria and intestinal helminthiasis in villages of the Hevecam company, investigate potential risk factors of their transmission, and appreciate the evolution of these diseases compared to data collected 31 years ago.

MATERIALS AND METHODS

Study type, period and place

This was a prospective cross-sectional study undergone in 2014. Data collected were then compared with previous data from a study done 31 years ago in the same area. The study took place in 4 villages of the Hevecam agroindusrial complex namely villages 2, 5, 6 and 8 for recruitment of participants. A first stool examination and staining blood smears took place in the Hevecam Central Hospital laboratory. A counter-examination of stool samples and stained blood films took place in the laboratory of the Faculty of Medicine and Pharmaceutical Sciences of the University of Douala and also in the Parasitology laboratory of the Yaoundé University Teaching Hospital in Cameroon. The Hevecam agroindustrial complex is specialized in cultivation of rubber trees and harvesting natural rubber. The Hevecam company was established in 1975 at Niete, a village situated deeply in the rainforest at 40 km from the nearest town Kribi. Its plantation covers nearly 40 000 ha area created after the destruction of the rainforest. The population of the Hevecam is estimated at 20 000 inhabitants of whom 6000 are employees of the society. Employees of the plantation and their families live in 16 encampments numbered from 1 to 16. Working as Hevecam employee, petty trading and peasant farming are the major occupation of the population. Sanitary conditions are poor in large parts of the community. The Hevecam company constructed a hospital with well trained personnel, and has also built health centers in each of the sixteen villages. Niete is located in an equatorial climate where mean atmospheric temperature is around 26.2°c in the rainy season and 28.7°c in the dry season. The hydrographic network is dominated by the Nyete river which traverses the Hevecam plantation. The Hevecam residents collect drinking and domestic water from pipes and taps constructed by the company.

Ethics

Permission to carry out this research work was obtained from the Ethical Committee of the University of Douala, the Regional Delegate of Public Health of the South Region in Cameroon and the administration of the Hevecam hospital. Then community leaders of the selected villages held a meeting during in which the study was explained by the research investigators. The date for participant recruitment was fixed together with the residents.

Study criteria

All inhabitants of each selected village were targeted as the study population. Visitors and those who (or whose parent) did not sign the study inform consent were not admitted in the study.

Data collection

In each village, residents were convened at the local health facility for recruitment. The aim and procedures of the study was carefully read and explained to the participants or the legal guardian (for children), then each participant was asked for consent before his (or his child) enrolment into the study. He (or the parent) was asked to sign the study informed consent sheet if he accepted to participate. Each person who agreed to participate in the study was questioned for the following data: sex, age, occupation, mosquito bites preventive tools used, sanitation types, provision of drinking water, history of any anti-malaria or regular anti-helminthic treatment. Children of two to 9 years old were examined for existence spleen enlargement to determine the spleen index. Participants were classified into five occupational groups namely preschool children, school-aged children, Hevecam rubber plantations workers, housewives and independent occupations. Independent occupations comprised trade, small-farming and jobless. The volunteer was then asked to give a stool sample in a container given by the investigator. Lastly, the participant underwent a thick and thin blood smears from finger pricking for microscopy identification and count of Plasmodium stages. Stool samples and blood smears were then transported to laboratory for analysis.

Thick and thin blood smears were stained with Giemsa, then dry at room temperature and examined under light microscope at high magnification. Plasmodium loads were expressed per microliter of blood with the assumption that each participant had a mean 7500 white blood cells/µl of blood. Stool samples were analysed in laboratory using the Kato-Katz technique by microscopic examination and count of all helminth eggs contained in a calibrated thick smear made from 41.66 mg moulded faeces (Katz et al., 1972; Martin and Beaver, 1968). Parasitic load of each helminth parasite was then brought to number of egg per gram of faeces for each participant.

For each of the diseases assessed, prevalence rates, intensity of infection and endemicity level was estimated. Prevalence of each diagnosed infection was estimated as the percentage of subjects who harboured the parasites in the biological specimen after laboratory examination. The malaria endemicity level was estimated according to spleen enlargement index according to WHO classification (Spencer, 1963; Hay et al., 2008). Spleen index classification defines hypoendemicity as spleen index $0 < SI \leq 10$ %; mesoendemicity as spleen index $10 < SI \leq 50\%$; hyperendemicity

Table 1. Malaria inction prevalence according to Plasmodium species, sex, age groups and spleen index.

Villages	N	Plasmodium infection prevalence																	Spleen index	
		Specific infections			Sex				Age groups (years)											
					F		M		0-4		5-9		10-14		≥15					
		Overall	*P. f*	*P. m*	N	%	N	%	N	%	N	%	N	%	N	%			N	Index
Village 2	148	32.4	32.4	0.0	87	27.7	61	39.3	45	17.8	29	62.1	25	40.0	49	24.5			62	21.0
Village 5	110	44.5	44.5	0.0	60	41.7	50	48.0	21	57.1	34	55.9	13	46.1	42	28.6			50	32.0
Village 6	109	25.7	23.9	1.8	68	23.5	41	29.3	19	21.1	24	45.8	10	50.0	56	14.3			36	27.8
Village 8	132	35.6	35.6	0.0	97	35.1	35	37.1	26	30.8	24	62.5	21	66.7	61	16.4			42	31.0
Mean	499	34.5	34.1	0.4	111	31.7	187	39.0	111	28.8	111	56.8	68	51.6	209	20.1			190	27.4
-	-	$\chi^2 = 4.6; p>0.05$			$\chi^2 = 4.6; p>0.038$				$\chi^2 = 52.8; p=0.00$										-	-

N = Sample size. *P.f = Plasmodium falciparum*. *P.m.= Plasmodium malariae.* F = females. M = males.

as spleen index 50 <SI≤ 75%; and holoenedmicity as spleen index SI > 75% (Spencer, 1963). Classification of intestinal helminhiasis into endemicity level and intensity of infection were made according to WHO guidelines (WHO, 2002, 2006, 2012). In either case, intensity of infection of the disease, the study could be classified as low-risk, moderate-risk or high risk.

Data were analyzed using the statistical package for the social sciences (SPSS) 18 statistical software and Chi-square test was used for statistical analysis. Differences were considered significant when p was less than 0.05.

RESULTS

Sample size examined

Recruitment of participants took place in four villages of the Hevecam plantation. A total 499 persons were recruited for malaria parasites detection in blood smears, 190 children aged between 2 years and 9 years were examined for spleen enlargement, and 312 subjects provided stool samples for helminth eggs and larva detection. In all villages, female participants were more represented than males.

Malaria infection trends at Hevecam

Prevalence of malaria infection

As indicated in Table 1, prevalence of malaria showed a meso-endemicity of malaria in the Hevecam agro-industrial complex as well as in either villages screened. There was a significant variation among malaria infection prevalence in the villages ($\chi 2 = 4.6$; p=0.03). Infection prevalences ranged between 25.7 and 44.5% with an overall 34.5% in the area. Malaria infection cases were due to *Plasmodium falciparum* in 98.8% cases and *Plasmodium malariae* in 1.2%. *P. malariae* infections were recorded only in village 6. Participants who were infected by *P. falciparum* harboured either asexual stages (97.1%), either gametocytes stages (2.3%) or both (0.6%). There was no co-infection by the two Plasmodium species.

According to spleen enlargement at Hevecam

Considering the clinical feature based on spleen enlargement among children aged between 2 years and 9 years, malaria was also mesoendemic in the Hevecam villages. The overall spleen index was 27.4. As recorded with infection rates, spleen enlargement index also varied significantly between villages from 21 to 31 ($\chi 2=63$; p=0.00) indicating a mesoendemicty of malaria in all villages. Sex did not influence significantly spleen indexes ($\chi 2 = 0.37$; p=0.54).

Influence of demographic factors on malaria infection

Influence of sex

The sample study was made of 62.5% females and 37.5% males. Female were also more represented in all villages screened. As indicated in Table 1, sex signify-cantly influenced the prevalence of malaria infections in all villages investigated ($\chi 2=4.6$; p = 0.03). Males were more infected than females (39 vs 31.7%) in the study area. However, predominant prevalence varied between sex varied from a village to another.

Influence of the age

Mean age of participants was 13.17 years (range 6 months to 75 years). There was a significant age-related influence on the Plasmodium infection prevalence in the whole area as well as in either study village ($\chi 2 = 52.8$; p=0,00). In the Hevecam area, prevalence of *Plasmodium* infections showed a unique peak in parti-

Table 2. Prevalence of Plasmodium infection according to occupation at Hevecam.

Occupation	Pre-school children	School children	Housewives	Rubber farm workers	Others
Sample size	84	232	91	68	24
Prevalence (%)	27.4	48.3	22	22.1	8.3

Table 3. Prevalence of Plasmodium infection according to mosquito bite prevention tool use.

Prevention tool	Mosquito net		Insecticide sprays		Screen on windows		Smokes	
Answer	Yes	No	Yes	No	Yes	No	Yes	No
Sample size	299	200	17	482	96	403	70	429
Infected	109	63	6	166	32	140	23	149
Prevalence (%)	36.5	31.5	35.3	34.4	33.3	34.7	32.9	34.7

participants aged between 5 to 14 years whereas lowest prevalence occurred in older group. This tendency also occurred in studied villages excepting village 5 where prevalence of infection was highest in younger participants and decreased with age.

Influence of specific occupation

Specific occupations influenced significantly prevalences of Plasmodium infections in the Hevecam agro-industrial complex ($\chi2=39$; $p=0,00$). Plasmodium infection prevalences were higher in school-aged and preschool children than in other groups. Housewives and Hevecam rubber plantation workers had significantly high *Plasmodium* infection rates (22 and 22.1% respectively) (Table 2).

Influence of mosquitoe bites prevention tools

All study participants used at least a mosquitoe bites prevention tool. Participants used either a mosquitoe net (59.9%), an insecticide spray (3.4%), smokes (14%) or net on windows (19.2%) or a combination of two tools. According to Table 3, there was no significant influence of mosquitoe bites prevention tools on Plasmodium infection prevalence rates ($\chi2 = 0.04$; $p = 0.94$). Moreover, prevalences of Plasmodium infections were not significantly different between those who used mosquito bites prevention tools and those who did not.

Intensities of plasmodium infections

Mean plasmodium infection load among infected subjects was 1 876.23 *Plasmodium*/µl of blood (range: 135-112500 *Plasmodium*/µl of blood). Male subjects usually had higher infection intensities than females. According to age, 99.4% of parasitized participants had less than 4000 *Plasmodium*/µl of blood of whom 75% were less than 15 years old and 53.5% less than 10 years old. All participants older than 50 years had Plasmodium parasites load less than 1000 *Plasmodium*/µl of blood.

Intestinal helminth infections trends

Intestinal helminth infections prevalence

A. lumbricoides and *T. trichiura* were the helminth parasites identified in the investigated villages. As indicated in Table 4, the Hevecam area and all villages were found to be globally a low-risk area for intestinal helminth infections according to WHO classification. However, village 6 was still a moderate-risk area with prevalence higher than 20% (21.1%). The overall intestinal helminthes infection prevalence was 14.1%. Intestinal helminth infection prevalence varied but not significantly among the study villages ($\chi2 = 4.6$; df = 3; $p > 0,05$). Village 8 had the lowest infection prevalence rate (8.8%) whereas village 6 had the highest (21.1%). According to parasites species, *A. lumbricoides* and *T. trichiura* infected 12.5 and 3.5% of participants respectively. *A. lumbricoides* and *T. trichiura* infections occurred each as mono-infection in 77.3 and 9.1% respectively. Mix-infection by the two parasites occurred in 13.6% of infected subjects. Prevalences of *A. lumbricoides* infections were always higher than *T. trichiura* in each village.

Influence of age, sex, drinking water source and periodic anti-helminthic practice

As indicated in Table 4, intestinal helminth infection

Table 4. Helminth infections prevalence at Hevecam according to village, parasite, gender and age group.

Villages	Global		Specific infections and co-infections			Gender				Age group (years)							
						M		F		0-4		5-14		15-29		≥30	
	N	%	*A. l*	*T. t*	*A.l+T.t*	N	%	N	%	N	%	N	%	N	%	N	%
Village 2	89	14.6	12.3	5.6	3.4	41	12.2	48	16.4	27	11.1	32	18.7	19	10.5	11	18.2
Village 5	72	12.5	12.5	0.0	0.0	35	14.3	37	10.8	10	10.0	30	13.3	11	18.2	21	9.5
Village 6	71	21.1	18.3	7.0	4.22	23	21.7	48	20.8	13	7.7	24	37.5	13	15.4	21	14.3
Village 8	80	8.8	8.7	0.0	0.0	22	0.0	58	12.1	16	0.0	26	7.7	28	14.3	10	10.0
Overall	312	14.1	12.2	3.2	1.9	121	12.4	191	15.2	66	7.6	112	18.7	71	14.1	62	12.3

N= sample size. F: female. M: male. *A.l.= Ascaris lumbricoides*. *T.t.= Trichuris trichiura*.

prevalence showed a single peak with a sharp increase from 7.6% in preschool-aged subjects to 20.3% in subjects aged between 5 to 14 years then decreased at elder ages. Despite the differences, age was not associated with intestinal helminth prevalence in the Hevecam area ($\chi2$ = 4.7; df = 3, p > 0,05). Prevalence of specific helminth infection (*A. lumbricoides* or *T. trichiura*) also showed the same trend with age of participants with a single peak which occurred in subjects aged between 5 to 14 years (Table 4). Female participants were more infected than males in the Hevecam area (Table 4). Sex was however not associated with intestinal helminth infection prevalence in the study area ($\chi2$ = 2.1; df = 1, p > 0,05). The relationship between helminth infections and sex varied between villages. In villages 5 and 6 for example, males appeared more infected than females while all infected recorded in village 8 were females. Prevalence rates of *A. lumbricoides* infection were higher in females than males, inversely males had higher *T. trichiura* infection rate than females. According to specific occupation, school children had the highest helminth infection prevalence rate (18.4%). Hevecam workers and housewives had 9.8 and 12.7% prevalence rates respectively. Participants to this study drank piped water originating either from a well constructed borehole (98.8%) or the main water distributor society named Camwater (1.2%).

All cases of helminth infection recorded were among those who drank water from borehole. Considering deworming practices, 81.1% of study participants swallowed an adequate antihelminthic drug against STH at least once a year. Some of them dewormed up to four times in the year. Helminth infection prevalence was lower among subjects who systematically took an antihelminthic each year (13.8%) than those who did not (17.5%). According to drinking water source, 98.7 and 1.3% of participants reported drinking water from borehole and piped respectively. Helminth infections were found only among those who reported drinking water from borehole at a prevalence of 14.3%.

Intestinal helminth intensities of infection

Intensities of infection by each of the helminth infection ranged between light to heavy. Light-intensity of infections were predominant in both helminth infections. Egg count in *A. lumbricoides* infections ranged between 48 and 50400 egg per gram of faeces. Mean parasitic load recorded was 3161 eggs per gram of faeces. Light-intensity of infections represented 90% while moderate and heavy-intensity of infections accounted for 7.5 and 2.5% respectively. The heavy-intensity of infection was recorded in a one year old child while all moderate-intensity of infections were found among school-aged participants. Parasitic loads recorded in *T. trichiura* infections ranged between 48 and 1440 eggs per gram of faeces. Mean parasitic load was 6384 eggs per gram of faeces. There was no heavy-intensity of infection. Light and moderate-intensities of infections represented 80 and 20% respectively. Moderate-intensity of infection was recorded mostly among under-fifteen years old participants.

Occurrence of Plasmodium and helminth parasites co-infections

Some of the study participants harboured both intestinal helminth and *Plasmodium* parasites.

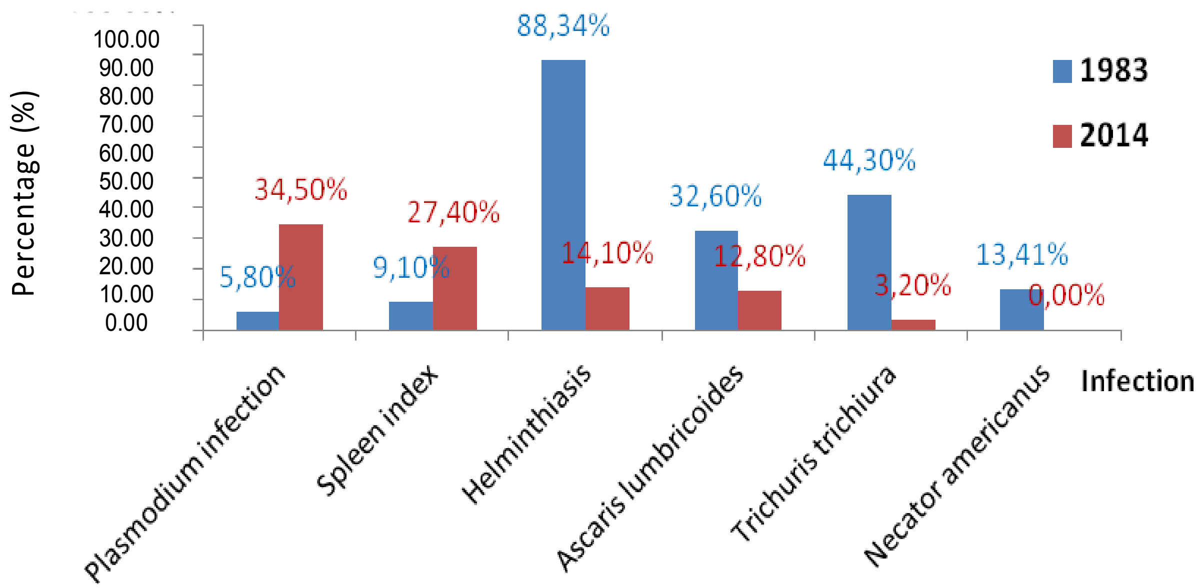

Figure 1. Prevalence of malaria and helminth infections at Hevecam in 1983 (Moyou et al., 1984) and 2014.

Such combination occurred in 4.5% subjects. Specific combinations recorded were *P. falciparum, A. lumbricoides* (3.2%), *P. falciparum, T. trichiura* (0.64%), *P. falciparum, A. lumbricoides* and *T. trichiura* (0.6%). Plasmodium plus intestinal helminth co-infections occurred most in female than male subjects, however differences were not statistically significant (p=0.98).

Evolution of malaria and intestinal helminth infections in the Hevecam villages from 1983 to 2014

As indicated in the figure below, comparison of data recorded in 1983 to actual data indicated a significant evolution in the health status of residents in the Hevecam villages either for malaria or intestinal helminthiasis. Concerning malaria, *P. falciparum* was the only species found in 1983. The occurrence of *P. malariae* together with *P. falciparum* in the area 31 years after indicated that malaria transmission trend is becoming complex in Hevecam settlements. Such complexity was confirmed by the significant increase in malaria prevalence rates from hypoendemic to mesoendemic according to WHO classification based on spleen index in 2 to 9 years old children. Unlike significant increase of spleen enlargement index, prevalence rates Plasmodium parasites carriage also significantly evolved within the same period increasing from 5.8% in 1983 to 34.5% in 2014 indicating also a move from hypoendemic to mesoendemic. The increase in Plasmodium carriage prevalence rate has also been significant in both sexes. The prevalence rate of Plasmodium infection in 2014 was almost three times the value in 1983 among male subjects (from 15.15 to 39%); and almost five times the prevalence rate in 1983 among female study participants (from 6.64% in 1983 to 31.7% in 2014) (Figure 1).

Evolution of intestinal helminth infections prevalence rates at Hevecam in 31 years

Overall intestinal helminth infections in Hevecam evolved in an opposite direction compared to malaria with a significant decrease in overall prevalence rate from 88.34 to 14.1% owing a 74.24% decrease in prevalence rate. This trend occurred also for each helminth parasites diagnosed in the area. Therefore, *A. lumbricoides* and *T. trichiura* infections prevalence rates dropped from 32.6 to 12.8% and from 44.3 to 3.2% respectively. Infections by hookworm which accounted for in 13.4% were not found in the 2014 investigations. The decrease in intestinal helminth infections was also significant in either sex group from 1983 to 2014.

DISCUSSION

This study aimed to assess the prevalence of malaria and intestinal helminthiasis in villages of the Hevecam agro-industrial company, and appreciate their evolutions in comparison to data obtained in 1983. The sample area included the same four villages which were also investigated in the 1983. Also, sampling methods used were the same used 31 years ago, namely spleen index measurement together with thin and thick blood smears for Plasmodium parasites detection for malaria diagnosis, and the Kato Katz technique for intestinal helminth diagnosis. These assessment tools used are the foremost recommended in field work for diagnosis of malaria (WHO, 2012) and intestinal helminthiasis (Hotez et al., 2006; Glinz et al., 2010).

Data obtained in the present study indicated low prevalence rates of intestinal helminthes whereas malaria infections were of moderate prevalence rate in the Hevecam area. The prevalence rates observed in this study implicate and confirm an overall good standard of hygiene in the study area but a low implementation of malaria control tracking system in the area. Two helminth species all belonging to the Nematodes group *A. lumbricoides* and *T. trichiura* were identified in the faeces of residents of the investigated villages though mostly at low infection intensities. These two species were the most prevalent 31 years ago (Moyou et al., 1984). However, hookworms which were also present in the previous data were not found in the present work indicating either their disappearance or whenever they exist may be at very infection intensity to be detected by the Kato Katz technique. Using more sensitive parasitological techniques such as formol-ether concentration or FLOTAC techniques may have diagnosed some cases (Glinz et al., 2010). The significant reduction of helminth infection prevalence rates as well as intensity of infections were a proof of better hygiene conditions as shown by the access to improved drinking water sources, and also the significant anti-helmintic chemotherapy prevention coverage. In all villages investigated, water suitable human consumption (potable water) was collected exclusively from piped water. Providing households to access to piped water has been demonstrated to reduce markedly the risk of soil-transmitted infection by 43 to 60%, while wearing shoes reduces hookworm infection risk by 71%.

Two Plasmodium species namely *P. falciparum* and *P. malariae* were identified in blood smears with *P. falciparum* being the predominant specie. Occurrence of *P. malariae* in the area indicated a complication of malaria transmission in the Hevecam villages since this specie was not found 31 years ago (Moyou et al., 1984). Since malaria infection were diagnosed using both malaria Rapid Diagnostic Tests complemented by a specie confirmation with blood smears, the prevalence rate recorded in this study may be a true value. However, the moderate prevalence rates were in accordance with the low rate of malaria transmission prevention tools use. In the Hevecam villages, the percentage of dwellers who used a mosquitoe bednet was less than half the 80% target to be reached in 2015 as recommended by the World Health Organization and approved by the Cameroon Ministry of Public Health for the achievement of the Millenium Goal through reduction of malaria under public health importance (WHO, 2012, 2013, 2014).

While comparing data of the present study to those obtained 31 years ago in the same villages, intestinal helminth infections had significantly decreased in the area while malaria infections evolved in opposite way from hypoendemicity to mesoendemicity level. This evolution has also been characterized by apparition of *P. malariae* and absence or disappearance of hookworms thus simplifying the intestinal helminthiasis profile. In 1983, *P. falciparum* was the only malaria pathogen identified while *A. lumbricoides*, *T. trichiura* and hookworms were the causative agents of intestinal helminthiasis reported (Moyou et al., 1984). Appearance of *P. malariae,* and disappearance of hookworms in the Hevecam 31 years after indicated an occurrence of a complex malaria epidemiological profile whereas intestinal helminth infection profile was becoming less complex. Nevertheless, *P. falciparum* and *A. lumbricoides* have remained the predominant parasites for malaria and intestinal helminthiasis respectively. *P. malariae* and *T. trichiura* are therefore secondary causative agents while hookworms were not recorded.

The significant increase in malaria infection from hypoendemic to mesoendemic level was indicative of lack or poor implementation of malaria control guidelines. This increase of malaria cases contrasts the statistics released in the 2014 WHO report which indicated that up to 2013, the number of malaria infections dropped to about 26%, and the average malaria infection prevalence had a relative declined of 48% in children aged 2 to 10 years (WHO, 2012, 2014). A proper implementation of WHO recommended control measures was expected to lower by one third the malaria-related mortality rate among under five years children in the African region (WHO, 2012, 2014). The proportion of the participants who had an ITN and sleeping under one were assessed in the present study through an household survey. The possession rate of ITN was far less than half of the 80% WHO Millenium target (WHO, 2013). However, results of the present study corroborate previous entomological data which showed that environmental modifications due to agro-industrial activities in Niete might have influenced vector distribution and the dynamics of malaria transmission leading to transmission occurring both in the dry and rainy season with the intensities peaking in the dry season (Bigoga et al., 2012). Also, the densities of Anopheles vectors seemed higher in the dry season than the rainy season (Bigoga et al., 2012). The Hevecam company has been therefore incited to provide more mosquito nets to prevent malaria transmission.

Prevalence of intestinal helminth infections showed a significant decrease between 1983 and 2014 probably due to significant improve in personal hygiene practices as well as improved access to safe water. The reduction in prevalence rate was estimated at 69.24%. Intestinal helminthiasis are primarily caused by the absence of safe drinking water, lack of hygienic behaviour, improper sanitary habits, poor faecal disposal systems, poor socio-economic status, and wide dispersion of parasites within human communities (Rai et al., 2000; Naish et al., 2012). The contribution of mass deworming and spontaneous practices was probably of greater influence in the decrease of helminthes infections in the Hevecam villages. In fact, the proportion of dwellers who swallowed one of the recommended anti-helminthic drugs at least once a year was greater than the 75% key target adopted by the World Health Organization for at risk-population by 2010 (WHO, 2002, 2012). Reduction of geohelminthiasis up to 73% has also been achieved in school-aged children through school-based survey in many health districts in Cameroon according (Tchuem et al., 2012, 2013).

Despite the low infection prevalence rate and overall low intensity of infection recorded in the present study, caution need to be taken in such clustered settlements where an outbreak of any communicable disease can occur at any time. Also, like heavy intensities of infections, a number of studies have suggested that even a moderate intensity of STH infections are considered a leading cause of sickness, absenteeism and disability adjusted life years (DALYs) lost as well as lost delayed physical growth and impaired cognitive development, particularly among school-children (Brooker, 2010; Curtale et al., 1998, 1999; Brooker et al., 2008; Bethony et al., 2006; Ostan et al., 2007; Murray et al., 2012). The magnitude of the burden of geohelminthiasis is often underestimated in most low income and middle income countries but it deserves to be given special attention because of its broad geographical distribution (WHO, 2012) and its negative health impact. Intestine inhabiting adult helminth have a significant health effect by interfering with the host's nutrition and inducing damage to the intestinal mucosa, therefore resulting in the host's reduced ability to extract and absorb nutrients from food which result in poor weight especially in children and women of child-bearing age (Bethony et al., 2006; Nokes and Bundy, 1994). Such impact implied that control system need to be sustained in the Niete area to lower the prevalence of intestinal helminth infections as well as other controllable communicable diseases. It is well known that preventive chemotherapy can eliminate infections of moderate and high intensity, but it does not prevent infection.

Therefore, reinfection often occurs rapidly after treatment as a result of poor sanitation, access to clean water and hygiene practices (Bartram and Cairncross, 2010; Jia et al., 2012). There is a need for combining preventive chemotherapy to other sustainable measures notably improvements to water, sanitation, and hygiene access and practices are highly recommended as a more effective elimination strategy of soil-transmitted helminth as public health problem in endemic areas (Bartram and Cairncross, 2010). Improving sanitation infrastructures coupled to good hygiene practices would ideally interrupt transmission of STH as well as other faecal-related infections and prevent the development of morbidity. Safe water access was shown to be operational in the Hevecam villages. Other efficient complementary measures such as sanitation access need to be implemented in the area.

The prevalence trends with age was in accordance to usually known data in endemic areas with a sharp increase from preschool-aged children to school-attending children followed by a marked decreased with adolescence. Such trend was also recorded in the data collected 31 years ago (Moyou et al., 1984). There were no standard sex-based differences in the prevalence of specific parasites infection among villages. Poly-parasitism by helminth parasites which occurred in 13.6% of participants followed a general rule in most intestinal helminthiasis endemic areas. Such co-infection was found in the study undergone in 1983 (Moyou et al., 1984). Also, the occurrence of co-infections by *Plasmodium* parasites, and one or two helminth parasites species as recorded were also reported 31 years ago in the Hevecam villages (Moyou et al., 1984). Such frequency of polyparasitic infections combining malaria parasites and helminth may have significant impact on the morbidity either by amplifying the clinical manifestations of each other diseases compared to mono-infection.

The evolution of malaria and intestinal helminth infections in the Hevecam scheme is certainly the consequence of the level of adhesion to recommended control strategies based on prevention and specific chemotherapy together with regular health education in the area.

Conclusion

This study raised that in 2014, malaria and intestinal helminth infections were mesoendemic and hypoendemic in the Hevecam agroindustrial complex respectively. When compared with previous data collected 31 years ago, malaria infection has significantly increased according to both parasitic infections as well spleen index, whereas intestinal helminth infections evolved in opposite direction decreasing from hyperendemic to hypoendemic. The present study indicated that *P. falciparum* was the leading malaria agent and *P. malariae* a secondary agent. Intestinal helminth infections were predominantly due to *A. lumbricoides* and secondary to *T. trichiura* with occurrence of co-infection by the two parasites species. These data appeal for implementation of an adequate integrated safeguard for disease surveillance in the Hevecam company which may need interventions of both the specific national control programs, the Hevecam administrations and health researchers.

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Conflict of interest

The authors of this manuscript declare that there is no conflict of interests regarding the publication of this research work.

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