Original Research Article

Epidemiological analysis of the 2019 dracunculiasis outbreak in the Liwi area, Salamat province (Chad): evidence of the role of pets

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ABSTRACT

Aims: Dracunculiasis is a neglected disease caused by a parasitic nematode, *Dracunculus medinensis*, also called the filaria of Medina. An outbreak of this disease occurred in the Salamat province in Chad in 2019, while the eradication of this disease worldwide was in its final stage. The outbreak occurred in the Bogam village (Liwi area), where this disease has never been reported in the past. The present work is aimed at identifying the factors that would have favored that outbreak, and the constraints that delay the eradication of dracunculiasis in Chad.

Study design: Retrospective study
Place and Duration of Study: The data retrospectively analyzed are those recorded during the census of patients by the Chadian National Guinea Worm Eradication Program (PEVG), from 2019 to 2020, and supplemented by those contained in the registers of previous years. The analyzes were carried out in N'Djamena, between July and November 2021, within the Laboratory of the Faculty of Medicine.

Methodology: The census of patients was carried out during a survey from 2019 to 2020 by PEVG. These data have been supplemented by those contained in the registers of previous years. Data were first stored in a Microsoft (Excel 2007 Software) spreadsheet, then transferred to the SPSS version 20.0 Software, after removal of outliers and input errors. The Chi-Square test (χ^2) made it possible to compare the percentages at the threshold of $p<0.005$.

Results: In summary it appeared that 52.4% of the patients were 5 to 20 years old, 62% were female, 90.48% lived in Bogam, 95.2% used dirty water from ponds and traditional wells, 33% were farmers, and 33% were breeders. In addition, most of the patients became infected between March and November 2018. The following risk factors combined could explain the Bogam 2019 dracunculiasis outbreak namely: cohabitation with infested pets coming into contact with water, the behavior of young and active people with respect to water, consumption of unhygienic water, gender, lack of containment of some patients that could enter water barefoot, period extending from April to September.

Conclusion: This work highlighted the obvious role of pets as a reservoir on the one hand, and the effectiveness of the PEVG in the fight against dracunculiasis through a treatment protocol combining a wet bandage associated with oral diclofenac + amoxicillin +

paracetamol.

Keywords: Guinea worm, emergence, tropical neglected disease, risk factors, eradication, Chad

1. INTRODUCTION

Dracunculiasis or guinea worm disease is one of the neglected tropical diseases. It is caused by a parasitic nematode, *Dracunculus medinensis*, also called little dragon of Medina. This nematode is transmitted through the consumption of water contaminated by copepods [1]. Human infestation has been known since Antiquity in India, Greece and the Middle East; female worms have been found in Egyptian mummies [2]. At the early 20th century, dracunculiasis spread to many countries in Africa and Asia; around 50 million cases were estimated by the 1950s. As a result of concerted efforts by the international community and endemic countries, the number of dracunculiasis cases was reduced to about 96,000 in 1999 [3]. In 2004, the total number of reported cases was 15,585 [4]. Over the years, this number has fallen from 3.5 million to 25 in 2016. However, the eradication objective has come up against and continues to come up against several constraints, namely social unrest, insecurity, and a persistent variety of epidemiological problems. Dracunculiasis has long been endemic in Chad, probably nearly 100 years ago, and was introduced from neighboring countries, via population movements; indeed, some crossed Chad to go to Mecca [2].

For a long time, dracunculiasis was not a notifiable disease; therefore very little data exists on this pathology in Chad. Those that are available do not reflect the actual physionomy of the disease. In 1991, the Chadian Guinea Worm Eradication Program (PEVG) was established; however, it was not until 1993 that the national case-finding survey was launched. This survey indentified 6 endemic provinces, namely the Moyen-Chari, the Mayo-Kebbi, the Salamat, the Guéra, the Logone Occidental, and the Chari-Baguirmi [5]. A total of 1231 cases distributed in 106 villages were then identified [5]. The eradication of dracunculiasis worldwide is now in the final stage, but outbreaks of this parasitosis in the canine population makes this elimination program difficult [6]. From January 2017 to June 2018, Hopkins *et al.* [7] reported 30 cases in Chad and Ethiopia combined.

From January to June 2018, only 3 cases have been identified in Chad and South Sudan combined, and one (1) case in Angola. In 2019, 48 patients were found in Chad, including 24 (50%) in the district of Aboudeia, Salamat province. Among the 24 patients from Aboudeia, 21 came from the Liwi area, including 19 from the Bogam village alone (table I) although this disease had never been reported there before [8].

As part of the eradication of the Guinea worm in Chad, this work has two objectives, to identify: on the one hand the factors that would have favored the 2019 outbreak of dracunculiasis in the Salamat province in general and in the Bogam village in particular; and on the other hand, the constraints that delay the eradication of dracunculiasis in Chad.

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2. MATERIAL AND METHODS

2.1. Study site

Bogam is located 20 km from Liwi (10,093056 North latitude and 19,437222 East longitude). It is a surveillance level 3 village, in the epidemiological surveillance scale of the Ministry of Health and Solidarity of Chad, from the district of Aboudeia, Salamat province (South-East of Chad). It has neither a source of potable drinking water, nor a school. Located on the border of Zakouma Zoological Park (Figure 1), it is subject to incursions of wild animals from this protected area. The climate of our study area includes a rainy season (May to September) and a dry season from October to April [9]. The Salamat region is semi-arid, with an average annual temperature of 28.4°C and an average annual rainfall of 821.8 mm [10].

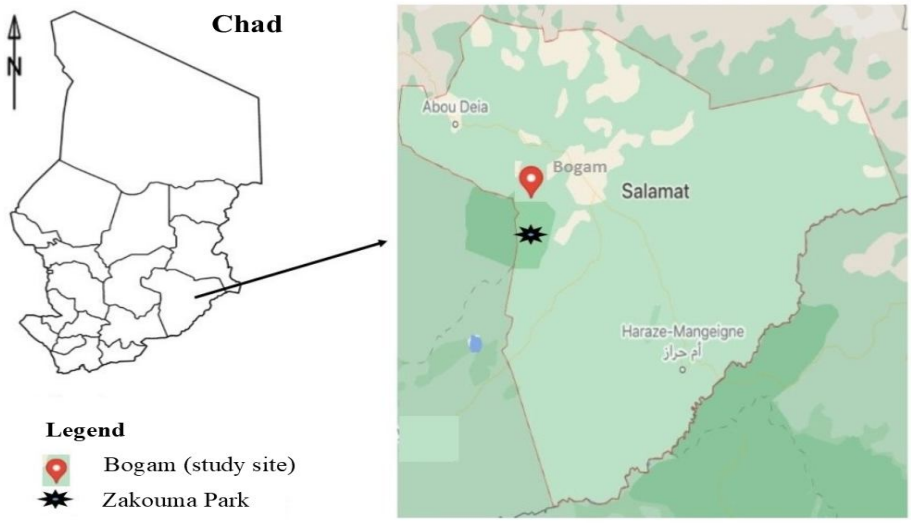

Figure 1: Study site [11].

2.2. Type and period study

This retrospective study analyzes data collected from January to December 2019.

2.3. Study population

The study population is made up of residents of Bogam and its surroundings.

2.4. Inclusion and exclusion criteria

In a first sorting, the patients that were included in this study were registered in the Bogam Health Center documents as suffering from dracunculiasis. To avoid interference with other diseases that could introduce bias to the analysis, we excluded from this first batch patients with other declared or visually detectable pathologies.

2.5. Study parameters

Socio-demographic and clinical parameters were considered in the current study. The sociodemographic parameters included age, gender, village, quality of water used, activity or profession of the patient. The clinical parameters were: symptoms, containment, worm emergence site, hospitalization duration, drugs prescribed, worm emergence period.

2.6. Sampling technique

The census of patients was carried out during a survey from 2019 to 2020 by PEVG. These data have been supplemented by those contained in the registers of previous years. Data were first stored in a Microsoft (Excel 2007 Software) spreadsheet, then transferred to the SPSS version 20.0 Software, after removal of outliers and input errors. The Chi-Square test (χ^2) made it possible to compare the percentages at the threshold of $p<0.005$.

2.7. Ethical and administrative considerations

This project has been evaluated and authorized by the staff management of the Faculty of Human Health Sciences and the PEVG (N'Djamena), while ensuring the confidentiality of patients' results.

3. RESULTS

3.1. Distribution of dracunculiasis patients in the administrative districts (table 1)

In Chad, 48 dracunculiasis patients were identified in 2019 amongst which 24 (50%) were from the Abondeia district (Salamat province) i.e. 21 from the Liwi area, including 19 (39.58%) from Bogam village.

Table 1: Distribution of dracunculiasis patients in the administrative districts in 2019.

Locality	**Number of patients (%)**
Aboudeia	24 (50)
Bailli	2 (4.2)
Bousso	2 (4.2)
Dourbali	1 (2.1)
Kouno	1 (2.1)
Danamadji	1 (2.1)
Korbol	1 (2.1)
Kyabé	8 (16.6)
Sarh	4 (8.3)
Haraze	3 (6.2)
Am-Timan	1 (2.1)
Total	48 (1..)

3.2. Distribution of dracunculiasis patients in the Liwi area according to socio demographic parameters (table 2)

Most patients 11/21 (52.4%) were 5-20 years old. The frequencies of patients decreased significantly ($p = 0.01$) with age. Female individuals were relatively ($p = 0.7$) more affected (n

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= 13: 62%) than males (n = 8: 38%). Among the 25 villages grouped in the Liwi area, dracunculiasis patients were only found in three, and more prevalent in Bogam (19/21 cases: 90.48%). Moreover, almost all patients in the Liwi area (20/21 cases: 95.2%) used dirty water. In decreasing order, they were farmers (7/21: 33.3%), breeders (7/21: 33.3%), farmers and fishermen (4/21: 19.1%), and unoccupied (3/21: 14.3%).

Table 2 : Distribution of dracunculiasis patients according to socio-demographic parameters.

Socio-demographic parameters		**Number of patients**	**(%)**	**P value**
Age (in years)	5-20 21-40 41-60 61-70	11 5 4 1	(52.4)[a] (23.8)[b] (19)[c] (4.8)[d]	0.01
Gender	Male Female	8 13	(38) (62)	0.7
Village	Bogam Liwi Tar	19 1 1	(90.48)[a] (4.76)[b] (4.76)[b]	0.001
Water used	Dirty water (ponds, wells) Potable water	20 1	(95.2[a] (4.8)[b]	0.002
Activity/profession	Farmer Breeder Farmer and fisherman Unoccupied	7 7 4 3	(33.3) (33.3) (19.1) (14.3)	0.97

Flagged percentages of the same letter on the same column are not statistically significant.

3.3. Affected villages of the Liwi area according to clinical parameters (table 3)

Most of the patients (15/21: 76.43%) vs 6 (28.57%) were placed in quarantine conditions. The frequency of associated symptoms observed decreased as follows: A (itch sensation) + B (pains) + C (burning sensation) + D (presence of blisters) in 7 (33.33%) patients > A+B+D in 6 (28.57%) patients > A+B+C in 5 (23.82%) patients > A+D, A+C+D+E (wounds), and A+B+E in 1 (4.76%) patient per association. It is worth noting that all patients suffered from itch sensation, while pains, blisters, and burning sensation were declared by 90%, 71% and 66% patients respectively.

Also, it was noticed that worms emerged mostly from legs, 19: 90.48% cases versus 2 (9.52%) from upper limbs. Another finding was that most of the patients (10/21: 47.6%) suffering from dracunculiasis were hospitalized for 15 to 24 days; but in general, the hospitalization duration extended from 4 to 43 days. Regarding drug prescription to treat dracunculiasis, it was noted that wet bandage associated with oral diclofenac + amoxicillin + paracetamol was administrated to 17 (80.9%) patients. It also appeared that in 10 (47.6%) and 7 (33.3%) patients, worms emerged in May and June respectively. In general, the emergence period extended from April to August (figure 2).

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Table 3 : Distribution of dracunculiasis patients according to clinical parameters.

Clinical parameters		Number of patients	%	P value
Patient Containment	Yes No	15 6	76.43[a] 28.57[b]	0.043
Symptoms	Itch+pains+burn+blisters Itch+pains+blisters Itch+pains+burn Itch+blisters Itch+wounds+burn+blisters Itch+pains+wounds	7 6 5 1 1 1	33.33 28.57 23.82 4.76 4.76 4.76	0.07
Worms emergence site	Legs Upper limbs	19 2	90.48[a] 9.52[b]	0.002
Hospitalizationduration (in days)	4-14 15-24 25-34 35-43	5 10 3 3	23.8 47.6 14.3 14.3	0.2
Drugs prescribed	Wet bandage+diclofenac+amoxicillin+paracetamol Diclofenac+amoxicillin+paracetamol Ibuprofen+diclofenac+amoxicillin+paracetamol Wet bandage+amoxicillin+paracetamol	17 2 1 1	80.9[a] 9.5[b] 4.8[c] 4.8[c]	0.0001
Worm emergence period	April May June July August	1 10 7 2 1	4.76[d] 47.6[a] 33.33[b] 9.52[c] 4.76[d]	0.001

Flagged percentages of the same letter on the same column are not statistically significant.

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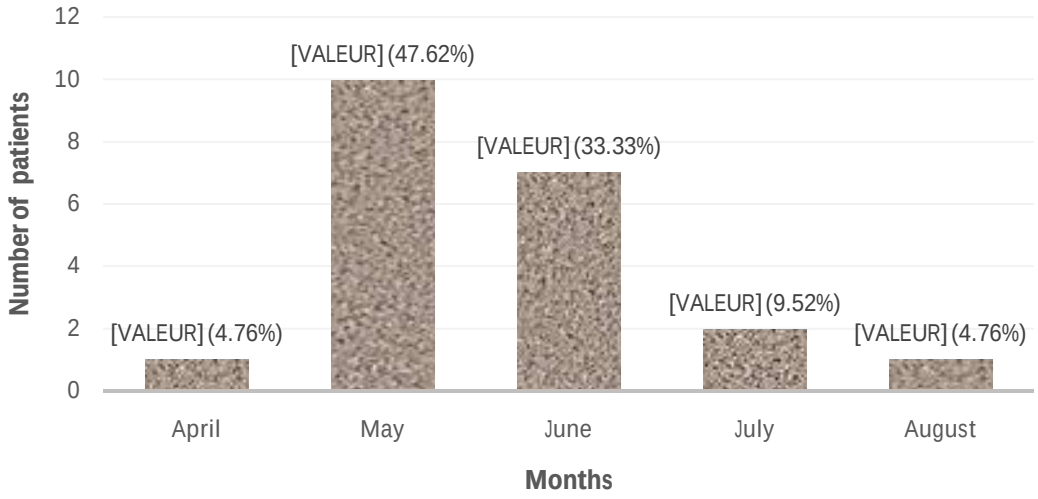

Figure 2 : Worm Emergence period

3.4. Variation in the number of dracunculiasis cases from 2015 to 2020 (table 4)

The analysis of the registers showed a monomodal profile of variation, in the number of humans declared as dracunculiasis patients from 2015 to 2020. This profile peaked in 2019, in both Chad (48 cases) and in the Salamat province (27 cases). On the other side, dog infections in Chad looked the same as in humans , but at a scale of 40 to 122 times depending on the year. Dog infections were also found in the Salamat province, from 2018 to 2020. Regarding cat infections, it increased annually from 5 in 2015 up to 63 cases in 2020 in Chad. Only 2 cases were found in the Salamat province.

Table.4. Human and pet infestation dracunculiasis cases from 2015 to 2020.

Host Species	Locality	Years					
		2015	2016	2017	2018	2019	2020
Human	Chad	8	16	15	17	48	12
	Salamat	1	7	2	7	27	3
Dog	Chad	503	1011	817	1040	1935	1472
	Salamat	-	-	-	6	9	5
Cat	Chad	5	11	13	47	46	63
	Salamat	-	-	-	-	2	-

4. DISCUSSION

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The current retrospective study aimed to contribute to the eradication of dracunculiasis in Chad. Regarding the 2019 outbreak in the Bogam village, we searched on the one hand to identify its determinants, and on the other hand to assess the impact of the Chadian Guinea Worm Eradication Program. A total of 48 patients were identified in Chad in 2019 (table 1), including 21 individuals in the Liwi area amongst which 19 came from Bogam . In Bogam, it was an emerging disease [8] since in the past, the Liwi area had not recorded any confirmed cases of dracunculiasis. Thus, the eradication of the Guinea worm disease is still a hot topic in Chad. At a national level, it was a re-emergence. Indeed after a few years without any notification of human dracunculiasis cases, Chad faced an upsurge in 2010 [12]. This upsurge was characterized by a high prevalence in pets (dogs and cats). It is important to note that for a few years, Bogam has become a transit village for nomadic herders. The back and forth movements of the latter are seasonal and linked to the search for good pasture for their livestock. The nomadic herders park in Bogam for weeks before continuing their journey. In their movements they also often settle in areas of southern Chad, e.g. Biobe, Kyabe and Danamadji, known a few years earlier as endemic for dracunculiasis [5]. The occurrence of this zoonosis [8] in Bogam would therefore be a result of the contamination of its unhygienic water points.

The current study has revealed a statistical ($p = 0.01$) relationship between infestation and the patient age, the proportion of patients decreasing with their age (table 2). This result differs from that of [13] who reported in Mali, a morbidity rate of 62.83% in patients aged 15 years and over versus 34.69% among those aged 5 to 14. Similarly, 58% of sufferers in Nigeria were 11 to 49 years old [14]. In the Chadian context, young people and those of working age were predominantly among the sick. For young people, it is due to their frequent bathing in stagnant dirty water [15, 16], where they can accidentally and further become infested by drinking these waters. For people of working age, it is important to note that farmers are often in contact with water because of the floods. During their labors in this semi-arid environment [10], together with breeders, they would more often sustain themselves with unhygienic water [17], thus increasing the risk of infestation.

The proportion of sick females (62%) was relatively ($p = 0.7$) higher than that of males (38%). In fact in Bogam, women are more concerned than men (mainly breeders) by water related activities, and are therefore more infested [2].

Considering the three villages Liwi, Tar and Bogam, the latter brought together significantly more patients (90.5%). Indeed, this locality, irrigated by a tributary of the Chari River and devoid of a safe water point, represents an environment at high risk of transmission [18]. Almost all patients in the Liwi area (20/21: 95.2%) declared that for various domestic needs (drink, cooking, etc.) they sourced water from ponds and traditional wells dug into the beds of dried up streams. Moreover, by entering the water barefoot, these patients re-contaminate water, and thus increase the risk of inhabitant infestation.

In Bogam, worms emerged mainly in May and June on the one hand, and from legs (90.48% cases) on the other hand (table 3). The latter result corroborates data from literature [12, 19]. It is suggested that this preference for legs facilitates the transmission of the parasite to the intermediate copepod hosts which are aquatic organisms. The incubation period for dracunculiasis is 10 to 14 months [12]. So as the maximum emergence of the worms occurred in May and June 2019, it could be inferred that the period of maximum infestation was between April and September 2018 i.e. from the late dry season to the rainy season [9]. Therefore, dracunculiasis is seasonal in nature [20].

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In this study, 6 (28.57%) patients were not isolated; thus possibly entering the water barefoot, and represented an undeniably serious risk factor of water re-contamination (OMS, 2019) [21].

A higher proportion (47.6%) of patients were hospitalized for 15 to 24 days. This duration could be extended for up to 43 days, probably already due to the number of worms and the time required to extract them.

Regarding symptomatology, we revealed that: (1) itches were permanent in dracunculiasis, and (2) most of the patients (33.33%) suffered from “itches + pains + burns + blisters”. The association of “blisters + wounds + burns” shows the dangerousness of the guinea worm; this calls for rapid and good patient care without which the vital prognosis could be affected due to secondary infections. Many patients recovered thanks to the treatment association of a wet bandage and oral diclofenac + amoxicillin + paracetamol. From 2015 to 2020, the profile of variation in the number of dracunculiasis patients in the Salamat region followed the trend of the evolution of cases throughout the country. After the peak in 2019, a drastic drop in incidence was noticed in 2020. This decrease was supported by the treatment recommended by the PEVG, mainly combining a wet bandage and the administration of “diclofenac + amoxicillin + paracetamol”. During the same period a spike in dog and cat infestations was also reported in Chad and Salamat in 2019. These pets represent therefore a serious reservoir of guinea worm disease.

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4. CONCLUSION

The current study aimed to identify the factors that favored the 2019 outbreak of dracunculiasis in the Salamat province in general, and the Bogam village in particular, and then the constraints that delay the eradication of this disease in Chad. Finally, factors that together have favored this outbreak were: cohabitation with infested pets coming into contact with water, very young children and people of working age, consumption of unhygienic water, gender, activities in flooding areas, lack of isolation of patients that possibly enter the water barefoot, and the transition period from the dry to the rainy season. This work highlights the evident role of pets in the 2019 outbreak of dracunculiasis in Bogam and the effectiveness of the PEVG in the fight against this disease through the treatment.

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