Case Study Brief
You are working as an Epidemic Intelligence Services Officer for the World Health Organization and you have received a report of a suspected outbreak of Guinea Worm Disease in Sudan.

Guinea Worm Disease Outbreak in Mazmum, Sudan
There has been a reported outbreak of Guinea Worm Disease in a small town in Sudan and the local hospital has recently reported treating a total of 319 patients over the past 12 months with the disease.

Background Information
Mazmum is a small town in the southern part of the Central State in Sudan, at 12"15'N, 33"33'E (Figure 1). It has 17313 inhabitants in two residential blocks: 9165 in the Western Block and 8148 in the Eastern Block. The town is the administrative and commercial centre for the Mazmum Rural Council, which covers an area of about 10000 km^2 and includes several hamlets inhabited by a total of 22036 sedentary farmers who cultivate various crops, mainly dura (*Sorghum ztulgare* or guinea corn) and sesame during the agricultural season (June-October, both for subsistence and cash. There is an annual influx of about 80000 seasonal agricultural workers, attracted by expanding mechanical crop production schemes in the area,). This temporary migrant labour force includes tribes from different parts of Sudan and from neighbouring African countries such as South Sudan, Ethiopia, Chad and Nigeria.

Nomadic tribes (mainly camel herders), with a population of 40692, also reside in Mazmum Rural Council area during the rainy season but in the dry season they move along the banks of the Blue Nile. Over the past few years the area has been home for refugees and displaced people from southern Sudan and neighbouring African countries. These populations interact regularly with the sedentary/fixed population of the Western and Eastern Block of Mazmum, either to share water sources or to attend weekly markets.

The study area is woodland savannah with clay soil and an annual rainfall of 500-600 mm. The rainy season starts at the beginning of June and ends by the end of September, and is usually followed by a long dry season (Figure 2). Some residents of Mazmum town obtain rain water by roof collection if they live in one of the few buildings with a corrugated iron roof but most residents collect rain water from the natural Soba pool (1 in Figure 1) and from *kurkurs*, natural trenches in the rocky hills that hold rain water (7 and 8 in Figure 1). Soba pool is rather shallow and water drawers have to wade into the pool before they can reach a depth that enables immersion of their water containers. Collection of water from the deep *kurkurs* is usually completed by two individuals. One steps into the water and fills a water container and then hands it to the other, who waits on the edge of the *kurkur*.

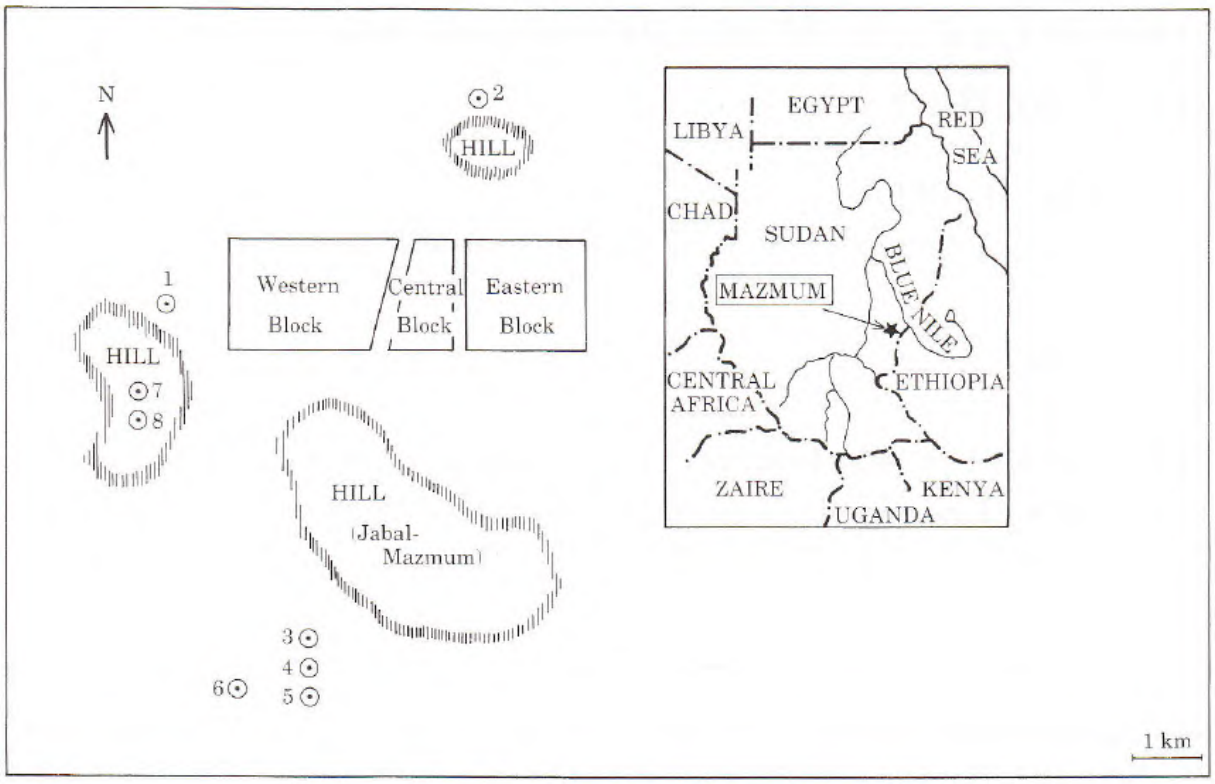

Figure 1. Sketch map of Mazmum town, showing the eight main water sources (⊙): the natural Soba pool (1), the five *hafirs* or artificial ponds (2-6) and the two *kurkurs* or water-filled trenches (7 and 8). Western Block residents tend to use water sources 1, 7 and 8; whilst the Eastern Block commonly use water sources 2-6.

During the dry season (November-May) *hafirs* (artificial ponds) are opened for public use and form the main water sources for the town (2-6 in Figure 1). They are closed again once the rainy season starts. Each *hafir* acts as a reservoir for collection and storage of up to 500000 m^3 of rain water for human and animal consumption. *Hafirs* are controlled by the local government which keeps a guard in each *hafir* who operates an engine-driven pump and collects fees from the water collectors. The Soba pond and the *kurkurs* are under no such control. Water from all these sources is collected either (i) directly by a member of the household (usually teenage daughters or other female family members) who will taste the water from the source or a small amount in the container prior to collection to assess palatability; or (ii) by water vendors who collect water in small tanks mounted on donkey-driven carts. In the houses, water is stored in jars or barrels.

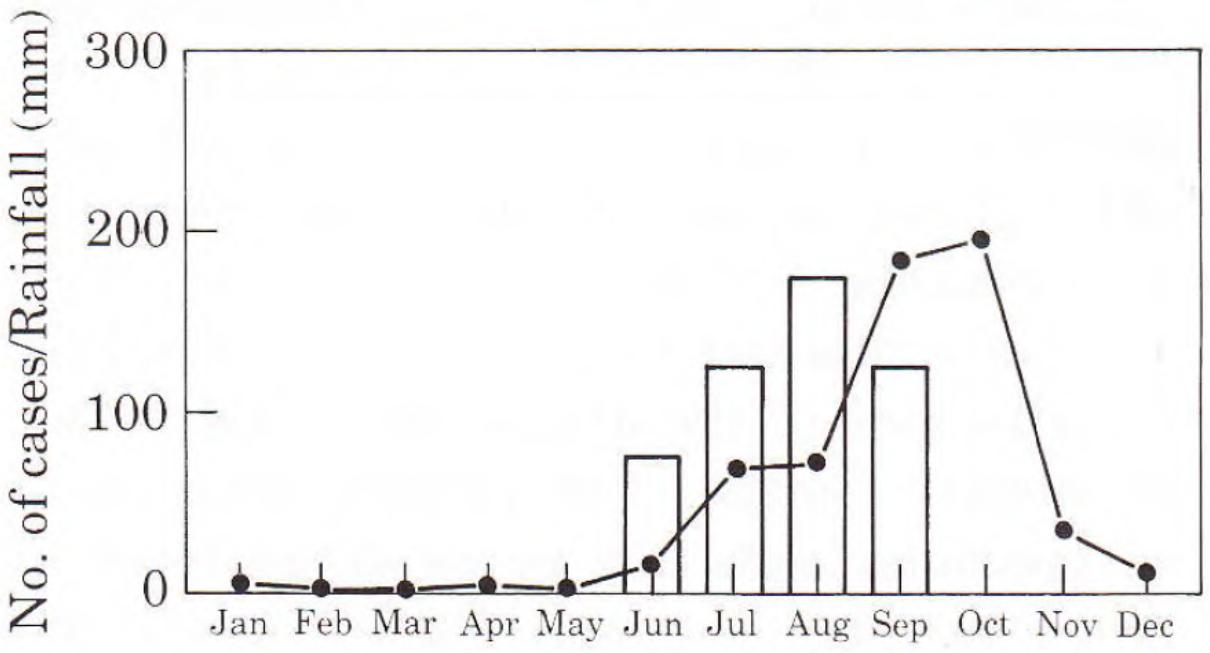

Figure 2. Guinea Worm Disease cases (––●––) seen at Mazmum Hospital and the rainfall (☐) over the same period.

Investigation of the Outbreak

As part of your outbreak investigation you review the clinical and epidemiological data from the 319 patients treated in the local hospital, conduct a household survey covering a sample of 757 subjects, interviews with 15 key informants from different nomadic populations/camps, a school survey covering 1390 school children, and examine all water sources. All 319 hospital cases were interviewed and asked about their personal, domestic and occupational activities, signs and symptoms of ill health, and predominant sources for collecting drinking water. A survey was conducted in Mazmum town and a map was drawn of the town and every 10th house visited. The age, sex and occupation of each member of the visited household were recorded. Any household members who had Guinea Worm Disease or who had had an episode of the disease during the past 12 months were noted. Information about the source of drinking water for the household and the individual(s) who collected the water was also taken. During the household survey, you randomly select 500 households to complete an interviewer-led standardised questionnaire assessing the knowledge, attitude and practice in the management of Guinea Worm Disease. The questionnaire was used to record the infection history of the respondents (time of last infection), normal source of water and any treatment of water, perception of the cause of Guinea Worm Disease, information on medical/herbal treatment used, and knowledge of the disease.

Nomad camps were selected by convenience, based on recommendations from the Mazmum Rural Council and local veterinarians or nomad representatives in selected districts. Semi-structured questionnaire-based interviews were conducted with 15 conveniently sampled key informants from each Nomadic population/camp. The key informants were asked about their general health, knowledge of Guinea Worm Disease transmission and prevention, migration patterns and potential interactions with sedentary/fixed populations, and the community water consumption practices of the nomadic population/camp. In addition, key informants were shown

a photograph of an emerging Guinea Worm and asked about awareness of or having ever seen a Guinea Worm.

All the schools in Mazmum town comprising four primary schools (for ages 7-13 years) and two general secondary schools (for ages 14-17 years) were surveyed. In all these schools, the students who had had Guinea Worm Disease during the past 12 months were enumerated. The Mazmum schools are attended by children from other villages and hamlets in which there have been no confirmed or suspected cases of the disease. Schools are closed during the rainy season to allow children to return to their home villages and hamlets to help their families in agricultural activities. Finally, the eight sites which supply the town with drinking water during the dry season (Figure 1) were visited. Water samples were collected from each site and passed through a standard 149-µm-mesh sieve. Material caught in the sieve was examined under a dissecting microscope and the number of copepods/litre determined.

Outbreak Investigation Findings

Hospital-Based Data

The ages of the Guinea Worm Disease patients ranged between 2 and 87 years. No cases younger than 2 years of age were found. About half (52.7%) harboured just one worm. The lower limbs were involved in 94.0% of cases, 8.7% had worms in the upper limbs, 5.6% in the trunk and 1.9% in the pelvic region. There were no cases of worms in the head or neck regions. Secondary bacterial infection occurred in 65.0% of cases but there were no cases of tetanus or other serious complications. Most (85.5%) of the patients questioned stated that due to their Guinea Worm Disease infection they had been unable to perform their normal work for variable durations. The mean duration of disability was 6.5 weeks (maximum 28 weeks). The disease caused severe disability (inability to perform normal work for more than 4 weeks) in a significantly higher proportion of males aged ≥30 years than in females of the same age group [78/116 (67.2%) *v*s. 14/41 (34.1%); P<0.05].

Household Survey Data

Table 1 shows the incidence of Guinea Worm Disease during the study period. The overall incidence of Guinea Worm Disease during the study period was 23.4%. Incidence in the Western Block of Mazmum was significantly higher than that in the Eastern Block [163/656 (24.8%) *vs.* 14/101 (13.9%); χ^2=5.90, P<0.05]. There was no significant difference between the overall incidence in males (94/398=23.6%) and that in females (83/359=23.1%), (χ^2=0.03, *P*>0.05). However, the incidence in females aged 10-19 years was significantly higher than that in males of the same age group [36/98 (36.7%) *vs*. 21/96 (21.9%); χ^2=5.16, *P*<0.05]. Sex differences in the other age groups were not statistically significant. Incidence in children less than 10 years of age was significantly lower than in older subjects [31/239 (13.0%) *vs*. 146/611 (23.9%); χ^2= 12.435, *P*<001). There was no significant association between incidence and any particular water source except for the incidence among subjects in households that obtained their drinking water from Soba natural pool (110/381=28.9%), which was higher than in those who did not use this pool (67/373=18.0%), χ^2=12.05, *P*<0.01).

Table 1. Incidence of Guinea Worm Disease in Mazmum

Age (years)	Males		Females		Total	
	N	No. (%) infected	N	No. (%) infected	N	No. (%) infected
<10	127	14 (11·0)	112	17 (15·2)	239	31 (13·0)
10–19	96	21 (21·9)	98	36 (36·7)	194	57 (29·4)
20–29	50	13 (26·0)	46	8 (17·4)	96	21 (21·9)
30–39	35	12 (34·3)	48	10 (20·8)	83	22 (26·5)
40–49	41	18 (43·9)	26	8 (30·8)	67	26 (38·8)
50–59	24	7 (29·2)	20	3 (15·0)	44	10 (22·7)
60+	25	9 (36·0)	9	1 (11·1)	34	10 (29·4)
Totals	398	94 (23·6)	359	83 (23·1)	757	177 (23·4)

Knowledge, Attitude and Practices Questionnaire Data

Two-hundred and eighty respondents (56.0%) from the random sample of 500 head of households reported that they had been infected with Guinea Worm Disease in the past. The majority of respondents (123/280; 43.9%) that had been infected in the past believed that the disease was present in the blood, whilst 40.4% (113/280) believed that it was from infected water (Table 2). Over half (145/280; 51.8%) of infected respondents reported using antibiotics for treatment and over a third (104/280; 37.1%) reported using herbs. When respondents were asked what predisposes one to susceptibility to Guinea Worm Disease, over half (54.6%; 273/500) stated inherited susceptibility (Table 2).

Nomad Questionnaire Data

Thirteen (87%) of 15 nomad camps consumed water from unsafe sources and only five (33%) of the 15 Nomad camp key informants knew about Guinea Worm Disease or recognised the Guinea worm from the photograph.

School Survey Data

After adjusting for age, the incidence in primary school children was significantly lower than that in children of the same age range in the household survey [153/1133 (13.5%) *vs.* 52/184 (28.3%); χ^2 = 26.22, P< 0.001]. Similarly, incidence among secondary school children was lower than that in children in the same age range in the house survey [17/257 (6.6%) *vs.* 18/54 (33.3%); χ^2=31.90, P<0.001]. It was not possible to obtain accurate records in the school survey for absenteeism caused by the disease but the sample of hospital patients studied included 40 school children, 17 (42.5%) of whom had been absent from school for ≥4 weeks due to the disease.

Water Sources Survey Data

Examination of all the water samples showed Cyclops spp. The density of copepods was relatively high in the natural pool (36 copepods per litre) and the *kurkurs* (29 copepods per litre); the counts in samples from *hafirs* were lower at 10-16 copepods per litre.

Table 2. Response to Selected Survey Questions by Respondent

Survey questions	Responses
What caused the guineaworm infection you had?	
Inherited in the blood	123(43.9%)
Infected water	113(40.4%)
Dont know	32(11.4%)
God's doing	12(4.3%)
Total	280(100%)
How did you treat?	
Antibiotics	145(51.8%)
Herbs	104(37.1%)
Shea butter	17(6.1%)
Palm oil	9(3.2%)
Nothing	5(1.8%)
Total	280(100%)
Why are some people susceptible to guineaworm infection?	
Inherited susceptibility	273(54.6%)
Use of bad water	186(37.2%)
Dont know	41(8.2%)
Total	500(100%)
What age is more susceptible?	
Any age	483(96.6%)
15+males and females	14(2.8%)
15+ males	2(0.4%)
15	1(0.2%)
15+females	-
Total	500(100%)
Can guineaworm infection be prevented?	
Yes	477(95.4%)
No	23(4.6%)
Total	500(100%)
Ways of preventing guineaworm disease	
Drinking good water	228(45.8%)
Drinking borehole water	104(20.8%)
Filtering all drinkable water	57(11.4%)
Praying to God	42(8.4%)
Boiling and filtering water	36(7.2%)
Treating infected people	33(6.6%)
Total	500(100%)

1. State the correct Latin name of the disease and briefly describe the disease including the pathogen, vector, life cycle and incubation period, primary mode of transmission, and the signs and symptoms of the disease ?

2. Briefly describe the epidemiology of Guinea Worm Disease over the past 30 years?

3. Briefly describe the global public health efforts related to the changing trends in the epidemiology of Guinea Worm Disease?

4. Figure 2 suggests a seasonal pattern to the outbreak. Briefly discuss some of the factors that may account for the observed seasonality in Mazmum ?

5. Briefly discuss why you think that were no cases of Guinea Worm Disease in children under the age of 2 years?

6. Briefly discuss why you think the incidence of Guinea Worm Disease was significantly higher in females aged 10-19 years compared to males of the same age?

7. Briefly discuss why you think that the incidence in the Western Block of Mazmum was significantly higher than that in the Eastern Block?

8. Develop a public health programme for Guinea Worm Disease in Mazmum. Discuss the important aspects of the programme such as surveillance, health education, case management, health education, and safe water source interventions and vector control. Consider the needs and characteristics of both the sedentary/fixed and nomadic Mazmum populations in your answer.