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Public health importance and risk factors for cercarial dermatitis associated with swimming in Lake Leman at Geneva, Switzerland

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SUMMARY

Fifteen cohorts of healthy bathers were recruited at four Lake Leman beaches between 3 July and 23 August 1996 to assess the public health importance of cercarial dermatitis in Geneva, Switzerland. Telephone follow-up interviews were carried out after 2–7 days. Overall, 153 bathers out of 555 reported probable cercarial dermatitis at follow-up. Median daily attack rate was 27·7% (2·2–57·7%). Of the cases, 11·1% noticed more than 30 skin lesions, 19·6% described severe itching, 50·3% used a drug treatment, 3·9% visited a doctor and 15% claimed they would reduce their bathing activities. History of cercarial dermatitis, time spent in the water, hour of the day, barometric pressure and maximum daily atmospheric temperature predicted disease occurrence in multivariate analysis. While a benign disease, cercarial dermatitis may have a negative impact on the local water recreation industry. The identification of risk factors for the disease may help produce better preventive recommendations for the bathers.

INTRODUCTION

Cercarial dermatitis ('swimmers' itch') is a common, neglected, and non-communicable cutaneous disease caused by the penetration of the skin by cercariae of some non-human parasitic trematodes of the family Schistosomatidae [1].

The life cycle of these worms is similar to those of human schistosomiasis. Generally male and female adults live in the portal vessels of aquatic birds. The gravid females produce eggs that are excreted in the faeces. If the eggs reach a body of water, they hatch and liberate a miracidium that swims about seeking an appropriate intermediate snail host. In the mollusc, the miracidium develops and gives rise to thousands of cercariae. Under favorable microconditions of temperature and light, the cercariae leave the snail and swim freely into the surrounding water. They die within a day if they are unable to locate a definitive vertebrate host and penetrate its skin. The life cycle is completed when the organisms mature to adult males and females in the new definitive host [1, 2]. Maturation is impossible in humans. Nevertheless, persons exposed to contaminated waters may become dead-end hosts when cercariae accidentally penetrate the skin and die.

The invasion of the exposed skin by cercariae may produce an immediate prickling sensation that lasts for about 1 h. The precocity and intensity of the following hypersensitivity response depends on the number of previous contacts with cercariae. In a primary infection, the skin reaction is either inapparent or mild. Small and transient macules or maculopapules develop after 5–14 days. In re-exposed persons erythematous papules or papulovesicules typically appear within 12–24 h. Urticarial-like lesions

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are common. Itching is severe and may cause insomnia. The eruption resolves over 1–3 weeks [3–6]. Rarely, massive infections cause fever, limb swelling, nausea and diarrhoea [7]. Diagnosis relies on clinical and epidemiologic data. The treatment of the dermatitis is symptomatic and relies on antipruritic topical preparations [1, 2]. Systemic antihistamines and corticosteroids are useful in the case of a massive infestation.

Cercarial dermatitis has a widespread distribution in temperate and tropical areas of the world [1, 2, 8–11]. In Asia, it is sometimes a debilitating occupational disease among rice farmers [12–15]. In Europe and the USA, it is seen as an emerging problem associated with swimming and other aquatic activities [1, 2, 7, 9, 11, 16]. In Switzerland, cercarial dermatitis is caused by *Trichobilharzia ocellata* [6, 7] and has been reported to the Swiss health authorities increasingly during the past 15 years [7, 16]. In Geneva, cercarial dermatitis has received considerable attention from the public and the media during the last few years. Local newspapers have repeatedly warned the population about the risk of contracting 'duck flea disease', as the infection is called there. The Geneva Department of Social Welfare and Public Health has carried out the present study to better answer the questions of the public, to assess the public health importance of cercarial dermatitis in Geneva, and to identify behavioural and meteorologic risk factors for the disease.

MATERIALS AND METHODS

Study sites

Studies were conducted at four Geneva beaches: Céligny and Versoix on the right bank of the Lake Leman, and Savonnière and Hermance on the left bank. These locations were selected out of 17 Geneva public beaches that the General Office of the Environment reported as adequate for swimming in 1996 on the basis of coliform counts. The beaches were at least 5 km from each other.

Study design and baseline questionnaire

The design consisted of a series of short prospective cohort studies that were carried out in July and August 1996. For each discrete study, interviewers contacted all individuals who visited a selected beach between 1100 and 1700 hours on a trial day. Enrolment usually took place on Tuesdays and Thursdays. The schedule had often to be adapted, however, as a result of poor weather. Interviewers distributed a letter of information signed by the Geneva health authority. The letter addressed the issue of cercarial dermatitis, explained that the study was performed as a response to public concern and stressed the confidentiality of the information that would be collected. Visitors were invited to complete a baseline self-administered questionnaire. Children less than 16 years old were excluded if no legal representative was present. When appropriate, a contact person was designated among the members of a same household.

The baseline questionnaire focused on bathing during the summers 1994 and 1995, bathing during the 7 days prior to the enrolment, intention to swim on the day of the survey, and history of skin lesions resembling insect bites after bathing in a lake. Additional information was collected on age, sex, residential area code, phone number and best time of the day to make telephone contact. Bathing was defined as any contact of a body part with the water of the lake. At the end of the questionnaire, a reminder encouraged participants to remember the timing and mode of their bathing.

Follow-up interview and case definition

Follow-up information was solicited by phone 2–7 days after the baseline interview. The follow-up survey was restricted to individuals who gave a phone number in Switzerland or in the nearby French area. Six attempts were made to contact each subject.

In close agreement with the clinical case definition proposed by the CDC [10], a probable cercarial dermatitis was defined as one or several skin lesions reported by the respondent that met the following characteristics: (1) they resembled skin lesions due to insect bites, (2) no actual insect bite was observed, and (3) the lesions appeared during or after the night following the beach visit.

Follow-up questions included inquiry on time, duration and type of swim on the enrolment day, on bathing during the following days, on prickling sensations while bathing or during the first hour after bathing, as well as on itching, and insomnia related to the skin eruption. An estimate of disability was obtained by asking whether the respondent felt too

sick to go back to the beach, too sick to work, too sick to leave home; whether he or she had to visit a pharmacy, to see a doctor or to go to the hospital. Attitude toward future bathing in the lake was assessed by asking whether the subject was planning to swim in the lake as usual, less often or never again.

Regional meteorological data collected at the Geneva airport were obtained from the Swiss Meteorological Institute. The following daily variable were considered: lower, mean and higher atmospheric temperatures (°C), barometric pressure (kPa), rainfalls (mm), average and maximal wind speeds (m/s), and solar energy (kW h/m²).

Statistical analysis

Since the number of observed skin lesions was reported on an ordinal scale, we used ordinal logistic regression modelling to examine the associations between bathing characteristics and self-reported cercarial dermatitis after adjusting for other potential risk factors [17]. Using BMDP LR [18], we built continuation ratio models that considered four outcome categories (0, 1–5, 6–10, and $\geqslant 11$ skin lesions) [19]. The proportion of subjects with at least one skin lesion among all subjects was modelled in a first outcome stratum; the proportion of subjects with at least 6 skin lesions among individuals with at least 1 skin lesion was modelled in a second outcome stratum, and the proportion of subjects with at least 11 skin lesions among individuals with at least 6 skin lesions was modelled in a third outcome stratum.

The overall goodness of fit of the models was assessed by using the Hosmer–Lemeshow goodness of fit test [20].

Table 1. *Characteristics of the respondents to the baseline questionnaire, by follow-up status*

Characteristics	With follow-up ($n = 681$) %	Without follow-up ($n = 493$) %	P*
Age (years)			
0–20	39·1	26·1	
21–40	34·5	43·6	
$\geqslant 41$	25·8	29·1	
Unknown	0·6	1·2	$< 0{\cdot}0001$
Sex			
Male	41·4	42·5	
Female	58·6	57·5	0·71
Country of residence			
Switzerland	87·3	66·3	
France	9·0	19·5	
Unknown, other	3·7	14·2	$< 0{\cdot}0001$
No. baths in a lake per summer (1994–5)			
0	7·3	13·6	
1–5	25·7	27·6	
6–20	30·8	38·1	
> 20	36·2	20·7	$< 0{\cdot}0001$
Bathing in a lake during the 7 days prior to the baseline interview			
Yes	47·8	38·7	
No	52·2	61·3	0·002
History of skin lesions after bathing in a lake			
Yes	37·0	27·2	
No	62·8	72·6	
Unknown	0·2	0·2	0·0005
Considered bathing on the day of the baseline interview			
Yes	83·4	69·6	
No	16·6	30·4	$< 0{\cdot}0001$

* Pearson's χ^2 test of independence

RESULTS

Between 3 July 1996 and 23 August 1996, the interviewers spent 15 days recruiting subjects at the beaches. Of the 1426 eligible individuals contacted, 252 (18%) refused to answer the initial questionnaire. Of these 152 persons (56%) refused because they already had contributed to the study on a previous occasion and 23 subject (9%) since they did not intend to swim that day. For 77 individuals (35%), the reason for refusal remained unknown. Seven hundred and eighty-nine subjects agreed to be recontacted by phone. Follow-up information was obtained from 681 of them (86%) 2–7 days (median: 3 days) after the initial beach interview. Table 1 compares baseline data for subjects with and without follow-up.

Five hundred and fifty-five subjects (81·5%) confirmed they swam on the day of the enrollment. Of them 30·3% reported one swim, 27·6% two swims, 20·9% three swims, and 21·2% from 4–10 swims. One hundred and seventy-seven persons (31·9%) swam at least once between 1000 and 1400 hours, 485 (87·4%) between 1400 and 1700 hours, and 172 (40·0%) after 1700 hours. Also, 42·1% of the bathers declared that,

Table 2. *Reported skin lesions, associated symptoms, and consequences of probable cercarial dermatitis among 153 swimmers in Geneva, Switzerland (1996)*

Reported manifestations and consequences	No.	%	95% CI*
No. skin lesions			
1–5	75	49·0	40·9, 57·2
6–10	39	25·5	18·8, 33·2
11–30	22	14·4	9·2, 21·0
> 30 (max. 100)	17	11·1	6·6, 17·2
Subjects with skin lesions			
Face	8	5·2	2·3, 10·0
Head and neck	19	12·4	7·6, 18·7
Upper limbs	72	47·1	38·9, 55·3
Hands	6	3·9	1·5, 8·3
Chest and back	84	54·9	4·4, 6·8
Under the swimming suit	29	19·0	13·1, 26·1
Lower limbs	116	75·8	68·2, 82·4
Feet	21	13·7	8·7, 19·9
Itching			
None	22	14·3	9·2, 21·0
Negligible	55	36·0	28·4, 44·1
Uncomfortable	46	30·1	22·9, 38·0
Distressing	23	15·0	9·8, 21·7
Unbearable	7	4·6	1·9, 9·2
Insomnia			
Slept as usual	126	82·4	75·4, 88·0
Slept less well because of the skin lesions	20	13·1	8·2, 19·5
Did not sleep for at least one night because of the skin lesions	6	3·9	1·5, 8·3
Disability			
Too sick to go back to the beach	10	6·5	3·2, 11·7
Too sick to work	1	0·7	0·0, 3·6
Too sick to leave home	1	0·7	0·0, 3·6
Used a drug treatment	77	50·3	42·1, 58·5
Visited a chemist	15	9·8	5·6, 15·7
Visited a doctor	6	3·9	1·5, 8·3
Was hospitalized	1	0·7	0·0, 3·6

* CI, confidence interval.

during each swim, they spent less than 10 min in the water, 47·2% 10–30 min and 10·7% more than 30 min. Finally, 34·5% reported that they mainly swam in water less than 1 m deep, 23·3% in water 1–2 m deep and 42·2% in water more than 2 m deep.

Overall, 10·5% of the bathers (95% confidence interval [CI] = 8·0, 13·3) reported prickling sensations during or immediately after bathing. The attack rate of prickling sensations was similar in men (9·3%) and women (11·3%; relative risk [RR] = 0·83; 95% CI = 0·50, 1·36; $P = 0{\cdot}49$). It was higher among subjects 11–20 years old than among any other age group (RR = 2·56 after collapsing the age groups 0–10 and > 20 into a single category; 95% CI = 1·54, 4·28; $P = {\cdot}01$). It was similar at Céligny (17·0%; 95% CI = 9·9, 26·6), Hermance (12·9%; 95% CI = 8·0, 19·4) and Savonnière (17·4%; 95% CI = 11·1, 25·3), but lower at Versoix (1·5%; 95% CI = 0·3–4·3).

One hundred and fifty-three bathers (27·6%) reported probable cercarial dermatitis as compared with only four non-bathers (3·2%). No non-bather had more than five new skin lesions. These data suggest that about 90% or more of the cases of dermatitis reported by bathers were attributable to bathing. The characteristics and the consequences of the skin eruptions are described in Table 2.

Among bathers, the median daily attack rate of probable cercarial dermatitis was equal to 27·7%

(Table 3) As shown in Figure 1, attack rates varied considerably from day to day throughout the entire season (range = 2·2–57·7) and strongly correlated with daily attack rate of prickling sensations while bathing (Pearson's coefficient of correlation: $R = 0{\cdot}65$; $P = 0{\cdot}008$). All except four subjects who reported prickling sensations while bathing were probable cases of cercarial dermatitis (RR = 11·61%; 95% CI = 4·51, 29·92, $P < 0{\cdot}0001$).

Figure 1 also indicates that the daily attack rate of probable cercarial dermatitis and regional barometric pressure covaried consistently throughout the entire study period except on 15 August and 16 August. Visual comparisons of curves suggested that maximal regional atmospheric temperature was an effect modifier of this relationship (data not shown). No other simple association was observed between the incidence of probable cercarial dermatitis and any other regional meteorologic factor listed in the method section (figures available from the authors).

Drug treatment for skin lesions included a systemic antihistamine in 10 subjects, a topical antihistamine in 26 subjects, and topical steroid in 10 subjects. Twenty-nine persons used various other topical pharmaceutical preparations, 9 used topical alcohol, vinegar or sodium hypochlorite, and 2 used a homeopathic preparation. Expenditures for drug treatment were \$4·0–30·0 (average: \$7·0).

Of the subjects who reported probable cercarial dermatitis after bathing, 2·6% (95% CI = 0·7, 6·6) claimed that, in the future, they would never swim in a lake anymore, 12·4% (95% CI = 7·6, 18·7) that they would swim in a lake less often than before, and 85·0% (95% CI = 78·3, 90·2) that they would swim as often as before.

After adjusting for calendar time to enrolment (Mantel–Haenszel procedure [21]), bathing at Versoix was associated with a lower risk of self-reported cercarial dermatitis than bathing at Céligny (RR = 0·41; 95% CI = 0·25, 0·69; $P = 0{\cdot}0002$), at Savonnière (RR = 0·48; 95% CI = 0·33, 0·70; $P = 0{\cdot}0009$), and at Hermance (RR = 0·61; 95% CI = 0·41, 0·91, $P = 0{\cdot}02$).

In multivariate analysis, the risk of cercarial dermatitis was strongly associated with history of cercarial dermatitis, time that bathers spent in the water, period of the day when bathing, beach, regional barometric pressure and regional maximum atmospheric temperature (Table 4). All factors except history of cercarial dermatitis were also strong predictors of the number of reported skin lesions. Sex, age, number and type of baths, bathing in a lake in 1994–5, bathing in a lake during the 7 days prior to the enrolment, bathing in a lake during follow-up, and time to follow-up did not contribute to the final model.

DISCUSSION

To our knowledge, this study is the first epidemiologic investigation intended to prospectively estimate attack rates of cercarial dermatitis in swimmers throughout a bathing season. Several important issues were clarified. First, cercarial dermatitis is a very common and widespread problem in Geneva although attack rates vary considerably from one day to another. Second, given a similar exposure to contaminated water, both sexes and all age groups are equally affected. Third, while a benign disease, cercarial dermatitis nevertheless inconveniences some bathers to the point where they reduce or stop their water activities. Finally, attack rates of self-reported cercarial dermatitis are strongly associated with factors related to the biology of the parasite, to the behaviour of the bathers, to previous history of cercarial dermatitis, and possibly to individual susceptibility to the cercariae. Provided they are corroborated, these results could lead to the development of improved prevention messages to the swimmers.

In multivariate analysis, swim duration, period of the day when swimming, barometric pressure and maximal atmospheric temperature strongly predicted not only cercarial dermatitis but also the number of reported skin lesions. In contrast, history of cercarial dermatitis was strongly associated with cercarial dermatitis but only weakly with the number of skin lesions.

These results are consistent with the fact that past cercarial dermatitis is a risk factor for early and strong skin reaction after a new infection [3, 5, 22], while swim duration, period of the day when swimming, barometric pressure and maximal atmospheric temperature reflect the likelihood that cercariea will reach the bather's skin. The probability of contact of cercariae with the skin increases with the amount of time spent in the water [23]. Cercariae of *T. ocellata* are mainly released during the morning hours and their activity decrease progressively with time [24]. It is also likely that meteorologic conditions somehow affect cercarial behaviour by modifying the physical characteristics of the water.

Table 3. *Crude attack rates of probable cercarial dermatitis among bathers in Geneva Switzerland (1996), by baseline, behavioral, and meteorological characteristics*

Characteristic	No. cases	No. Non-cases	Attack rate, %	Relative risk (95% CI*)
Age, years				
0–10	48	124	27·9	1·0†
11–20	30	47	39·0	1·40 (0·97, 2·02)
21–30	19	63	23·2	0·83 (0·52, 1·32)
31–40	20	78	20·4	0·73 (0·46, 1·16)
⩾ 41	36	88	29·0	1·04 (0·72, 1·50)
Sex				
Male	69	177	28·0	1·0†
Female	84	225	27·2	0·97 (0·74, 1·27)
Number of baths in a lake per summer (1994–5)				
0	5	26	16·1	1·0†
1–5	31	105	22·8	1·41 (0·60, 3·34)
6–20	45	129	25·9	1·60 (0·69, 3·72)
> 20	72	141	33·8	2·10 (0·92, 4·78)
Bathing in a lake during the past 7 days				
No	62	201	23·6	1·0†
Yes	91	200	31·3	1·33 (1·01, 1·75)
History of skin lesions after bathing in a lake				
Never	61	289	17·4	1·0†
1–5 times	65	94	40·9	2·35 (1·75, 3·15)
⩾ 6 times	27	19	58·7	3·37 (2·41, 4·70)
No. of baths (recruitment day)				
1	40	128	23·8	1·0†
2	48	105	31·4	1·32 (0·92, 1·88)
3	31	56	35·6	1·50 (1·01, 2·21)
⩾ 4	34	113	23·1	0·97 (0·65, 1·45)
Bathing time (recruitment day)				
1000–1400 hours	63	114	35·6	1·0†
1400–1700 hours	133	352	27·4	0·77 (0·60, 0·98)
After 1700 hours	40	132	23·3	0·65 (0·47, 0·91)
Average bath duration (recruitment day, min)				
< 10	39	194	16·7	1·0†
10–30	88	174	33·6	2·01 (1·44, 2·80)
> 30	26	33	44·1	2·63 (1·75, 3·95)
Type of bath (recruitment day)				
In < 1 m of water	49	142	25·7	1·0†
In 1–2 m of water	41	88	31·8	1·24 (0·87, 1·76)
In > 2 m of water	63	171	26·9	1·05 (0·76, 1·45)
Beach (recruitment day)				
Versoix	39	160	19·6	1·0†
Céligny	29	59	33·0	1·68 (1·12, 2·53)
Hermance	44	103	29·9	1·53 (1·05, 2·22)
Savonnière	41	80	33·9	1·73 (1·19, 2·52)
Recruited in				
July	116	270	30·1	1·0†
August	37	132	21·9	0·73 (0·53, 1·01)

Table 3.—*cont.*

Characteristic	No. cases	No. Non-cases	Attack rate, %	Relative risk (95% CI*)
Time to follow-up (days)				
2–3	63	218	22·4	1·0†
4–7	90	184	32·8	1·47 (1·11, 1·93)
Additional bath in a lake during follow-up				
No	83	238	25·9	1·0†
Yes	70	164	29·9	1·16 (0·88, 1·52)
Max. atmospheric temperature (°C) (Barometric pressure, kPa)				
$< 24{\cdot}5$				
< 969	2	18	10·0	1·0†
$\geqslant 969$	19	31	38·0	3·80 (0·97, 14·83)
$\geqslant 24{\cdot}5$				
< 969	28	93	23·1	2·31 (0·60, 8·96)
$\geqslant 969$	104	260	28·6	2·86 (0·76, 10·75)

* CI, confidence interval.
† Referent category.

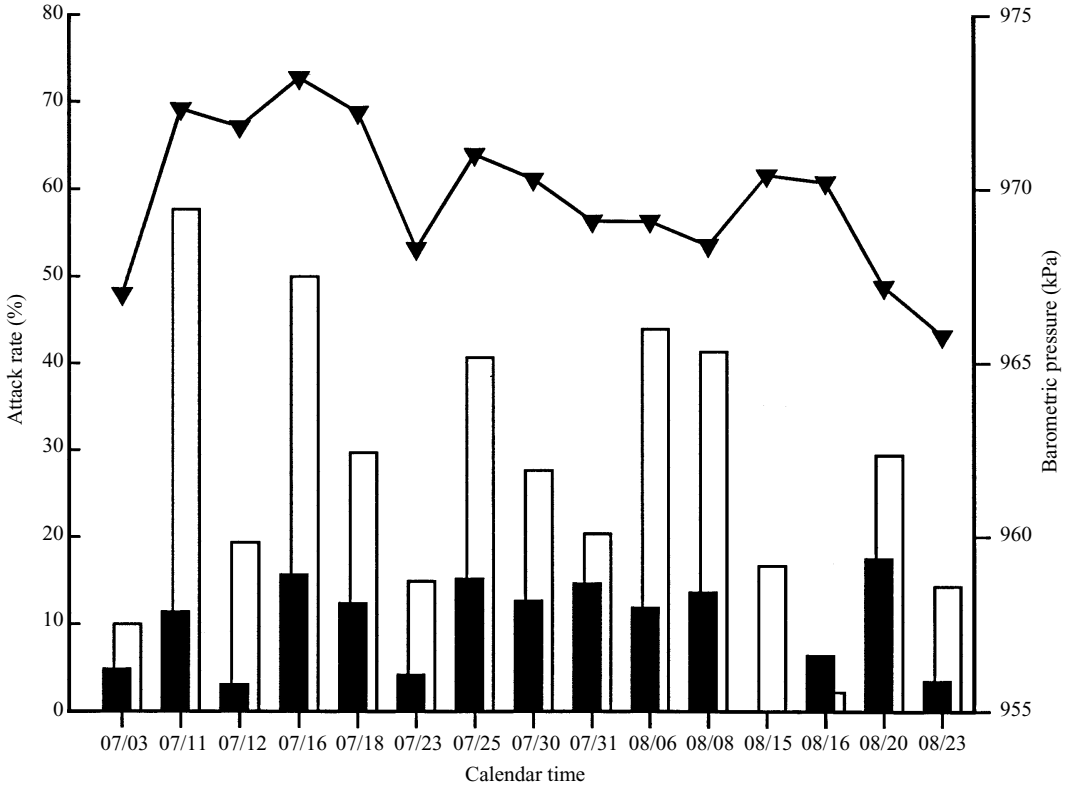

Fig. 1. Attack rates of probable cercarial dermatitis in summer 1996. ■, Prickling sensation; □, cercarial dermatitis; ◆, barometer pressure.

Table 4. *Results of ordinal logistic regression analysis* (*continuation ratio model*) *for the relation between probable cercarial dermatitis and various risk factors among swimmers in Geneva, Switzerland, 1996*

	Adjusted			
Characteristic	No. subjects	Odd ratio*	95% CI†	*P*
History of skin lesions after bathing in a lake (outcome stratum 1)‡				
Negative	325	1·0§		
1–5 times	136	3·09	2·24, 4·28	< 0·0001
< 5 times	46	9·58	6·94, 13·24	< 0·0001
History of skin lesions after bathing in a lake (outcome stratum 2)‡				
Negative	61	1·0§		
1–5 times	57	1·16	0·66, 2·04	0·60
< 5 times	27	3·60	2·05, 6·30	< 0·0001
History of skin lesions after bathing in a lake (outcome stratum 3)‡				
Negative	31	1·0§		
1–5 times	32	0·64	0·45, 1·34	0·12
> 5 times	15	1·97	0·93, 4·16	0·06
Average bath duration (recruitment day, min‖)				
< 10	283	1·0§		
10–30	344	1·82	1·40, 2·37	< 0·0001
> 30	103	3·32	2·56, 4·32	< 0·0001
Bathing time‖				
Exclusively < 1400 hours	251	1·0§		
Between 1400 and 1700 hours	302	0·73	0·58, 0·92	0·007
After 1700 hours	177	0·53	0·42, 0·92	< 0·0001
Beach‖				
Versoix	258	1·0§		
All others	472	1·63	1·10, 2·41	0·014
Max. atmospheric temperature (°C) (Barometric pressure, (kPa)				
< 24·5‖				
< 969	23	1·0§		
⩾ 969	80	7·53	1·86, 30·4	0·005
⩾ 24·5				
< 969	152	4·09	1·07, 15·7	0·04
⩾ 969	475	3·58	1·89, 6·73	< 0·0001

Fifty-six observations representing five covariate pattens were excluded from the analysis on the basis of regression diagnostics [20]. Goodness of fit test for the final model: $P = 0{\cdot}463$.

* Odds ratios were adjusted for history of skin lesions after bathing in a lake, average bath duration, hour of the day when bathing, beach, regional maximum atmospheric temperature and regional barometric pressure.

† CI, confidence interval.

‡ In outcome stratum 1, the odds estimates the risk of reporting skin lesions among all swimmers. In outcome stratum 2, the odds estimates the risk of reporting 6–10 skin lesions among swimmers who reported at least one skin lesion. In outcome stratum 3, the odds estimates the risk of reporting more than 10 skin lesions among swimmers who reported at least 6 skin lesions.

§ Referent category.

‖ Odds ratio estimates did not vary significantly across outcome strata 1, 2 and 3.

There are, however, alternative explanations to these findings. A first possibility is that selection of the bathers occurred on the basis of their relative susceptibility to infection. Under experimental conditions, cercariae penetrate the skin of some persons but avoid others [3]. If the risk of infection given a similar

exposure to cercariae were higher in some individuals than in others, the former would be more likely to repeatedly develop numerous skin lesions. Thus, they may selectively avoid swimming in the lake. Detection bias is another issue. Subjects who had already experienced episodes of cercarial dermatitis may have been more likely to identify and report one or a few lesions than subjects without such experience.

Overall, our study presents several limitations. The strategy of case identification was neither very sensitive nor specific. It is likely that light and primary infections were underreported since both types of infection lead to trivial symptoms. However cercarial dermatitis is not a transmitted disease. Therefore, cases that remained unnoticed were of no public health significance. More importantly, self-reported cases of cercarial dermatitis may have been confused with dermatitis of bacterial etiology, contact dermatitis, or insect bites from chiggers, fleas and mosquitoes [2, 10]. No confirmatory procedure was used. Serologic tests and skin biopsies are of limited practical value [12, 25] and physical examination was considered to be too obtrusive. Nevertheless, authors and interviewers observed many typical cases of cercarial dermatitis among the study site visitors. Moreover, the widespread distribution of *T. ocellata* in the Lake Leman is well established [7]. A study performed in 1983–4 reported confirmed cases at 34 beaches around the lake including Versoix and Hermance [7]. Since then, infested snail hosts have repeatedly been collected at various locations. In our study, few new skin lesions were reported at follow-up by subjects who did not swim on the date of enrollment. As already mentioned, around 90% or more of the probable cercarial dermatitis reported by bathers were attributable to bathing. Finally, according to bacteriologic tests the study beaches were suitable for swimming and no cause of dermatitis related to bathing in Lake Leman other than *T. ocellata* has yet been described.

Another weakness of our study was the difficulty of maintaining a high participation rate throughout the entire investigation. Individually, the return rate to the baseline questionnaire was high, the proportion of subjects who accepted to be recontacted by phone was in the range expected for such a survey in Geneva [26], and follow-up was obtained for most subjects who communicated their telephone number. Overall, however, a substantial proportion of eligible individuals either did not participate or were lost to follow-up. As shown in Table 1, they were more likely to be adults and to be occasional bathers. They were also less likely to consider bathing on the day of the interview and to have a reported history of skin lesions after bathing in a lake. As a result, the overall attack rate of cercarial dermatitis was probably overestimated since participants were more likely to be exposed to cercariae, to have a strong skin reaction after infection, and to report skin lesions.

The role of regional meteorologic factors remains unclear. It is hard to imagine a plausible biological explanation that would support a direct causal relationship between barometric pressure and cercarial dermatitis. Most likely the observed association is due to the confounding effect of one or several unmeasured factors jointly associated with the regional meteorologic conditions and the risk of cercarial dermatitis. Because many exploratory comparisons were made, the complex relationship observed among regional barometric pressure, regional maximum atmospheric temperature, and attack rate of cercarial dermatitis may also be due to chance only.

In conclusion, the frequency of cercarial dermatitis in Geneva and its interference with popular leisure activities are causes of concern to the population. Our study indicated that cercarial dermatitis is usually a benign disease among swimmers. It also showed that the incurred direct costs are low. Nevertheless, bathing in the lake is very popular in Geneva and economic activities related to the lake are substantial. Therefore, indirect costs to the community may be significant. Overall, this situation suggests that cercarial dermatitis is a public health issue that deserves more attention.

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