Leptospira Exposure in Urban River Surfers, Germany, 2024

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After 4 urban river surfers in Munich, Germany, were hospitalized with severe leptospirosis, we conducted a controlled cross-sectional study. *Leptospira* IgG seroreactivity was more frequent among surfers than controls, and *Leptospira* DNA was detected in 1 soil sample. Freshwater surfing could represent an underrecognized exposure setting in temperate cities.

Leptospirosis is usually associated with tropical and subtropical regions, but reports have noted increasing case numbers in temperate countries (*1*,*2*). Pathogenic *Leptospira* spp. are shed in the urine of reservoir animals, particularly rodents (*3*). Human infection occurs primarily through contact with contaminated water or soil (*4*). Recreational freshwater exposure is a recognized risk factor, and investigations have revealed outbreaks linked to water sports, including river surfing, in Europe (*5*,*6*). However, data on *Leptospira* exposure in urban freshwater settings remain limited. In Germany, available seroprevalence data suggest low background exposure (1.6%–4.2%) in the general population (*7*,*8*).

During 2021–2024, four previously healthy men who regularly surfed the Eisbach River wave in Munich, Germany, were diagnosed with severe leptospirosis. We investigated whether regular surfing the Eisbach River wave (Video, https://wwwnc.cdc.gov/EID/article/32/12/26-0879-V.htm) was associated with increased serologic evidence of *Leptospira* exposure.

The Study

We conducted a controlled, cross-sectional study during September 4–November 7, 2024, comparing Eisbach River surfers with nonsurfing controls selected to achieve similar age and sex distribution. We did not perform individual matching. We recruited surfers on site at the Eisbach River surfing wave, an urban side arm of the Isar River; we recruited controls from a pool of employees at Technical University of Munich University Hospital. Eligible surfers had surfed the Eisbach ≥3 times during the 12 months before study enrollment; controls reported no river surfing during that period. Participants were ≥18 years of age and had no known history of leptospirosis.

Participants completed a standardized questionnaire assessing demographics, travel history, animal contact, and symptoms consistent with leptospirosis during the 12 months before study enrollment (Appendix, https://wwwnc.cdc.gov/EID/article/32/12/26-0879-App1.pdf). We obtained blood samples for serologic testing and PCR. We collected 15 environmental water and soil samples at the Eisbach surfing site on 5 sampling days during September 2024, including river water samples at the standing wave and soil samples from both banks at the surfers' entry and exit areas.

The *Leptospira* Reference Laboratory of the German Federal Institute for Risk Assessment (Berlin, Germany) tested samples for leptospiral IgG using

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an in-house ELISA (*9*). We classified borderline and positive IgG results as seroreactive because we aimed to detect prior exposure rather than acute infection. We used microscopic agglutination test (MAT) on IgG-positive samples to assess detectable serogroup-specific agglutinating antibodies and determine serogroup information (*10*). We tested blood and environmental samples by PCR targeting *lipL32* (*Leptospira* major outer membrane protein) (*11*). We reviewed human leptospirosis notifications, rat infestation estimates, severe canine leptospirosis cases, and climate and hydrologic (*12*) data from regional public health, veterinary, and environmental sources. We performed statistical analyses using Fisher exact, Mann–Whitney U, and linear regression tests, as appropriate (Appendix).

We enrolled 102 surfers and 100 controls with serologic data; 100 surfers and 98 controls had questionnaire data. Median age was 29 years in both groups; 70% of surfers and 71% of controls were male. Surfers reported a median of 4 years of river surfing and a median frequency of 10 sessions/month. Travel to countries with a high incidence of leptospirosis was more common among surfers than controls, but animal contact and other baseline characteristics were similar (Table).

Leptospira-specific IgG seroreactivity was more frequent among surfers than controls (10/102 [9.8%] vs. 3/100 [3.0%]; relative risk 3.27 [2-sided 90% CI 1.13–9.41]; p = 0.041 by 1-sided Fisher exact test, p = 0.082 by 2-sided Fisher exact test). Among surfers, 7 were IgG-positive and 3 borderline; among controls, 2 were positive and 1 borderline. When we restricted the analysis to c positive IgG results, the effect estimate was similar but less precise (7/102 [6.9%] vs. 2/100 [2.0%]; relative risk 3.43 [90% CI 0.94–12.6]).

All IgG-positive samples were negative by MAT, and *Leptospira* DNA was not detected in any of the blood samples. Most seroreactive participants reported no symptoms consistent with leptospirosis during the 12 months before study enrollment (Appendix Table 1). Exposure characteristics and potential confounding factors assessed by questionnaire showed no marked differences between seroreactive and seronegative surfers (Appendix Table 2). A sensitivity analysis excluding participants with travel to high-incidence countries showed the same direction of association, although precision was limited by small sample size (Appendix Table 3).

We reviewed regional surveillance and environmental data as contextual indicators. During 2016–2024, public health authorities in Munich received

Table. Characteristics of participants in study of *Leptospira* exposure in urban river surfers, Germany, 2024*

Characteristic	Controls	Surfers	Effect measure (95% CI)	p value (method)†
Participants with available questionnaire data	98	100		
Median age, y (IQR)	29 (25–33)	29 (25–36)	HL 0 (−2 to 3)	0.726 (Mann–Whitney U-test)
Sex				
F	28 (29)	30 (30)	OR 1.07 (0.55–2.07)	0.825 (χ^2 test)
M	70 (71)	70 (70)	Referent	Referent
Recent travel abroad	86 (88)	91 (91)	OR 1.41 (0.52–3.99)	0.459 (χ^2 test)
Travel to high-risk countries	12 (12)	33 (33)	OR 3.53 (1.62–8.06)	0.002 (χ^2 test)
Frequent animal contact	27 (28)	36 (36)	OR 1.48 (0.78–2.83)	0.202 (χ^2 test)
Years surfing EW, median (IQR)	NA	4 (1.25– 8.75)	NA	NA
Median surfing sessions per month during summer (IQR)	NA	10 (6–12)	NA	NA
Signs and symptoms in previous 12 mo				
Fever	36 (37)	32 (32)	OR 0.81 (0.43–1.52)	0.483 (χ^2 test)
Conjunctivitis	4 (4.1)	5 (5)	OR 1.24 (0.26–6.43)	>0.999 (Fisher exact test)
Scleral icterus	1 (1)	1 (1)	OR 1.0 (0.06–16.5)	>0.999 (Fisher exact test)
General muscle pain	6 (6.1)	16 (16)	OR 2.92 (1.02–9.50)	0.027 (χ^2 test)
No symptoms‡	56 (57.1)	60 (60)	OR 1.12 (0.6–2.06)	0.683 (χ^2 test)
EW surfing within 14 d before symptom onset	NA	27 (27)		
Underlying kidney disease	1 (1)	1 (1)	OR 1.02 (0.06–16.5)	>0.999 (Fisher exact test)
Underlying liver disease	3 (3)	1 (1)	OR 0.32 (0.01–4.08)	0.366 (Fisher exact test)

*Values are no. (%) except as indicated. Characteristics are based on participants with available questionnaire data: 100 surfers and 98 controls. Percentages were calculated using available data for each variable. Denominators may vary because of missing questionnaire data. Effect measures compare surfers with controls. EW, Eisbach River wave; IQR, interquartile range; HL, Hodges-Lehmann estimator; NA, not applicable; OR, odds ratio.
†Comparisons between groups were performed using Mann–Whitney U-test for continuous variables and χ^2 or Fisher exact test for categorical variables, as appropriate. p<0.05 was considered statistically significant.
‡Includes fever, conjunctivitis, scleral icterus, and general muscle pain.

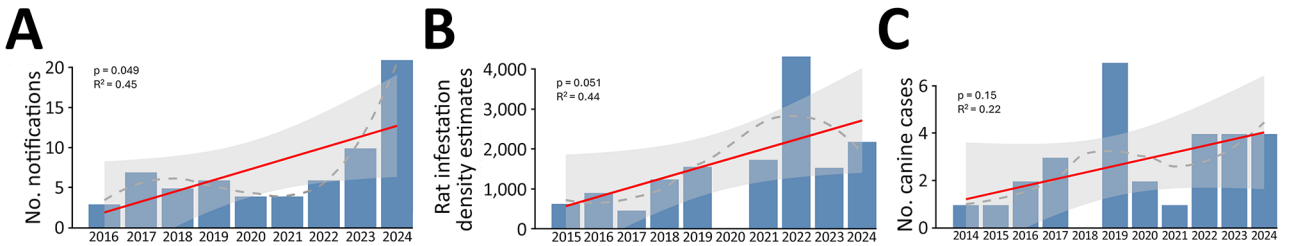


Figure 1. Indicators of local leptospirosis activity in the Munich region for study of *Leptospira* exposure in urban river surfers, Germany, 2024. Curved dashed gray lines represent locally estimated scatterplot smoothing (LOESS) curves, illustrating the smoothed trends in the observed data; shading indicates the corresponding 95% CI. Solid red lines represent the linear regression fits used to estimate the annual changes. A) Human leptospirosis notifications reported to public health authorities in Munich, 2016–2024. All notifications [meeting national reporting criteria were included, irrespective of final confirmation status. Linear regression estimated an average annual increase of 1.35 (95% CI 0.01–2.69) notifications/year (red line and shading) (p = 0.049 by 2-sided Wald test; R^2 = 0.45). B) Rat infestation activity in the Munich city area during 2015–2024, based on infestation density estimates from officially confirmed reports. No rat infestation surveys were conducted in 2020; the values for that year were extrapolated. Linear regression estimated an average annual increase of 238 (95% CI −1.8 to 478.7) rat infestations/year (red line and shading) (p = 0.051 by 2-sided Wald test; R^2 = 0.44). C) Number of dogs treated for confirmed leptospirosis at the LMU Small Animal Clinic, Munich, during 2014–2024. Linear regression estimated an average annual increase of 0.28 (95% CI −0.12 to 0.69) cases/year (red line and shading) (p = 0.15 by 2-sided Wald test; R^2 = 0.22).

72 human leptospirosis notifications meeting initial reporting criteria. Annual notifications increased from 3 in 2016 to 21 in 2024; linear regression indicated an average increase of 1.35 (95% CI 0.01–2.69) notifications/year (p = 0.049 by 2-sided Wald test) (Figure 1, panel A). Among the 72 notifications, available public health and clinical documentation identified Isar River or Eisbach exposure in 12; of those, 10 also had documented Eisbach surfing, including the 4 hospitalized surfers whose illnesses prompted the study. Recreational water exposure, including river surfing, was not systematically recorded during the full observation period. Rat infestation estimates in Munich increased after 2018 and peaked in 2022, and severe canine leptospirosis cases treated at the LMU Small Animal Clinic increased from 2022 onward (Figure 1, panels B, C).

Among the 15 environmental samples collected, 1 soil sample from a puddle near the surfer exit point tested positive for *Leptospira* DNA by PCR; all other samples were negative (Appendix Figure). Ambient temperature in Munich increased significantly during 2000–2024 (p = 0.002), and water temperature in the Eisbach showed a nonsignificant upward trend during 2015–2024 (Figure 2). Hospitalizations of the 4 surfers with severe leptospirosis occurred shortly after flooding events of the Isar River (Figure 3).

Conclusions

Urban river surfers in Munich had higher *Leptospira* IgG seroreactivity than nonsurfing controls, exceeding previously reported seroprevalence estimates from Germany (*7*,*8*). All IgG-positive samples were MAT-negative, and *Leptospira* DNA was

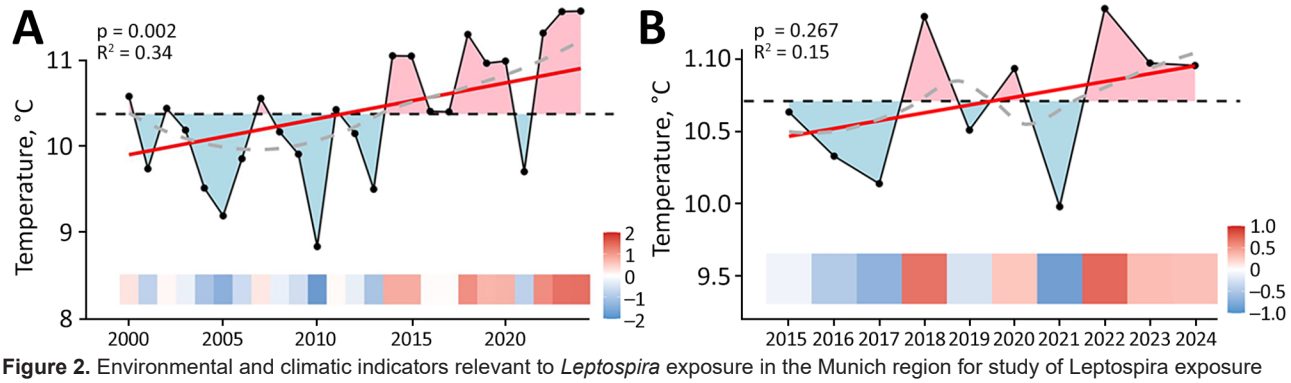


Figure 2. Environmental and climatic indicators relevant to *Leptospira* exposure in the Munich region for study of Leptospira exposure in urban river surfers, Germany, 2024. A) Annual average ambient temperature in Munich for 2000–2024, displayed as a climate stripe and line plot. The dashed black line depicts the calculated mean temperature over the observed period. Linear regression estimated an average annual increase of 0.06°C (95% CI 0.024–0.094)/year (p = 0.002 by 2-sided Wald test; R2 = 0.34). B) Average water temperature of the Eisbach River for 2015–2024. The dashed black line depicts the calculated mean temperature over the observed period. Linear regression estimated an average annual increase of 0.06°C (95% CI −0.056 to 0.177)/year (p = 0.267 by 2-sided Wald test; R2 = 0.15).

not detected in blood samples, findings compatible with past rather than active infection at the time of sampling. The controlled design supports the interpretation that regular river surfing was associated with increased serologic evidence of exposure beyond that observed in nonsurfing controls. Similar observations have been reported among persons with occupational (*13*–*15*) or recreational freshwater exposure (*5*,*6*), consistent with increased exposure among river surfers.

Detection of *Leptospira* DNA in 1 environmental soil sample from the surfing site, together with the preceding cluster of severe cases, is compatible with possible local environmental exposure. Converging human, animal, and environmental indicators suggest a potential role of local environmental conditions in *Leptospira* exposure risk. Most seroreactive surfers did not report recent symptoms compatible with leptospirosis, consistent with previous studies demonstrating that a substantial proportion of infections remain asymptomatic or mildly symptomatic, which might contribute to underrecognition of infection in low-incidence settings (*1*).

Our study's cross-sectional design does not permit causal attribution of individual infections or temporal attribution of seroreactivity. Therefore, we cannot determine whether seroreactivity resulted from Eisbach surfing or from other exposures. We assessed potential confounding by travel, animal contact, and other freshwater exposure, but residual confounding cannot be excluded. Controls were recruited from hospital employees, were not randomly selected, and were not individually matched to surfers, which might have introduced selection bias. Environmental sampling was limited, and regional human, animal, and infestation data were used as contextual indicators, not direct measures of transmission. Thus, our findings are compatible with local environmental exposure but do not establish timing, location, or causal pathway of infection. Generalizability to other urban freshwater settings depends on local environmental conditions, rodent activity, water management, and intensity of recreational exposure.

After the observed cluster and study findings, the Munich Department of Health implemented targeted risk communication measures for the local surfing community and updated related municipal online information on leptospirosis. The effects of those measures cannot yet be assessed.

In summary, higher *Leptospira* IgG seroreactivity among urban river surfers, together with environmental detection and contextual One Health indicators, suggests that urban freshwater environments in temperate cities could represent underrecognized settings for exposure to and infection with *Leptospira* spp. Our findings support integrated surveillance and increased clinical awareness after urban freshwater exposure.

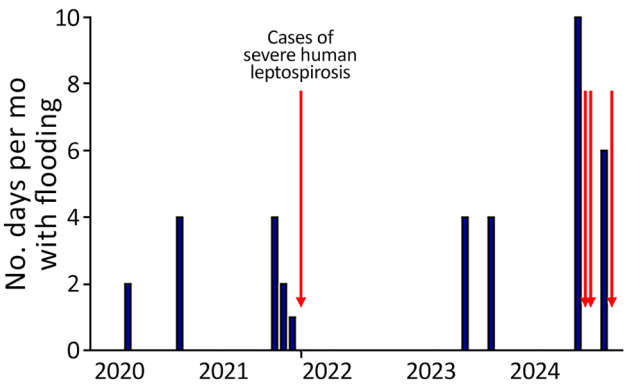


Figure 3. Temporal occurrence of flooding events of the Isar River during 2020–2024 used for study of *Leptospira* exposure in urban river surfers, Germany, 2024. Flooding was defined as days with a water level ≥240 cm (alert level 1). Red arrows indicate periods during which Eisbach surfers were treated for severe leptospirosis as inpatients at Technical University of Munich School of Medicine and Health in Munich.

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We used artificial intelligence tools GPT-5 (OpenAI, https://chatgpt.com) to support language editing and manuscript organization. The authors take full responsibility for the content of this manuscript.

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