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"Aare You Safe?" River-related presentations and clinical outcomes at a Swiss tertiary emergency department: a retrospective cross-sectional study

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Summary

BACKGROUND: Urban swimming, especially in the Aare River, is popular in Switzerland but carries risks, particularly for those unfamiliar with its currents and hazards. This study describes the epidemiology of river-related emergency department (ED) visits, focusing on injury patterns, patient demographics and presentation characteristics.

METHODS: A retrospective cross-sectional study at the University Hospital of Bern was conducted, analysing river-related ED visits from 2012 to 2024. Data on demographics, injury types, triage levels and outcomes were extracted from electronic medical records.

RESULTS: A total of 263 river-related ED visits were identified among a total of 541,561 ED visits over the study period (proportional incidence: 0.49 per 1000 ED consultations, 95% CI: 0.43–0.55). Most patients were male (62.7%), aged ≤35 years (65.4%) and Swiss nationals (65.4%). The most frequent injuries were trauma (63.1%), mainly affecting the lower extremities (30.8%) and head/face (16.3%), often due to collisions with submerged objects or bridge jumping. Drowning cases (12.2%) were less common, with seven fatalities (2.7%). Most incidents occurred in the summer between June and August (78.7%), with 37.3% on weekends. Suicide attempts (20.4% vs 3%) and boating-related incidents (11.2% vs 6.7%) were more common in females and jumping-related incidents more frequent in males (22.4% vs 11.2%), p <0.001. Hypothermia was significantly more often found in non-Swiss nationality ED visits (p = 0.002) and those of people aged >35 years (p <0.001). Compared to younger patients, those aged >35 years were significantly more likely to be triaged as life-threatening (22% vs 7.6%; p <0.001), report intentions other than swimming (notably more suicide attempts and accidents; p <0.001), and had higher rates of admission to an ICU or of transfer to a psychiatric clinic (p <0.001).

CONCLUSION: River-related ED visits are a recurring seasonal concern, primarily affecting young males. People with non-Swiss nationality and those engaging in high-risk activities are at higher risk. Adopting a multilingual approach could be a key objective of safety campaigns to more effectively reduce risks for non-Swiss swimmers and promote safer swimming practices in urban waters. Prevention efforts should continue to focus on public education, enhanced safety signage and improved emergency preparedness.

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Introduction

Urban swimming is a long-standing cultural tradition in Switzerland, with the Aare River in Bern serving as one of its most iconic locations [1]. Recognised by the Federal Office of Culture as part of Switzerland's intangible cultural heritage, swimming in the Aare attracts large numbers of participants each year [2]. On hot summer days, up to 30,000 individuals can be seen walking along the river each day, preparing to swim downstream with the current [3]. The river offers a range of activities, including swimming, boating, surfing and bridge jumping, and is a favoured location for sunbathing and relaxation, drawing both locals and tourists.

However, swimming in an unsupervised natural river presents significant hazards. In the section of the Aare River flowing through the city of Bern, the flow velocity typically ranges between 6 and 19 km/h, depending on seasonal variations and discharge levels. Entry into the Aare is advised only for strong swimmers, and participation is at one's own risk [4].

The river's unpredictable currents and varying flow conditions pose dangers, especially to those with limited experience. In response to these risks, the City of Bern and the Swiss Lifesaving Society (SLRG; *Schweizerische Lebensrettungs-Gesellschaft*) have initiated multiple public awareness campaigns (e.g. "Aare you safe?") aimed at improving safety [5].

Over the past decade, about 50 drowning deaths have been documented annually across Switzerland, with a significant portion attributed to river and lake incidents: in 2023 for instance, 59 individuals lost their lives due to drowning, 71% of whom were adult males. Most of these fatalities occurred in natural bodies of water, including lakes (46%) and rivers (41%) [6].

While fatal drownings remain a tragic and high-profile concern, non-fatal swimming- and bathing-related injuries are also prevalent. According to recent data from SUVA, Switzerland's largest accident insurer, an average of 5593 swimming- and bathing-related accidents were reported annually between 2017 and 2021, resulting in an average insurance cost of 34.6 million Swiss francs per year [7]. An extrapolated estimate from the Swiss Advisory Centre for Accident Prevention (BFU) suggests that the actual number of incidents may be significantly higher, with an average of 12,160 swimming-related accidents reported annually between 2016 and 2020 [8].

The goal of the present study was to analyse river-related emergency department (ED) visits over more than eleven years, with an emphasis on epidemiological patterns, injury mechanisms, triage severity and clinical outcomes, at Switzerland's largest trauma centre, which records over 50,000 ED visits per year [9]. Particular attention was given to three subgroups relevant for prevention efforts: (1) sex differences, which may reflect varying risk-taking behaviours; (2) non-Swiss nationals, who may be unfamiliar with local river conditions; and (3) younger and older individuals, who may face distinct risk profiles due to activity preferences or physical limitations. By examining these subgroups, the study aims to support targeted prevention strategies and strengthen interdisciplinary approaches to improving river-related safety.

Methods

This study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines [10]. According to the local ethics committee (Req-2023-00537), the study was exempt from the Human Research Act and did not require general informed consent. A study plan was submitted to the local ethics committee as part of the mandatory ethics committee responsibility declaration.

Study design, period and setting

This retrospective cross-sectional study utilised ED data collected over a period of eleven years and nine months. To identify and analyse river-related ED visits, all ED data from patients who consulted the study site during the study period (1 June 2012 to 29 February 2024) were examined.

The adult ED at Bern University Hospital, a tertiary care centre, operates as a self-contained, interdisciplinary unit, staffed by approximately 45 emergency physicians (primarily from internal medicine or anaesthesia) and 120 nurses, managing over 50,000 patient visits (age ≥16 years) annually [11]. Major trauma cases are managed in a dedicated shock room under the supervision of an emergency physician, in collaboration with trauma and anaesthesia teams following institutional trauma protocols. Specialty consultations are requested as needed. Children (<16 years) are treated in a paediatric ED nearby.

Participants

All ED records are digitally stored in the patient management system (E.care; Mesalvo Turnhout BV, Turnhout, Belgium). A full-text search for the keywords "Aare" and "Fluss" (German for "river") in the patient's history was conducted to identify relevant cases. The identified records were manually reviewed using the following exclusion criteria:(1) Situations in which "Aare" or "Fluss" were mentioned in the patient's history but had no direct connection to the ED visit (e.g. a person who had a heart attack while strolling by the river);(2) Patients aged under 16, who were not included as they received care in the paediatric ED.

Data collection and definition of variables

All medical records of patients who visited the ED during the study period were screened based on the inclusion criterion that the keyword "Aare" or "Fluss" appeared in the patient's history at the time of admission. The keywords were used to ensure comprehensive identification of river-related incidents. The term "Fluss" was included to capture all cases referring to any river exposure, while "Aare" was added because the Aare is the most frequently visited river in the Bern region, and is therefore expected to account for most river-related injuries.

A manual review of the data was conducted to evaluate the eligibility criteria.

The data were retrieved from the patient management system through both automated extraction and manual review of medical records. Both steps were performed by one author (T.M.). To ensure data accuracy, 50% of the dataset was independently rechecked by J.H., yielding a concordance rate of 99.7%.

The study made use of factors that were regularly gathered and evaluated at the time of ED admission; these variables were then incorporated directly into a structured dataset for analysis. No separate study database was created. The dataset was reviewed for plausibility and internal consistency by a statistics expert (M.M.) during data analysis. Among the factors were demographics (patient's age, sex and nationality); consultation information (year, month and weekday of admission); triage classification based on the Swiss Emergency Triage Scale (from non-urgent, 5, to life-threatening, 1).

Additionally, the study authors used free-text analysis of medical records to extract new factors:

- *Intention of swimming in the Aare:* Activities included swimming, jumping, boating, surfing, rescue attempts, accidental falls, fleeing from police, suicidal intent or "Unknown" circumstances.
- *Specialty:* Classified as medical, surgical/orthopaedic, resuscitation room, surgical trauma-room, ear-nose-throat, fast-track centre or "Other".
- *Trauma diagnoses:* Traumatic injuries were categorised based on the affected body region, including head & face trauma, neck and spine trauma, upper extremity trauma, lower extremity trauma, and thorax & abdominal trauma.
- *Non-trauma diagnoses:* Cases were classified into drowning, intoxication, hypothermia or "Other" medical conditions.
- *Main diagnosis group.*
- *Outcome:* Patients were either discharged home or admitted to a medical ward, surgical ward, intensive care unit, psychiatric clinic or underwent surgery. Cases resulting in death were also recorded.

Study size

All available cases that met the inclusion criteria were included. The study period corresponds to the timeframe during which the patient management software E.care was in use in our emergency department. The system was introduced on 1 June 2012 and remained in use until 29 February 2024.

Statistical analysis

Stata® 18.1 (StataCorp, College Station, Texas, USA) was used for statistical analysis. While continuous variables, including patient age, were expressed as median with interquartile range (IQR; 25th to 75th percentile), categorical variables were summarised as absolute numbers and percentages. For proportional incidences, 95% confidence intervals (CIs) were calculated. To analyse the number of river-related ED visits over the study period, a two-way fractional polynomial prediction plot with a 95% confidence interval was generated.

Three subgroup analyses were performed comparing i) male vs female, ii) Swiss vs non-Swiss nationality, and iii) younger vs older (≤35 years vs >35 years) ED visits. Age was dichotomised at 35 years, in keeping with established drowning and injury epidemiology strata that distinguish young adults from older adult groups beginning at 35 years [12, 13]. For each subgroup, differences in patient demographics, accident characteristics, consultation characteristics, injury characteristics and discharge outcomes were assessed.

The chi-squared test was used to evaluate group differences for categorical variables, and the Wilcoxon rank-sum test for continuous variables. As this study was primarily exploratory and descriptive, no predefined hypotheses were tested. Instead, a broad range of group comparisons was performed to identify potential patterns and associations. Given the large number of statistical

tests conducted, p-values were interpreted descriptively rather than as confirmatory evidence. To adjust for multiple testing, we used a cut-off of p <0.005 as proposed by Ioannidis [14]. All findings should therefore be considered hypothesis-generating and require confirmation in future studies.

Ethics statement

The study was conducted in accordance with Swiss law and submitted to the local ethics committee (Req-2023-00537). The committee determined that the study does not fall within the scope of the Human Research Act (Art. 2, Para. 1) and therefore does not require approval. As a retrospective data analysis, no informed consent was necessary.

Results

Study population

Over the longer than 11-year study period, a keyword search for “Aare” and “Fluss” in the Emergency Department (ED) database identified 720 patient records. After applying predefined exclusion criteria, 456 cases (63%) were excluded due to the absence of a clear connection between the patient’s interaction with the river and their ED admission. One additional case was excluded because the patient was under 16 years of age (figure 1). This resulted in 263 patient records (36.5%) being included in the final analysis, corresponding to 0.49 (95% CI: 0.43–0.55) river-related ED visits per 1000 ED consultations. Among the 263 cases included in the analysis, the vast majority of incidents (n = 250, 95.1%) occurred in the Aare. Only 13 cases (4.9%) were associated with other rivers. The median age of patients was 31 years (IQR: 24–45), with 34.6% aged over 35 years. Males accounted for 62.7% of cases and females for 37.3%. Swiss nationals comprised 65.4% of the sample, while foreign nationals accounted for 34.6%. The majority of patients (89%) were categorised as at least urgent upon presentation to the ED. Baseline characteristics are shown in table 1.

Figure 1: Study flowchart. Abbreviations: ED: Emergency Department.

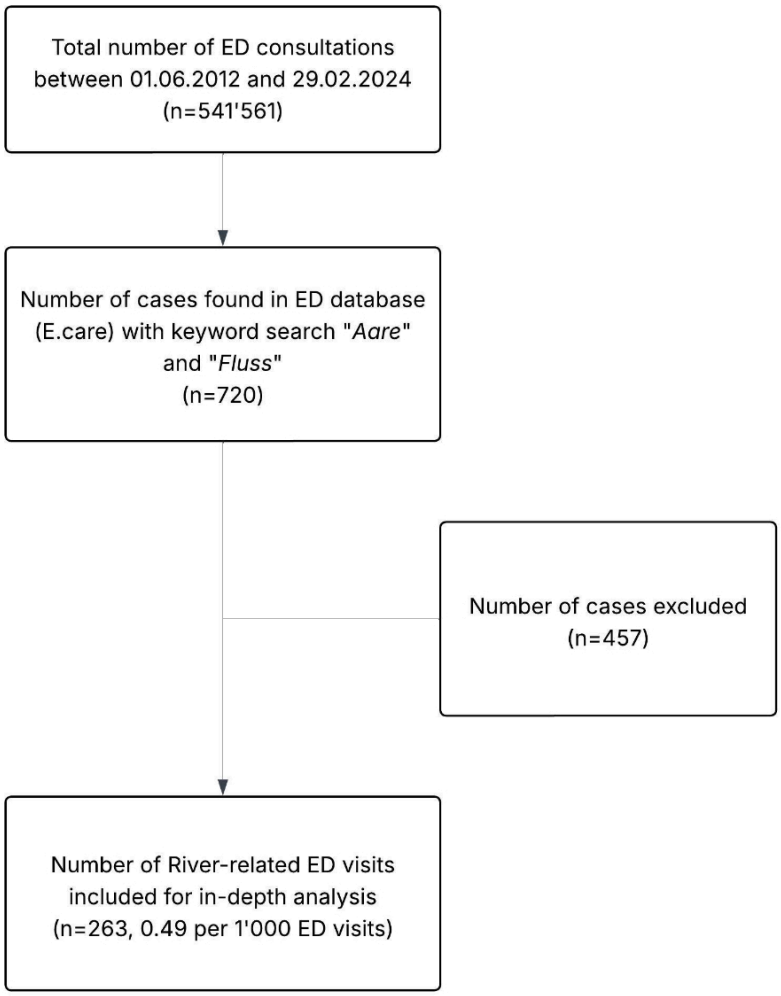


Table 1: Baseline characteristics of the 263 included river-related Emergency Department visits.

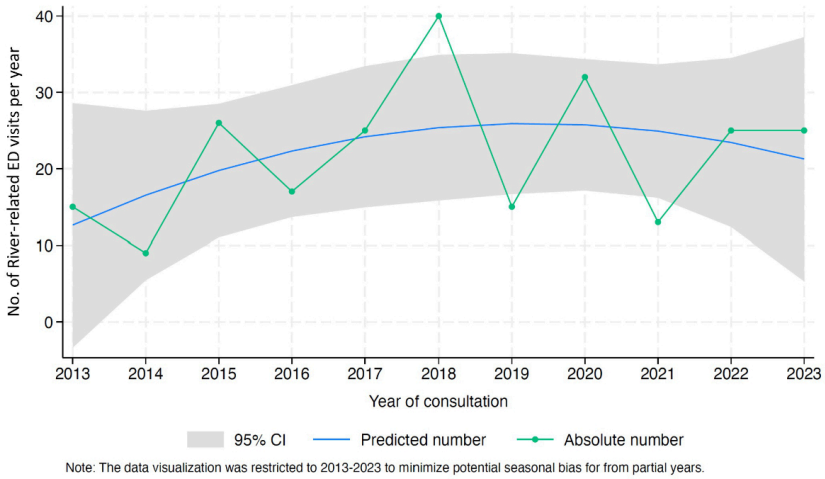
Characteristics		n	%
Age group	16–25y	77	29.3%
	>25–35y	95	36.1%
	>35–50y	41	15.6%
	>50–65y	32	12.2%
	>65y	18	6.8%
Sex	Female	98	37.3%
	Male	165	62.7%
Nationality	Foreign	91	34.6%
	Swiss	172	65.4%
Accident: month	January	4	1.5%
	February	3	1.1%
	March	2	0.8%
	April	6	2.3%
	May	6	2.3%
	June	42	16%
	July	81	30.8%
	August	84	31.9%
	September	19	7.2%
	October	6	2.3%
	November	7	2.7%
	December	3	1.1%
Accident: day of week	Monday	31	11.8%
	Tuesday	33	12.5%
	Wednesday	29	11.0%
	Thursday	42	16.0%
	Friday	30	11.4%
	Saturday	51	19.4%
	Sunday	47	17.9%
Triage	Life-threatening	33	12.5%
	High-urgent	63	24%
	Urgent	138	52.5%
	Semi-urgent	25	9.5%
	Non-urgent	4	1.5%
Discharge	Home	197	74.9%
	Medical ward	7	2.7%
	Surgical ward	6	2.3%
	Operation	4	1.5%
	ICU	17	6.5%
	Psychiatric clinic	21	8.0%
	ED death	7	2.7%
	Other	4	1.5%

Abbreviations: ED: Emergency Department; ICU: Intensive Care Unit.

Yearly frequency of river-related ED visits

The annual frequency of river-related ED visits ranged from a minimum of 9 cases in 2014 to a peak of 40 cases in 2018, with an average of 22.4 cases per year. Figure 2 illustrates the yearly trend in river-related ED visits. The trend shows a stable number of cases over the longer than 11-year study period.

Figure 2: Number of river-related ED visits per year over the study period. Note: The green line represents the absolute number of river-related ED visits per year. The blue line represents the predicted trend, with the grey area indicating the 95% confidence interval, based on a fractional polynomial model. Abbreviations: CI: confidence interval; ED: Emergency Department.



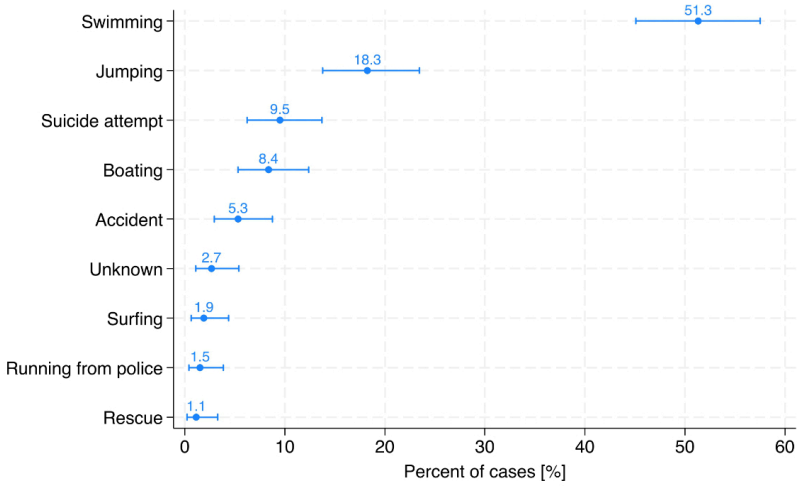
Temporal trends

Most river-related ED visits occurred during the summer months, with 78.7% of cases recorded in June, July or August. Over one-third of patients (n = 98, 37.3%) presented to the ED on a weekend. Among weekdays, Thursday had the highest number of incidents (n = 42, 16%).

Incident characteristics

Figure 3 presents the distribution of activities associated with river-related ED visits. In more than half of the cases, the incident was triggered by swimming (n = 135, 51.3%). Other popular leisure activities included jumping from a bridge (n = 48, 18.3%) and boating on the river (n = 22, 8.4%). The third most common cause overall was entering a river in the context of a suicide attempt (n = 25, 9.5%).

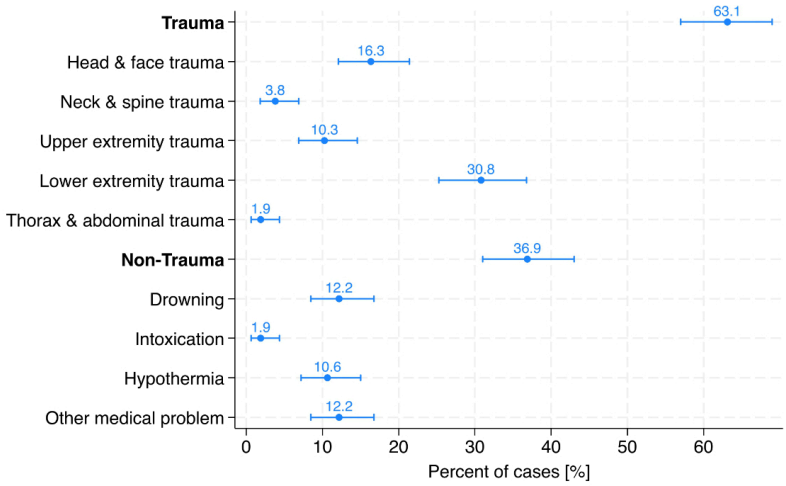
Figure 3: Activities related to the 263 river-related Emergency Department visits, shown as percentages with 95% confidence intervals and ordered by frequency. Abbreviations: ED: Emergency Department.



Diagnosis / clinical findings

In total, 63.1% of river-related visits were classified as trauma cases based on the main diagnosis, with nearly one-third of these involving injuries to the lower extremities (figure 4).

Figure 4: Main diagnosis group related to the 263 river-related Emergency Department visits, shown as percentages with 95% confidence intervals. Abbreviations: CI: confidence interval; ED: Emergency Department.



All ED diagnoses (main and secondary diagnoses) are summarised in table 2. The most common diagnosis was lower extremity trauma, accounting for 30.8% of cases. Among these, contusions of the ankle and foot (8.7%) and open wounds of the ankle and foot (9.1%) were the most frequently observed injuries. Head and face trauma was the second most frequent category, accounting for 16.3% of cases. Within this group, open wounds of the head (8.0%), traumatic rupture of the ear drum (4.2%) and ear barotrauma (3.4%) were the most frequently reported injuries. Upper extremity trauma was diagnosed in 10.3% of cases, with dislocation of the shoulder (3.4%) being the most prevalent injury in this category. Drowning incidents made up 12.2% of cases, with 9.9 % classified as nonfatal and 1.9% as fatal. Hypothermia was documented in 10.6% of cases.

Table 2: Main and secondary detailed diagnoses of river-related Emergency Department visits: (A) Trauma diagnosis, (B) Non-trauma diagnosis; n = 263 patients (100%).

Diagnoses of river-related ED visits		**n***	**%****
Trauma diagnosis			
Head and face trauma	Open wound of head	21	8.0%
	Fracture of skull	4	1.5%
	Sprain of jaw	1	0.5%
	Concussion	8	3.2%
	Traumatic rupture of ear drum	11	4.3%
	Ear barotrauma	9	2.7%
	Dissection of vertebral artery	2	0.8%
Neck and spine trauma	Fracture of neck	3	1.1%
	Sprain of neck	1	0.4%
	Fracture of thoracic spine	4	1.5%
	Upper back pain	1	0.4%
	Fracture of lumbar spine	4	1.5%
	Lower back pain	2	0.8%
Upper extremity trauma	Fracture of humerus	1	0.4%
	Dislocation of shoulder	9	3.4%
	Contusion of elbow and forearm	3	1.1%
	Open wound of forearm	7	2.7%
	Contusion of wrist and hand	6	2.3%
	Open wound of wrist and hand	7	2.7%
	Fracture of wrist and hand	1	0.4%
Thorax and abdominal trauma	Contusion of thorax	9	3.4%
	Lung injury	5	1.9%
	Open wound of abdomen	1	0.4%
Drowning	Nonfatal drowning	26	9.9%
	Fatal drowning	5	1.9%
	Drowning following fall	2	0.8%
Lower extremity trauma	Contusion of hip and thigh	4	1.5%
	Open wound of hip and thigh	2	0.8%
	Injury of muscle or tendon of hip	1	0.4%
	Contusion of knee and lower leg	7	2.7%
	Open wound of knee and lower leg	11	4.2%
	Injury of knee joint	4	1.5%
	Ankle fracture	3	1.1%
	Contusion of ankle and foot	23	8.7%
	Open wound of ankle and foot	24	9.1%
	Foot fracture	7	2.7%
	Injury of ankle	3	1.1%
	Puncture wound	7	2.7%
Non-trauma diagnosis			
Intoxication	Behavioural disorder, alcohol	8	3.0%
	Behavioural disorder, multiple drugs	6	2.3%
	Alcohol intoxication	17	6.4%
	Amphetamine intoxication	3	1.1%
Hypothermia		28	10.6%

Other medical problem	Acute stress reaction	3	1.1%
	Arthritis	1	0.4%
	Cardiac arrest	13	4.9%
	Cerumen impaction	5	1.9%
	Dissociative disorder	2	0.8%
	Erysipelas	1	0.4%
	Foreign body in oesophagus	1	0.4%
	Foreign body in eye	1	0.4%
	Intentional self-harm by jump	3	1.1%
	Otitis externa	8	3.0%
	Pulmonary oedema	1	0.4%
	Syncope	1	0.4%
	Urticaria	4	1.5%

* n includes all 355 diagnoses of 263 patients (63 patients had two diagnoses, 7 patients had three and 5 patients had four).
** The total number of patients (n = 263) is used as the denominator.

Among non-trauma diagnoses, intoxication was reported in 1.9% of cases, including behavioural disorders related to alcohol (3%) and multiple drug use (2.3%). "Other" medical problems accounted for 12.2% of cases, with cardiac arrest (4.9%) and otitis externa (3%) being the most common within this category.

Outcomes

Most patients (74.9%) were discharged home (n = 197). Hospital admissions were relatively uncommon, with 7 patients (2.7%) admitted to a medical ward and 6 patients (2.3%) to a surgical ward. Additionally, 4 patients (1.5%) underwent an immediate operation.

A notable proportion of patients required intensive care or psychiatric treatment, with 17 patients (6.5%) admitted to the ICU and another 21 patients (8%) transferred to a psychiatric clinic. A total of 7 patients (2.7%) succumbed to their injuries and were classified as ED death. Four patients (1.5%) were discharged to other destinations.

Subgroup time-trend analysis

The time-trend analysis demonstrated a stable pattern in both absolute and relative values across all subgroups over the study period. Individuals aged ≤35 years, males as well as Swiss nationals consistently showed higher incidence rates. During the COVID-19 year with mitigation measures in place (2020), the number of cases involving foreign nationals was low, whereas the number of river-related presentations among Swiss nationals reached its peak (figure S1 in the appendix).

Males vs females

Accident characteristics showed statistically significant differences between males and females ($p < 0.001$), with suicide attempts (20.4% vs 3%) and boating-related incidents (11.2% vs 6.7%) more common in females and jumping-related incidents more frequent in males (22.4% vs 11.2%). In contrast, no significant differences were observed between sexes in demographic, consultation, injury or procedure characteristics (table S1 in the appendix).

Younger vs older patients

Compared to younger patients (≤35 years), those aged >35 years were significantly more likely to present with hypothermia (19.8% vs 5.8%; $p < 0.001$), be triaged as life-threatening (22% vs 7.6%; $p < 0.001$), report intentions other than swimming (notably more suicide attempts and accidents; $p < 0.001$), and have higher rates of ICU admission and psychiatric or surgical interventions at discharge ($p < 0.001$) (table S2 in the appendix).

Swiss vs non-Swiss nationality

Hypothermia was significantly more common among non-Swiss nationals (18.7%) compared to Swiss nationals (6.4%) ($p = 0.002$) with no other significant differences found (table S3 in the appendix).

Discussion

This cross-sectional study analysed 263 ED visits related to recreational use of rivers over a period of 11 years and 9 months. While all river-related ED visits were included, 95.1% involved the Aare, underscoring its central role as the region's most accessible and commonly used river. For this reason, the discussion predominantly addresses Aare-related incidents, as the small number of cases from other rivers precludes meaningful comparisons.

Young adults, particularly males, were the most affected group, with swimming, bridge jumping and boating identified as the leading causes. Most incidents occurred during summer weekends, and trauma was the predominant clinical category. We will now discuss these findings in relation to existing literature, with a focus on risk profiles, injury mechanisms, mental health and clinical outcomes.

The predominance of male patients in this cohort (62.7%) is consistent with existing literature, which reports higher rates of water-related injuries and drowning among males across all age groups [15–17]. Several factors may contribute to this overrepresentation, including greater exposure to open-water environments, higher participation in risk-prone activities such as bridge jumping and a general propensity for risk-taking behaviour in males. Such behavioural tendencies may explain both incidence and injury severity. The sex disparity observed in the present data thus mirrors international findings but also underscores the importance of targeted prevention strategies addressing risk perception and behaviour, particularly among young men engaging in recreational river activities. Notably, most cases occurred during summer months and on weekends, with an additional peak on Thursdays, likely reflecting increased river exposure during leisure time, after-work activities and pre-weekend social gatherings.

Previous studies reported a general decline in leisure and traffic accidents during the COVID-19 pandemic, accompanied by a rise in domestic injuries and mental health emergencies [18, 19]. In contrast, the number of river-related ED visits among Swiss nationals increased in 2020 in this cohort, possibly reflecting intensified use of local recreational spaces due to restricted travel and limited leisure alternatives.

More than half of the injury events in our cohort were triggered by swimming (51.3%), followed by bridge jumping (18.3%) and boating (8.4%). These findings likely reflect the specific recreational culture surrounding rivers such as the Aare, where swimming long distances downstream is a long-standing seasonal practice, particularly in the city of Bern [1, 2]. The high accessibility of the river, combined with minimal barriers to entry and limited formal supervision, may increase exposure and the likelihood of adverse events during swimming.

Bridge jumping, although less frequent (18.3%), represents a high-risk activity, primarily among males in this cohort. Previous studies have documented severe trauma, spinal injuries and drowning following jumps from medium-height bridges [20, 21]. Fatal outcomes often result from drowning rather than impact trauma, illustrating the interaction of kinetic trauma and immersion risk.

Notably, 9.5% of incidents in our cohort were classified as suicide attempts. These were significantly more common in women, contrasting with the overall male predominance in injury events. This aligns with previous research from coastal regions in Australia and urban rivers in Shanghai, where drowning and jumping into water were common suicide methods, especially among female patients, often associated with psychiatric illness, prior suicidal behaviour and seasonal patterns [22, 23]. These observations highlight the need for integrated prevention strategies that include mental health support and surveillance.

Trauma represents the predominant risk associated with urban swimming. In the present dataset, 63.1% of river-related incidents (166 of 263 cases) were traumatic in nature, highlighting the hazardous conditions of natural urban waterways. Fast-moving currents, submerged obstacles and uneven riverbeds contribute significantly to injury risk.

Lower extremity trauma, particularly ankle contusions and lacerations, was frequent and often caused by unstable or rocky riverbeds. Head and facial trauma was also common, comprising 16.3% of cases. Injuries included lacerations, concussions and tympanic membrane ruptures, primarily in younger individuals following high-velocity bridge jumps. Bridge jumping also contributed to shoulder dislocations, spinal and internal injuries.

Collisions with submerged structures were a frequent mechanism, especially following unintended or misjudged entries. Puncture wounds and lacerations were frequently linked to debris, such as fishing hooks, nails or glass fragments. These accounted for a substantial proportion of

non-blunt injuries. The observed injury pattern contrasts with data from the US National Electronic Injury Surveillance System (NEISS), where head and neck trauma was most frequent (37%) and lower extremity injuries ranked second (33%) [16]. The reversed pattern in our cohort may reflect river-specific mechanisms, such as impacts with submerged rocks or unstable riverbeds.

Drowning was documented in 12.2% of cases, including both fatal and non-fatal outcomes, while hypothermia occurred in 10.6% of patients. These findings reflect the inherent risks of swimming in dynamic, cold-water environments such as the Aare, where strong currents, fluctuating temperatures and physical exhaustion may contribute to rapid deterioration. Hypothermia and severe outcomes were more frequently observed in older individuals (>35 years) and non-Swiss nationals, underlining the physiological vulnerability of these groups. Although medical comorbidities were not assessed in this dataset, previous studies have identified them as important modifiers of drowning risk. A Canadian study showed that seizure disorders and ischaemic heart disease significantly increase the likelihood of fatal drowning [24]. Global data further point to alcohol use and occupational exposure as key contributors to drowning-related burden, particularly among men [25]. Taken together, these findings underscore the complex interplay of environmental stressors and individual vulnerability, and highlight the need for prevention strategies that go beyond behavioural education to also address physiological and situational risk factors.

In the present cohort, 74.9% of patients were discharged home, whereas 6.5% required intensive care and another 8% psychiatric treatment. The discharge rate is lower than in the NEISS dataset [16], in which 94.5% of patients were treated and released from the ED, indicating a higher clinical complexity of river-related injuries. This difference may be explained by the setting: while NEISS injuries occurred predominantly in or around swimming pools (87%), this study focused exclusively on an urban river environment, characterised by uncontrolled currents, variable depths and limited supervision. Among older patients (>35 years), triage as life-threatening and the need for ICU care or psychiatric/surgical interventions were significantly more common, indicating both clinical severity and resource intensity in this subgroup.

Public health and clinical implications

The findings point to several relevant implications for prevention and health system preparedness. Risk communication should particularly address young males and non-Swiss nationals, who represented key risk groups. Multilingual information campaigns, visible signage at river access points and seasonal lifeguard presence might help reduce acute incidents.

The notable share of suicide attempts, particularly among female patients, highlights the role of rivers as a site of psychiatric crisis. Mental health considerations should therefore be integrated into water safety strategies, including early detection, outreach and coordination with crisis services.

Lower extremity trauma was common, often resulting from contact with uneven riverbeds, rocks or debris. Preventive measures could include improved riverbed maintenance and awareness regarding protective footwear or safe entry techniques.

Hypothermia occurred in a substantial proportion of cases, even during warmer months. This underlines the need for public education on cold-water risks and the importance of timely rescue. Older adults and non-Swiss nationals were disproportionately affected and may benefit from targeted communication strategies.

To support effective interventions, continued surveillance of river-related injuries and coordination between healthcare providers, local authorities and community organisations are essential.

Limitations

When evaluating the results, it is important to consider the limitations of this study.

Selection bias is a significant drawback given that only patients who visited the University ED were included in this single-centre study. Even though this hospital has the largest ED in the Canton of Bern, it mostly handles moderate-to-severe cases, so minor injuries treated by general practitioners, walk-in clinics or smaller EDs were not taken into account and hence are likely to be underrepresented. This likely resulted in an overestimation of the severity of injuries and an underestimation of the actual number of river-related occurrences.

Furthermore, the relatively small number of cases (n = 263) limits the generalisability of these findings. However, this number reflects the true burden of river-related emergencies at Switzerland's largest tertiary trauma centre.

The absence of visiting data, which makes it impossible to calculate incidence rates accurately, is another drawback. It is impossible to calculate the actual risk of harm in relation to exposure without knowing the entire number of people who swam in rivers like the Aare throughout the study period. Furthermore, it is challenging to evaluate risk variables and make inferences regarding relative risk and possible protective treatments due to the lack of a control group of swimmers who are not harmed.

Additionally, this study only included patients who were admitted to the ED; hence, the dataset did not include individuals who were found dead at the scene and not transported to the hospital. This 'forgotten cohort' represents an important patient group that is often overlooked, as they are frequently excluded from analysed datasets [26]. Furthermore, the vulnerable subgroup of children was not assessed.

Lastly, because the research is based on pre-existing medical data, which could have inconsistent or insufficient documentation, the retrospective study design raises the risk of information bias, regarding the documentation of the river name in the medical report. Some river-related cases may have been missed if neither the river name "Aare" nor the word "Fluss" was explicitly documented in the clinical records, potentially leading to an underestimation of the true number of cases. Furthermore, the accuracy of the data may be impacted by factors like the precise circumstances of occurrences, drug or alcohol use, and pre-existing medical issues that may not have been accurately documented.

Conclusions

River-related ED visits are a seasonal issue that primarily affects young males who participate in dangerous activities. Trauma, especially involving head and lower extremities, predominated over drowning incidents. Numerous injuries were caused by collisions with submerged items or jumping from bridges, underscoring the risks involved with urban river swimming.

The proportion of non-Swiss nationalities was notably high. This finding suggests that visitors and foreign residents are less knowledgeable about the river's currents, exits and possible hazards such as hypothermia. This implies that to guarantee water safety for all swimmers, multilingual safety information and focused preventive initiatives should be initiated.

Although public safety campaigns along the Aare have been in place for several years, systematic data on injury characteristics and clinical outcomes have been limited. This study provides an evidence-based overview that can inform and refine ongoing prevention strategies, serving as a basis for evaluating their future impact.

Prevention measures should therefore focus on: i) Educating the public, particularly young adults, about the risks associated with river swimming, ii) Enhancing warnings and signs at high-risk areas, such as river entry points and bridge jumping points, and iii) Improving emergency readiness by guaranteeing prompt rescue operations and first aid supplies along rivers. By addressing the unique risks and challenges associated with urban swimming, public health campaigns can help create a safer environment for both locals and visitors while preserving this iconic Swiss tradition.

Data sharing statement

The dataset supporting the conclusions of this study is not publicly available due to institutional and legal data protection regulations. Deidentified data may be made available from the corresponding author upon reasonable request.

Custom code was developed for data cleaning and analysis and is available from the corresponding author upon reasonable request.

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Author contributions: Martin Müller, Sabrina Jegerlehner and Thomas Maurer conceptualised the study and designed the methodology. Thomas Maurer conducted data collection and managed data curation. Martin Müller performed the data analysis. Julius Husarek, Thomas Maurer and Martin Müller prepared the original draft of the manuscript. Karsten Klingberg, Sabrina Jegerlehner and Aristomenis Exadaktylos edited the manuscript. All authors contributed to the revision of the manuscript and approved the final version.

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Appendix

Supplement Table 1. Comparison of characteristics between male and female river-related ED visits.

	Female (n=98)		Male (n=165)		P-value
DEMOGRAPHICS					
Age, med (IQR)	30.5	[24; 48]	31	[24; 42]	0.884
Age group, n (%)					
16-25y	29	[29.6]	48	[29.1]	
>25-35y	34	[34.7]	61	[36.9]	
>35-50y	13	[13.6]	28	[16.9]	
>50-65y	14	[14.3]	18	[10.9]	
>65y	8	[8.2]	10	[6.1]	0.752
Nationality, n (%)					
Foreign	28	[28.6]	63	[38.2]	
Swiss	70	[71.4]	102	[61.8]	0.113
ACCIDENT CHARACTERISTICS					
Intention, n (%)					
Swimming	47	[48.0]	88	[53.3]	
Jumping	11	[11.2]	37	[22.4]	
Boating	11	[11.2]	11	[6.7]	
Surfing	1	[1.0]	4	[2.4]	
Rescue	2	[2.0]	1	[0.6]	
Accident	5	[5.1]	9	[5.5]	
Running from police	0	[0.0]	4	[2.4]	
Suicide attempt	20	[20.4]	5	[3.0]	
Unknown	1	[1.0]	6	[3.6]	<0.001
CONSULTATION CHARACTERISTICS					
Triage, n (%)					
Life-threatening	14	[14.3]	19	[11.5]	
High-urgent	21	[21.4]	42	[25.5]	
Urgent	51	[52.0]	87	[52.7]	
Semi-urgent	11	[11.2]	14	[8.5]	
Non-urgent	1	[1.0]	3	[1.8]	0.819
INJURY CHARACTERISTICS					
Diagnosis group overview, n (%) *					
Head & face trauma	11	[11.2]	32	[19.4]	
Neck & spine trauma	3	[3.1]	7	[4.2]	
Upper extremity trauma	7	[7.1]	20	[12.1]	
Lower extremity trauma	32	[32.7]	49	[29.7]	
Thorax & abdominal trauma	2	[2.0]	3	[1.8]	
Drowning	12	[12.2]	20	[12.1]	
Intoxication	3	[3.1]	2	[1.2]	
Hypothermia	12	[12.2]	16	[9.7]	
Other medical problem	16	[16.3]	16	[9.7]	0.423
HEAD & FACE TRAUMA DETAIL					

Any head & face trauma, n (%)	12	[12.2]	44	[26.7]	0.006
Open wound of head, n (%)	3	[3.1]	18	[10.9]	0.023
Fracture of scull, n (%)	1	[1.0]	3	[1.8]	0.609
Sprain of jaw, n (%)	0	[0.0]	1	[0.6]	0.440
Concussion, n (%)	2	[2.0]	6	[3.6]	0.466
Traumatic rupture of ear drum, n (%)	2	[2.0]	9	[5.5]	0.181
Ear barotrauma, n (%)	4	[4.1]	5	[3.0]	0.650
Dissection of vertebral artery, n (%)	0	[0.0]	2	[1.2]	0.274
NECK & SPINE TRAUMA DETAIL					
Any neck & spine trauma, n (%)	4	[4.1]	11	[6.7]	0.382
Fracture of neck, n (%)	1	[1.0]	2	[1.2]	0.887
Sprain of neck, n (%)	0	[0.0]	1	[0.6]	0.440
Fracture of thoracic spine, n (%)	2	[2.0]	2	[1.2]	0.595
Upper back pain, n (%)	0	[0.0]	1	[0.6]	0.440
Fracture of lumbar spine, n (%)	1	[1.0]	3	[1.8]	0.609
Lower back pain, n (%)	0	[0.0]	2	[1.2]	0.274
UPPER EXTREMITY TRAUMA DETAIL					
Any upper extremity trauma, n (%)	9	[9.2]	25	[15.2]	0.163
Fracture of humerus, n (%)	0	[0.0]	1	[0.6]	0.440
Dislocation of shoulder, n (%)	0	[0.0]	9	[5.5]	0.019
Contusion of elbow and forearm, n (%)	2	[2.0]	1	[0.6]	0.289
Open wound of forearm, n (%)	3	[3.1]	4	[2.4]	0.756
Contusion of wrist and hand, n (%)	2	[2.0]	4	[2.4]	0.840
Open wound of wrist and hand, n (%)	1	[1.0]	6	[3.6]	0.203
Fracture of wrist and hand, n (%)	1	[1.0]	0	[0.0]	0.194
LOWER EXTREMITY TRAUMA DETAIL					
Any lower extremity trauma, n (%)	38	[38.8]	58	[35.2]	0.616
Contusion of hip and thigh, n (%)	2	[2.0]	2	[1.2]	0.595
Open wound of hip and thigh, n (%)	2	[2.0]	0	[0.0]	0.065
Injury of muscle or tendon of hip, n (%)	0	[0.0]	1	[0.6]	0.440
Contusion of knee and lower leg, n (%)	2	[2.0]	5	[3.0]	0.630
Open wound of knee and lower leg, n (%)	4	[4.1]	7	[4.2]	0.950
Ankle fracture, n (%)	1	[1.0]	2	[1.2]	0.887
Injury of knee joint, n (%)	3	[3.1]	1	[0.6]	0.116
Contusion of ankle and foot, n (%)	7	[7.1]	16	[9.7]	0.478
Open wound of ankle and foot, n (%)	9	[9.2]	15	[9.1]	0.980
Foot fracture, n (%)	3	[3.1]	4	[2.4]	0.756
Injury of ankle, n (%)	3	[3.1]	0	[0.0]	0.024
Puncture wound, n (%)	2	[2.0]	5	[3.0]	0.630
THORAX & ABDOMINAL TRAUMA DETAIL					
Any thorax & abdominal trauma, n (%)	4	[4.1]	11	[6.7]	0.382
Contusion of thorax, n (%)	4	[4.1]	5	[3.0]	0.650
Lung injury, n (%)	0	[0.0]	5	[3.0]	0.082
Open wound of abdomen, n (%)	0	[0.0]	1	[0.6]	0.440
DROWNING					
Any drowning, n (%)	13	[13.3]	20	[12.1]	0.787
Nonfatal drowning, n (%)	9	[9.2]	17	[10.3]	0.769
Fatal drowning, n (%)	3	[3.1]	2	[1.2]	0.288
Drowning following fall, n (%)	1	[1.0]	1	[0.6]	0.708
INTOXICATION					

Any intoxication, n (%)	16	[16.3]	18	[10.9]	0.205
Behavioural disorder alcohol, n (%)	4	[5.7]	4	[3.4]	0.449
Behavioural disorder multiple drugs, n (%)	4	[5.7]	2	[1.7]	0.132
Alcohol intoxication, n (%)	7	[10.0]	10	[6.1]	0.730
Amphetamine intoxication, n (%)	1	[1.4]	2	[1.7]	0.888
HYPOTHERMIA					
Hypothermia, n (%)	12	[12.2]	16	[9.7]	0.517
OTHER MEDICAL PROBLEM					
Any other medical problem, n (%)	21	[21.4]	23	[13.9]	0.116
Erysipelas, n (%)	0	[0.0]	1	[0.6]	0.440
Pulmonary oedema, n (%)	1	[1.0]	0	[0.0]	0.194
Arthritis, n (%)	0	[0.0]	1	[0.6]	0.440
Syncope, n (%)	1	[1.0]	0	[0.0]	0.194
Cardiac arrest, n (%)	6	[6.1]	7	[4.2]	0.496
Foreign body in oesophagus, n (%)	1	[1.0]	0	[0.0]	0.194
Foreign body in eye, n (%)	0	[0.0]	1	[0.6]	0.440
Acute stress reaction, n (%)	1	[1.0]	2	[1.2]	0.887
Dissociative disorder, n (%)	1	[1.0]	1	[0.6]	0.708
Intentional self-harm by jump, n (%)	3	[3.1]	0	[0.0]	0.024
Otitis externa, n (%)	3	[3.1]	5	[3.0]	0.989
Cerumen impaction, n (%)	2	[2.0]	3	[1.8]	0.898
Urticaria, n (%)	2	[2.0]	2	[1.2]	0.595
DISCHARGE					
Procedure, n (%)					
Home	69	[70.4]	128	[77.6]	
Medical ward	2	[2.0]	5	[3.0]	
Surgical ward	3	[3.1]	3	[1.8]	
Operation	1	[1.0]	3	[1.8]	
ICU	7	[7.1]	10	[6.1]	
Psychiatric clinic	13	[13.3]	8	[4.8]	
ED death	3	[3.1]	4	[2.4]	
Other	0	[0.0]	4	[2.4]	0.228

*Diagnosis group overview is coded as mutually exclusive according to the main diagnosis (n=263), whereas the detailed sub analysis includes all coded diagnoses (n=355)

Supplement Table 2. Comparison of younger (≤35 years) and older (>35 years) river-related ED visits.

	Age ≤ 35y (n=172)		Age > 35y (n=91)		P-value
DEMOGRAPHICS					
Gender, n (%)					
Female	63	[36.6]	35	[38.5]	
Male	109	[63.4]	56	[61.5]	0.770
Nationality, n (%)					
Foreign	58	[33.7]	33	[36.3]	
Swiss	114	[66.3]	58	[63.7]	0.680
ACCIDENT CHARACTERISTICS					
Intention, n (%)					
Swimming	91	[52.9]	44	[48.4]	
Jumping	41	[23.8]	7	[7.7]	
Boating	17	[9.9]	5	[5.5]	
Surfing	5	[2.9]	0	[0.0]	
Rescue	1	[0.6]	2	[2.2]	
Accident	2	[1.2]	12	[13.2]	
Running from police	3	[1.7]	1	[1.1]	
Suicide attempt	9	[5.2]	16	[17.6]	
Unknown	3	[1.7]	4	[4.4]	<0.001
CONSULTATION CHARACTERISTICS					
Triage, n (%)					
Life-threatening	13	[7.6]	20	[22.0]	
High-urgent	35	[20.3]	28	[30.8]	
Urgent	100	[58.1]	38	[41.8]	
Semi-urgent	20	[11.6]	5	[5.5]	
Non-urgent	4	[2.3]	0	[0.0]	<0.001
INJURY CHARACTERISTICS					
Diagnosis group overview, n (%) *					
Head & face trauma	30	[17.4]	13	[14.3]	
Neck & spine trauma	9	[5.2]	1	[1.1]	
Upper extremity trauma	21	[12.2]	6	[6.6]	
Lower extremity trauma	56	[32.6]	25	[27.5]	
Thorax & abdominal trauma	4	[2.3]	1	[1.1]	
Drowning	17	[9.9]	15	[16.5]	
Intoxication	4	[2.3]	1	[1.1]	
Hypothermia	10	[5.8]	18	[19.8]	
Other medical problem	21	[12.2]	11	[12.1]	0.013
HEAD & FACE TRAUMA DETAIL					
Any head & face trauma, n (%)	38	[22.1]	18	[19.8]	0.663
Open wound of head, n (%)	11	[6.4]	10	[11.0]	0.191
Fracture of scull, n (%)	1	[0.6]	3	[3.3]	0.087
Sprain of jaw, n (%)	1	[0.6]	0	[0.0]	0.466
Concussion, n (%)	5	[2.9]	3	[3.3]	0.861
Traumatic rupture of ear drum, n (%)	10	[5.8]	1	[1.1]	0.069

Ear barotrauma, n (%)	8	[4.7]	1	[1.1]	0.132
Dissection of vertebral artery, n (%)	2	[1.2]	0	[0.0]	0.302
NECK & SPINE TRAUMA DETAIL					
Any neck & spine trauma, n (%)	11	[6.4]	4	[4.4]	0.506
Fracture of neck, n (%)	2	[1.2]	1	[1.1]	0.963
Sprain of neck, n (%)	1	[0.6]	0	[0.0]	0.466
Fracture of thoracic spine, n (%)	3	[1.7]	1	[1.1]	0.684
Upper back pain, n (%)	1	[0.6]	0	[0.0]	0.466
Fracture of lumbar spine, n (%)	2	[1.2]	2	[2.2]	0.514
Lower back pain, n (%)	2	[1.2]	0	[0.0]	0.302
UPPER EXTREMITY TRAUMA DETAIL					
Any upper extremity trauma, n (%)	23	[13.4]	11	[12.1]	0.768
Fracture of humerus, n (%)	0	[0.0]	1	[1.1]	0.168
Dislocation of shoulder, n (%)	9	[5.2]	0	[0.0]	0.026
Contusion of elbow and forearm, n (%)	2	[1.2]	1	[1.1]	0.963
Open wound of forearm, n (%)	5	[2.9]	2	[2.2]	0.734
Contusion of wrist and hand, n (%)	2	[1.2]	4	[4.4]	0.095
Open wound of wrist and hand, n (%)	5	[2.9]	2	[2.2]	0.734
Fracture of wrist and hand, n (%)	0	[0.0]	1	[1.1]	0.168
LOWER EXTREMITY TRAUMA DETAIL					
Any lower extremity trauma, n (%)	65	[37.8]	31	[34.1]	0.551
Contusion of hip and thigh, n (%)	2	[1.2]	2	[2.2]	0.514
Open wound of hip and thigh, n (%)	1	[0.6]	1	[1.1]	0.646
Injury of muscle or tendon of hip, n (%)	1	[0.6]	0	[0.0]	0.466
Contusion of knee and lower leg, n (%)	5	[2.9]	2	[2.2]	0.734
Open wound of knee and lower leg, n (%)	6	[3.5]	5	[5.5]	0.439
Ankle fracture, n (%)	1	[0.6]	2	[2.2]	0.240
Injury of knee joint, n (%)	1	[0.6]	3	[3.3]	0.087
Contusion of ankle and foot, n (%)	19	[11.0]	4	[4.4]	0.069
Open wound of ankle and foot, n (%)	17	[9.9]	7	[7.7]	0.557
Foot fracture, n (%)	5	[2.9]	2	[2.2]	0.734
Injury of ankle, n (%)	3	[1.7]	0	[0.0]	0.205
Puncture wound, n (%)	4	[2.3]	3	[3.3]	0.642
THORAX & ABDOMINAL TRAUMA DETAIL					
Any thorax & abdominal trauma, n (%)	8	[4.7]	7	[7.7]	0.312
Contusion of thorax, n (%)	5	[2.9]	4	[4.4]	0.528
Lung injury, n (%)	3	[1.7]	2	[2.2]	0.798
Open wound of abdomen, n (%)	0	[0.0]	1	[1.1]	0.168
DROWNING					
Any drowning, n (%)	17	[9.9]	16	[17.6]	0.073
Nonfatal drowning, n (%)	13	[7.6]	13	[14.3]	0.082
Fatal drowning, n (%)	3	[1.7]	2	[2.2]	0.798
Drowning following fall, n (%)	1	[0.6]	1	[1.1]	0.646
INTOXICATION					
Any intoxication, n (%)	20	[11.6]	14	[15.4]	0.388
Behavioural disorder alcohol, n (%)	3	[1.7]	5	[5.5]	0.092
Behavioural disorder multiple drugs, n (%)	5	[2.9]	1	[1.1]	0.350
Alcohol intoxication, n (%)	9	[5.2]	8	[8.8]	0.264
Amphetamine intoxication, n (%)	3	[1.7]	0	[0.0]	0.205
HYPOTHERMIA					

Hypothermia, n (%)	10	[5.8]	18	[19.8]	<0.001
OTHER MEDICAL PROBLEM					
Any other medical problem, n (%)	26	[15.1]	18	[19.8]	0.335
Erysipelas, n (%)	0	[0.0]	1	[1.1]	0.168
Pulmonary oedema, n (%)	1	[0.6]	0	[0.0]	0.466
Arthritis, n (%)	0	[0.0]	1	[1.1]	0.168
Syncope, n (%)	1	[0.6]	0	[0.0]	0.466
Cardiac arrest, n (%)	5	[2.9]	8	[8.8]	0.036
Foreign body in oesophagus, n (%)	1	[0.6]	0	[0.0]	0.466
Foreign body in eye, n (%)	1	[0.6]	0	[0.0]	0.466
Acute stress reaction, n (%)	3	[1.7]	0	[0.0]	0.205
Dissociative disorder, n (%)	1	[0.6]	1	[1.1]	0.646
Intentional self-harm by jump, n (%)	2	[1.2]	1	[1.1]	0.963
Otitis externa, n (%)	4	[2.3]	4	[4.4]	0.352
Cerumen impaction, n (%)	3	[1.7]	2	[2.2]	0.798
Urticaria, n (%)	4	[2.3]	0	[0.0]	0.143
DISCHARGE					
Procedure, n (%)					
Home	144	[83.7]	53	[58.2]	
Medical ward	4	[2.3]	3	[3.3]	
Surgical ward	3	[1.7]	3	[3.3]	
Operation	1	[0.6]	3	[3.3]	
ICU	4	[2.3]	13	[14.3]	
Psychiatric clinic	9	[5.2]	12	[13.2]	
ED death	4	[2.3]	3	[3.3]	
Other	3	[1.7]	1	[1.1]	<0.001

*Diagnosis group overview is coded as mutually exclusive according to the main diagnosis (n=263), whereas the detailed sub analysis includes all coded diagnoses (n=355)

Supplement Table 3. Comparison of characteristics between Swiss and non-Swiss nationality river-related ED visits.

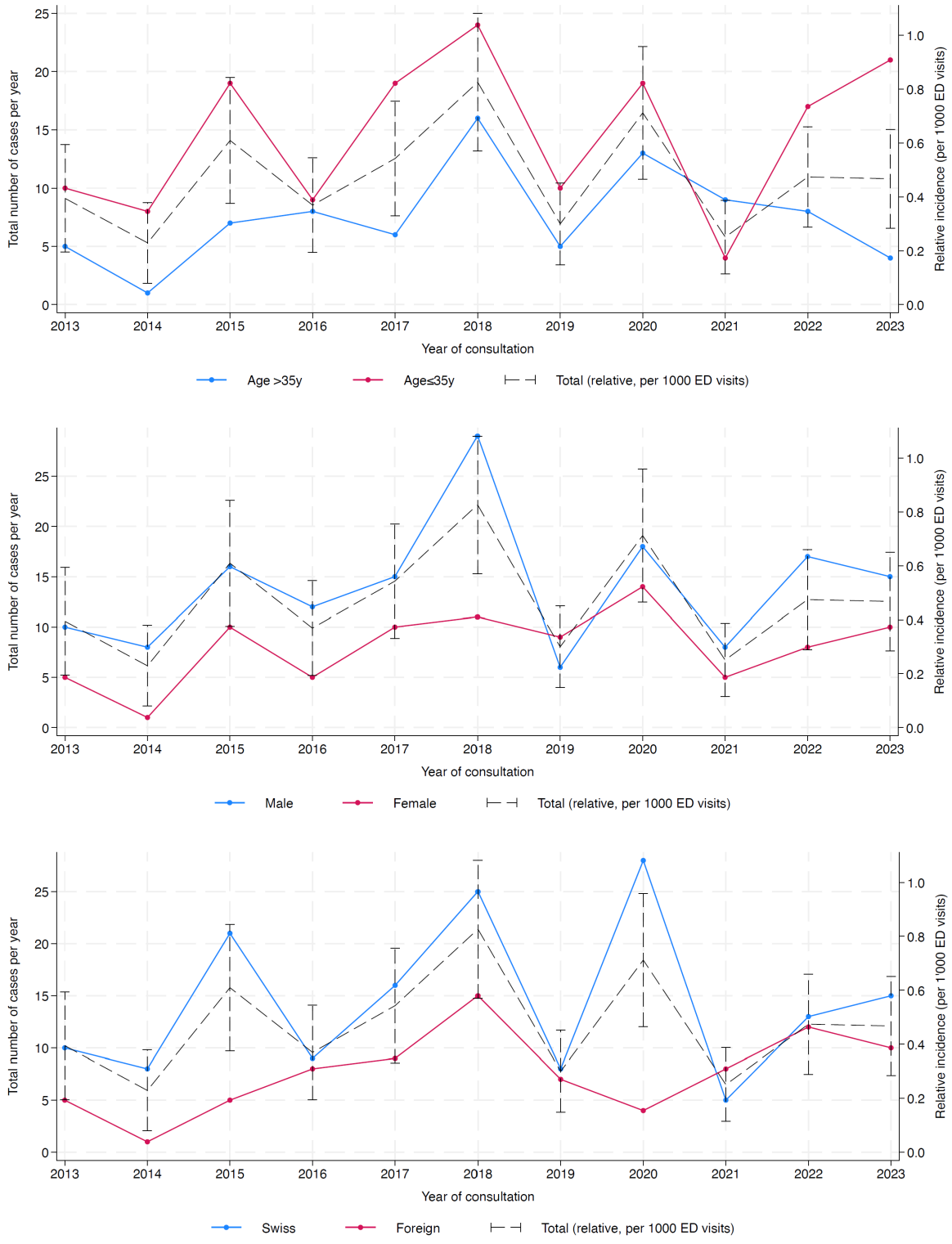
	Non-Swiss nationality (n=91)		Swiss nationality (n=172)		P-value
DEMOGRAPHICS					
Age, med (IQR)	31	[26; 42]	30	[24; 45.5]	0.325
Age group, n (%)					
16-25y	21	[23.1]	56	[32.6]	
>25-35y	37	[40.6]	58	[33.7]	
>35-50y	18	[19.8]	23	[13.4]	
>50-65y	12	[13.2]	20	[11.6]	
>65y	3	[3.3]	15	[8.7]	0.160
Gender, n (%)					
Female	28	[30.8]	70	[40.7]	
Male	63	[69.2]	102	[59.3]	0.113
ACCIDENT CHARACTERISTICS					
Intention, n (%)					
Swimming	53	[58.2]	82	[47.7]	
Jumping	11	[12.1]	37	[21.5]	
Boating	4	[4.4]	18	[10.5]	
Surfing	1	[1.1]	4	[2.3]	
Rescue	2	[2.2]	1	[0.6]	
Accident	8	[8.8]	6	[3.5]	
Running from police	3	[3.3]	1	[0.6]	
Suicide attempt	8	[8.8]	17	[9.9]	
Unknown	1	[1.1]	6	[3.5]	0.042
CONSULTATION CHARACTERISTICS					
Triage, n (%)					
Life-threatening	8	[8.8]	25	[14.5]	
High-urgent	26	[28.6]	37	[21.5]	
Urgent	48	[52.7]	90	[52.3]	
Semi-urgent	7	[7.7]	18	[10.5]	
Non-urgent	2	[2.2]	2	[1.2]	0.447
INJURY CHARACTERISTICS					
Diagnosis group overview, n (%) *					
Head & face trauma	10	[11.0]	33	[19.2]	
Neck & spine trauma	3	[3.3]	7	[4.1]	
Upper extremity trauma	9	[9.9]	18	[10.5]	
Lower extremity trauma	28	[30.8]	53	[30.8]	
Thorax & abdominal trauma	1	[1.1]	4	[2.3]	
Drowning	15	[16.5]	17	[9.9]	
Intoxication	0	[0.0]	5	[2.9]	
Hypothermia	17	[18.7]	11	[6.4]	
Other medical problem	8	[8.8]	24	[14.0]	0.025
HEAD & FACE TRAUMA DETAIL					
Any head & face trauma, n (%)	13	[14.3]	43	[25]	0.044
Open wound of head, n (%)	8	[8.8]	13	[7.6]	0.726
Fracture of scull, n (%)	0	[0.0]	4	[2.3]	0.143

Sprain of jaw, n (%)	0	[0.0]	1	[0.6]	0.466
Concussion, n (%)	3	[3.3]	5	[2.9]	0.861
Traumatic rupture of ear drum, n (%)	0	[0.0]	11	[6.4]	0.014
Ear barotrauma, n (%)	1	[1.1]	8	[4.7]	0.132
Dissection of vertebral artery, n (%)	1	[1.1]	1	[0.6]	0.646
NECK & SPINE TRAUMA DETAIL					
Any neck & spine trauma, n (%)	4	[4.4]	11	[12.1]	0.506
Fracture of neck, n (%)	1	[1.1]	2	[1.2]	0.963
Sprain of neck, n (%)	0	[0.0]	1	[0.6]	0.466
Fracture of thoracic spine, n (%)	1	[1.1]	3	[1.7]	0.684
Upper back pain, n (%)	0	[0.0]	1	[0.6]	0.466
Fracture of lumbar spine, n (%)	1	[1.1]	3	[1.7]	0.684
Lower back pain, n (%)	1	[1.1]	1	[0.6]	0.646
UPPER EXTREMITY TRAUMA DETAIL					
Any upper extremity trauma, n (%)	13	[14.3]	21	[12.2]	0.633
Fracture of humerus, n (%)	0	[0.0]	1	[0.6]	0.466
Dislocation of shoulder, n (%)	5	[5.5]	4	[2.3]	0.179
Contusion of elbow and forearm, n (%)	0	[0.0]	3	[1.7]	0.205
Open wound of forearm, n (%)	1	[1.1]	6	[3.5]	0.252
Contusion of wrist and hand, n (%)	3	[3.3]	3	[1.7]	0.422
Open wound of wrist and hand, n (%)	3	[3.3]	4	[2.3]	0.642
Fracture of wrist and hand, n (%)	1	[1.1]	0	[0.0]	0.168
LOWER EXTREMITY TRAUMA DETAIL					
Any lower extremity trauma, n (%)	32	[35.2]	64	[37.2]	0.743
Contusion of hip and thigh, n (%)	1	[1.1]	3	[1.7]	0.684
Open wound of hip and thigh, n (%)	0	[0.0]	2	[1.2]	0.302
Injury of muscle or tendon of hip, n (%)	0	[0.0]	1	[0.6]	0.466
Contusion of knee and lower leg, n (%)	2	[2.2]	5	[2.9]	0.734
Open wound of knee and lower leg, n (%)	4	[4.4]	7	[4.1]	0.900
Ankle fracture, n (%)	0	[0.0]	3	[1.7]	0.205
Injury of knee joint, n (%)	2	[2.2]	2	[1.2]	0.514
Contusion of ankle and foot, n (%)	9	[9.9]	14	[8.1]	0.633
Open wound of ankle and foot, n (%)	7	[7.7]	17	[9.9]	0.557
Foot fracture, n (%)	2	[2.2]	5	[2.9]	0.734
Injury of ankle, n (%)	3	[3.3]	0	[0.0]	0.017
Puncture wound, n (%)	2	[2.2]	5	[2.9]	0.734
THORAX & ABDOMINAL TRAUMA DETAIL					
Any thorax & abdominal trauma, n (%)	5	[5.5]	10	[5.8]	0.915
Contusion of thorax, n (%)	2	[2.2]	7	[4.1]	0.427
Lung injury, n (%)	2	[2.2]	3	[1.7]	0.798
Open wound of abdomen, n (%)	1	[1.1]	0	[0.0]	0.168
DROWNING					
Any drowning, n (%)	15	[16.5]	18	[10.5]	0.161
Nonfatal drowning, n (%)	14	[15.4]	12	[7.0]	0.030
Fatal drowning, n (%)	1	[1.1]	4	[2.3]	0.488
Drowning following fall, n (%)	0	[0.0]	2	[1.2]	0.302
INTOXICATION					
Any intoxication, n (%)	10	[11]	24	[13.9]	0.495
Behavioural disorder alcohol, n (%)	3	[4.5]	5	[4.1]	0.861
Behavioural disorder multiple drugs, n (%)	1	[1.5]	5	[4.1]	0.350

Alcohol intoxication, n (%)	6	[6.6]	11	[9.1]	0.950
Amphetamine intoxication, n (%)	0	[0.0]	3	[2.5]	0.205
HYPOTHERMIA					
Hypothermia, n (%)	17	[18.7]	11	[6.4]	0.002
OTHER MEDICAL PROBLEM					
Any other medical problem, n (%)	11	[12.1]	33	[19.2]	0.142
Erysipelas, n (%)	0	[0.0]	1	[0.6]	0.466
Pulmonary oedema, n (%)	0	[0.0]	1	[0.6]	0.466
Arthritis, n (%)	0	[0.0]	1	[0.6]	0.466
Syncope, n (%)	0	[0.0]	1	[0.6]	0.466
Cardiac arrest, n (%)	4	[4.4]	9	[5.2]	0.766
Foreign body in oesophagus, n (%)	0	[0.0]	1	[0.6]	0.466
Foreign body in eye, n (%)	0	[0.0]	1	[0.6]	0.466
Acute stress reaction, n (%)	2	[2.2]	1	[0.6]	0.240
Dissociative disorder, n (%)	0	[0.0]	2	[1.2]	0.302
Intentional self-harm by jump, n (%)	2	[2.2]	1	[0.6]	0.240
Otitis externa, n (%)	1	[1.1]	7	[4.1]	0.182
Cerumen impaction, n (%)	2	[2.2]	3	[1.7]	0.798
Urticaria, n (%)	0	[0.0]	4	[2.3]	0.143
DISCHARGE					
Procedure, n (%)					
Home	70	[76.9]	127	[73.8]	
Medical ward	4	[4.4]	3	[1.7]	
Surgical ward	0	[0.0]	6	[3.5]	
Operation	0	[0.0]	4	[2.3]	
ICU	3	[3.3]	14	[8.1]	
Psychiatric clinic	9	[9.9]	12	[7.0]	
ED death	2	[2.2]	5	[2.9]	
Other	3	[3.3]	1	[0.6]	0.079

*Diagnosis group overview is coded as mutually exclusive according to the main diagnosis (n=263), whereas the detailed sub analysis includes all coded diagnoses (n=355)

Figure S1. River-associated ED visits over the study.



Note: The data visualization was restricted to 2013-2023 to minimize potential seasonal bias from partial years.

Left axis with red/blue curve: Total number of cases per year according to A) age group (≤35 years vs. >35 years), B) sex, C) nationality (Swiss vs. Foreign).

Right axis with dotted line: relative incidence with 95% CI of river-related ED visits of total population (per 1'000 ED visits)