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Cycling injuries and alcohol

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ABSTRACT

Background: Most of the cycling accidents that occur in Finland do not end up in the official traffic accident statistics. Thus, there is minimal information on these accidents and their consequences, particularly in cases in which alcohol was involved. The focus of the present study is on cycling accidents and injuries involving alcohol in particular.
Methods: Data on patients visiting the emergency department at North Kymi Hospital because of a cycling accident was prospectively collected for two years, from June 1, 2004 to May 31, 2006. Blood alcohol concentration (BAC) was measured on admission with a breath analyser. The severity of the cycling injuries was classified according to the Abbreviated Injury Scale (AIS).
Results: A total of 217 cycling accidents occurred. One third of the injured cyclists were involved with alcohol at the time of visiting the hospital. Of these, 85% were males. A blood alcohol concentration of $\geq$ 1.2 g/L was measured in nearly 90% of all alcohol-related cases. A positive BAC result was more common among males than females ($p < 0.001$), and head injuries were more common among cyclists where alcohol was involved (AI) (60%) than among sober cyclists (29%) ($p < 0.001$). Two thirds (64%) of the cyclists with AI were not wearing a bicycle helmet. The figure for serious injuries (MAIS $\geq$ 3) was similar in both groups. Intoxication with an alcohol level of more than 1.5 g/L and the age of 15 to 24 years were found to be risk factors for head injuries. The mean cost of treatment was higher among sober cyclists than among cyclists with AI (€2143 vs. €1629), whereas in respect of the cost of work absence, the situation was the opposite (€1348 vs. €1770, respectively).
Conclusions: Cyclists involved with alcohol were, in most cases, heavily intoxicated and were not wearing a bicycle helmet. Head injuries were more common among these cyclists than among sober cyclists. As cycling continues to increase, it is important to monitor cycling accidents, improve the accident statistics and heighten awareness of the risks of head injuries when cycling under the influence of alcohol.

Introduction

As cycling has become more popular, admissions to hospital due to cycling injuries are rising. According to previous studies, a third of patients tested for alcohol after bicycle-related accidents were found to be intoxicated [1,2]. Previous studies show that alcohol has a serious effect on cycling injuries. However, in most cyclist injury cases, data on alcohol impairment is missing. In a recent German study (n = 2 250), only 6% of cases contained information on acute alcohol use at the time of admission to hospital [3].

A strong correlation has been shown between cycling under the influence of alcohol and head injuries [4]. Alcohol intoxication is associated with higher medical costs when patients are hospitalised or discharged as a result of bicycle-related injuries [1,2,5]. According to a German study, only 13% of injured cyclist cases could be found in police reports [3]. The main reason for the high level of underreporting is the high proportion of singlecycling accidents, i.e. accidents that do not involve another party and the police [6,7]. In Sweden, however, there is a national information system (STRADA) containing data on traffic accidents and injuries based on traffic accident reports provided by the police, and on medical reports provided by hospitals [8].

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According to a study on the health burden of serious road injuries (defined as a hospitalised non-fatal road casualty with an injury score) in the Netherlands from 2000 to 2011, about half of the serious road injuries were due to bicycle accidents not involving a motor vehicle [9]. The proportion of casualties among ≥60-year-olds was relatively high (43% in 2011) in these accidents. Head injuries (31%) and injuries to the lower extremities (37%) were most prevalent [9].

In Finland, bicycle injuries are also highly underreported because most incidents are single accidents, which are not recorded in official statistics. In such cases the information is only recorded in the hospitals' patient record systems and possibly in the rescue services' statistics. Finland's official traffic accident statistics are maintained by Statistics Finland and are based on information from the police [10,11].

The purpose of the present study was to describe an overall picture of the involvement of alcohol in bicycle accidents occurring in a catchment area comprising 100,000 inhabitants over a period of two years. We analysed the injuries, their severity and the consequences of accidents involving alcohol (AI) and compared the findings with cycling accidents in which the cyclists were sober. Furthermore, the aim was to estimate the risk factors for head injuries.

Patients and methods

The staff in the Emergency Department (ED) of the North Kymi Hospital, Kouvola, Finland, prospectively registered consecutive cycling accident victims who visited the ED for 2 years, from June 1, 2004 to May 31, 2006. During this period, it was possible to collect the injury data directly in the electronic patient record system via an injury database created for this purpose. According to population statistics during the study years, the North Kymi Hospital (level II trauma centre) was responsible for an area comprising nearly 100,000 inhabitants. The catchment area is a typical area in Finland, including both urban and rural municipalities.

The data included type of injury, external cause of injury and diagnoses of injuries, all in accordance with ICD-10 (FM) classification (International Classification of Diseases, 10th version, Finnish modification) and the use of a bicycle helmet (yes/no/not known). In all cases the blood alcohol concentration (BAC) of the patient was routinely checked by the staff of the ED with a breathalyser, and expressed as g/L.

Bicycle accidents were identified according to the external cause of injury (codes V10–V19 in ICD-10 FM). If the patient was referred for further treatment to the nearest central hospital of Kymenlaakso (level I trauma centre) or to the Department of Orthopaedics and Traumatology, Helsinki University Central Hospital (level I trauma centre), the patient's injury data was obtained from these hospitals.

The data was then checked and augmented with the following data, obtained from patient records or determined by the researchers: treatment of injury, length of stay as an inpatient in hospital (LOS), severity of injuries through two classifications and the period of absence from work.

The severity of the injuries was classified retrospectively according to the Abbreviated Injury Scale (AIS) version 2005 [12], and the New Injury Severity Score (NISS) [13] by one of the authors (P. L., surgeon in orthopaedics and traumatology). AIS classification has become internationally recognised due to its coverage and sensitivity [12]. On the AIS, injuries have been divided into nine categories according to body region: head; face; neck; thorax; abdomen; spine; upper extremity; lower extremity; unspecified. Severity has been assessed on a scale from 1 to 6 (1 = minor; 2 = moderate; 3 = serious; 4 = severe; 5 = critical; 6 = maximal. More generally, injuries have been classified as minor (AIS 1–2) or major (AIS 3–6). AIS classification does not involve assessing the combined effect of injuries; each injury is assessed separately, and an individual patient may be assigned several AIS values. The overall severity of injuries has been depicted with the MAIS (Maximum AIS) value. MAIS is defined as the patient's highest AIS value if there is more than one injury [12].

Furthermore, as a complementary classification to MAIS, the New Injury Severity Score (NISS) was calculated. The NISS [13] is a simple modification of the Injury Severity Score ISS [14]. ISS does not take into account multiple injuries in the same body region. NISS sums the squares of the three most severe injuries, regardless of the injured body region.

Direct costs (i.e. healthcare costs) of bicycle-related injuries were calculated using the hospital district price list and indirect costs (i.e. sick leave costs) to employers were estimated on the basis of the Finnish average salary statistics (€3378). All costs were expressed according to the 2017 price level.

The risk for head injury was analysed by calculating odds ratios (OR) with 95% confidence intervals for selected variables. Consequently, the adjusted odds ratio (OR) curves with 95% confidence intervals were drawn to graphically describe in detail the OR values for the observed risk factors. The detailed OR values were calculated densely using a smoothing procedure. The-weighted smoothing was performed with weights 1–2-4-2-1.

A statistical analysis was performed using SPSS software version 25. The χ^2 –test, the *t*-test and the Mann-Whitney test were used. The p-values of < 0.05 were considered statistically significant.

The study protocol was approved by the Ethics Committees of the Kymenlaakso Hospital District.

Results

During the two-year period, a total of 217 cyclists were involved in accidents, leading to a total of 307 injuries. The proportion of male drivers was 60% (n = 131). One third (31%, 67/217) of the injured cyclists were involved with alcohol (AI) at the time of visiting the hospital and 85% of them were males (n = 57). High alcohol levels predominated; 87% of all patients with AI had a breathalyser reading equal to or more than 1.2 g/l. The mean age of cyclists with AI was 43.7 years (SD 13.5) and the median was 39.3 years. The corresponding figures of sober cyclists were 37.0 years (SD 24.5) and 40.9 years. There was significant difference in mean age between these groups (t = 2.553, d.f. = 205.78, p = 0.011).

There was a significant difference in the figures of positive breathalyser results between males and females (57/131, 44% vs. 10/86, 12%, respectively) (χ^2 = 23.26, d.f. = 1, $p < 0.001$). Of the male cyclists with AI, nearly half (46%) were in the age group 35 to 49 years. (Table 1)

There were also two fatalities (not included in the data). Both involved collisions with a motor vehicle. Head injury was the cause of death in both cases. Neither of the victims was wearing a helmet. One of the victims died at the scene of the accident and the other was transported from the accident site via an ambulance rescue helicopter to Helsinki University Central Hospital, where the patient died.

Circumstances of accidents

Single accidents, i.e. accidents not involving another party, accounted for 81% of the cycling accidents (n = 174). The figures for accidents involving cyclists falling off their bicycles on their own were even higher for cyclists with AI (61/67, 91%) than for those without AI (113/150, 75%) (χ^2 = 6.24, d.f. = 1, p = 0.012). Cyclists with AI were more likely to have an accident on a weekend than those who were sober (43/67, 64% vs. 48/150, 32%) (χ^2 = 18.40, d. f. = 1, $p < 0.001$). The time of the accident remained unknown in 54

Table 1
Cycling accidents of males (n = 131) and females (n = 86) by involvement in alcohol (AI) according to age.

Age (years)	Males (n = 131)		Females (n = 86)		Total (n = 217)	
	AI n (%)	Sober n (%)	AI n (%)	Sober n (%)	AI n (%)	Sober n (%)
<5	0 (0%)	0 (0%)	0 (0%)	2 (3%)	0 (0%)	2 (1%)
5–9	0 (0%)	12 (16%)	0 (0%)	7 (9%)	0 (0%)	19 (13%)
10–14	0 (0%)	17 (23%)	0 (0%)	11 (14%)	0 (0%)	28 (19%)
15–19	4 (7%)	7 (9%)	0 (0%)	4 (5%)	4 (6%)	11 (7%)
20–24	1 (2%)	1 (1%)	1 (10%)	1 (1%)	2 (3%)	2 (1%)
25–29	5 (9%)	5 (7%)	2 (20%)	4 (5%)	7 (10%)	9 (6%)
30–34	3 (5%)	6 (8%)	0 (0%)	2 (3%)	3 (4%)	8 (5%)
35–39	8 (14%)	1 (1%)	3 (30%)	0 (0%)	11 (16%)	1 (1%)
40–44	7 (12%)	4 (5%)	0 (0%)	3 (4%)	7 (10%)	7 (5%)
45–49	11 (19%)	1 (1%)	2 (20%)	3 (4%)	13 (19%)	4 (3%)
50–54	4 (7%)	6 (8%)	0 (0%)	8 (11%)	4 (6%)	14 (9%)
55–59	6 (11%)	6 (8%)	2 (20%)	7 (9%)	8 (12%)	13 (9%)
60–64	5 (9%)	2 (3%)	0 (0%)	7 (9%)	5 (7%)	9 (6%)
65–69	2 (4%)	2 (3%)	0 (0%)	5 (7%)	2 (3%)	7 (5%)
70–74	1 (2%)	1 (1%)	0 (0%)	4 (5%)	1 (1%)	5 (3%)
75–79	0 (0%)	1 (1%)	0 (0%)	6 (8%)	0 (0%)	7 (5%)
80–84	0 (0%)	1 (1%)	0 (0%)	2 (3%)	0 (0%)	3 (2%)
85–89	0 (0%)	1 (1%)	0 (0%)	0 (0%)	0 (0%)	1 (1%)
Total	**57 (100%)**	**74 (100%)**	**10 (100%)**	**76 (100%)**	**67 (100%)**	**150 (100%)**

(26%) cases of which 17 were alcohol related and 37 were other accidents. Furthermore, of the remaining accidents with AI, 78% (39/50) occurred in the evening or during the night between 20.00 and 06.00, whereas the corresponding proportion among sober cyclists was 11% (12/113) (χ^2 = 70.10, d.f. = 1, p < 0.001) (Fig. 1).

Of the cyclists with AI, two thirds were not wearing a helmet, and among the remaining cyclists the use of a helmet was not known. Of the sober victims, one fifth were wearing a helmet, half of them were not wearing a helmet, and for 29% of cyclists the use of a helmet remained unknown. (Table 2) None of those who were wearing a helmet was under the influence of alcohol when admitted for treatment.

Injuries and their severity

Accidents with AI were more likely to lead to a head injury than those in which the cyclist was sober (40 out of 67, 60% vs. 43 out of 150, 29%, respectively). The difference was significant (χ^2 = 17.60, d.f. = 1, p < 0.001). On the other hand, there were significantly more elbow and forearm (χ^2 = 4.97, d.f.=1, p = 0.026) and wrist and hand injuries (χ^2 = 7.67, d.f. = 1, p = 0.006) among sober cyclists than among cyclists with AI. (Fig. 2). Two of the injured cyclists with AI (3%) and three of the sober cyclists (2%) received serious head injuries (AIS ≥ 3).

Single fractures were sustained by 23 (34%) of the cyclists with AI. Of the sober cyclists, 77 (51%) sustained fractures, on average 1.18 fractures per patient. The proportion of patients with a fracture to the head or face was almost as high in both groups: 9% (6/67) in cyclists with AI and 7% (10/150) in sober cyclists (χ^2 = 0.10, d.f. = 1, p = 0.753).

No differences were found between the sober cyclists and cyclists with AI according to AIS scores (Mann-Whitney test, p = 0.085). MAIS scores (Table 3) showed no difference, either. 9% of cyclists with AI (6 out of 67) and 8% of sober cyclists (13 out of 150) were seriously injured (MAIS ≥ 3) (χ^2 = 0.00, d.f. = 1, p = 1.000). The mean NISS severity scores of all cyclists was 3.8. Moreover, there were no significant differences in mean NISS values between the sober cyclists and cyclists with AI: 3.8 and 3.7, respectively (t = 0.260, d.f. = 215, p = 0.795).

Risk of head injury

Univariate analysis included the following variables; alcohol level, sex, age and another party. The results with odd ratios (OR) are shown in Table 4. An alcohol level of more than 1.5 g/L emerged

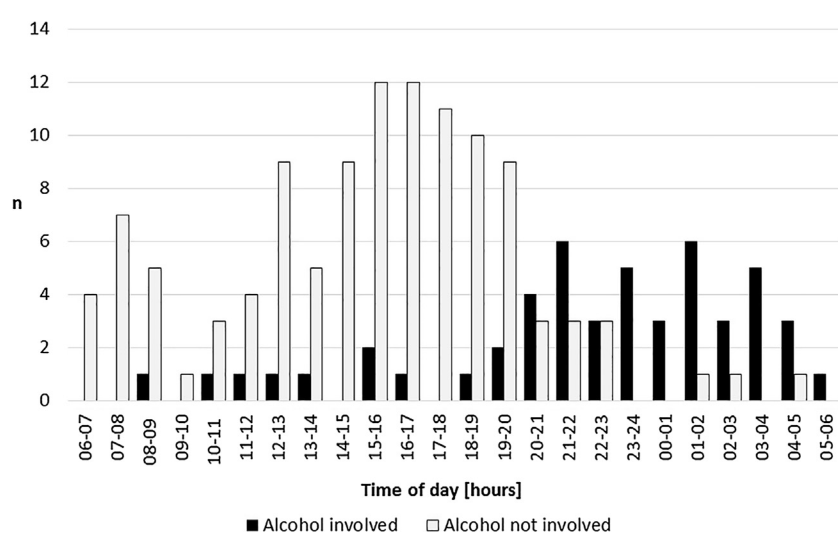

Fig. 1. Number of accidents among cyclists with and without involvement with alcohol according to the time of day.

Table 2
Use of bicycle helmet among cyclists according to involvement in alcohol.

	Alcohol involved (n = 67)		Alcohol not involved (n = 150)		Total (n = 217)	
	n	%	n	%	n	%
Yes	0	0	30	20	30	14
No	44	66	76	51	120	55
Unknown	23	34	44	29	67	31
Total	67	100	150	100	217	100

χ^2 = 15.66, d.f. = 2, p < 0.001.

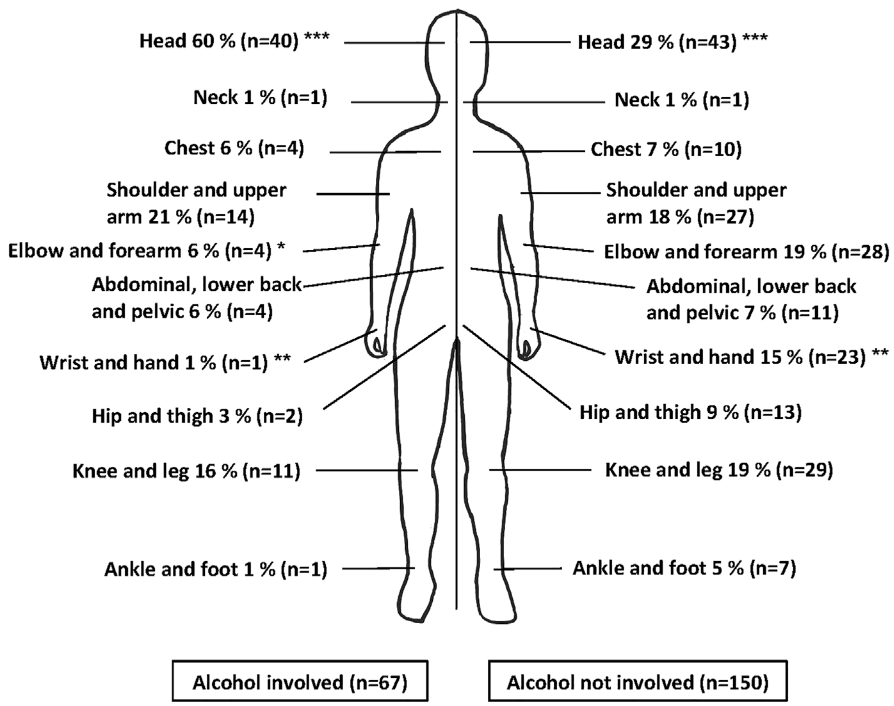

Fig. 2. Location of injuries among cyclists with and without involvement in alcohol, χ^2 chi-squared test * χ = 4.97, df = 1, p = 0.026, ** χ = 7.67, df = 1, p = 0.006, *** χ = 17.60, df = 1, p < 0.001.

Table 3
MAIS classification of injuries among cyclists according to involvement in alcohol.

MAIS[1]	Alcohol involved (n = 67)		Alcohol not involved (n = 150)	
	n	**%**	**n**	**%**
1	37	55	65	43
2	24	36	72	48
3	4	6	12	8
4	1	1	1	1
5	1	1	0	0
Total	**67**	**100**	**150**	**100**

Mann-Whitney test, p = 0.170.
[1] MAIS: Maximum AIS.

as a risk factor for head injuries (OR = 6.71, 95% CI: 3.37–13.34) as well as the age of 15 to 24 years (OR = 4.00, 95% CI: 1.64–9.78). The ORs for head injury according to age and, correspondingly, according to blood alcohol level, are shown in more detail in Figs. 3 and 4.

Treatment of injury and sick leave

One in four cyclists with AI were admitted to inpatient care (18 out of 67, 27%). The mean LOS per patient with AI was 5.8 days and the median was 3 days. The proportion of sober cyclists admitted to inpatient care was almost the same (43 out of 150, 29%) as those with AI (27%). The mean LOS per sober patient was 9.3 days and the median was 3 days. There was no significant difference in mean LOS between sober cyclists and cyclists with AI (t = 1.124, d.f. = 59, p = 0.265).

A surgical procedure was necessary in 13% of cyclists with AI (9 out of 67) and in 19% of sober cyclists (28 out of 150) (χ^2 = 0.57, d. f. = 1, p = 0.452). Two cyclists with AI (3%) and seven sober cyclists (5%) underwent more than one surgical procedure (χ^2 = 0.04, d. f. = 1, p = 0.837).

Nearly one third (67/217, 31%) of all patients required sick leave. One third (22/67, 33%) of the cyclists with AI were absent from work, whereas the corresponding figure in sober cyclists was 29% (44/150). The mean length of sick leave was 48 days per patient with AI and 41 days per sober patient (t = 0.387, d.f. = 64, p = 0.700).

Cost

The total cost of treatment of all bicycle-injury related patients was €430,602 and the mean cost per patient was €1984. The total cost of work absence was €320,775, and the mean cost per patient was €1478. The mean cost of treatment was higher among sober cyclists than among cyclists with AI (€2143 vs. €1629), whereas in

Table 4
Univariate analysis of 4 variables in relation to head injury data (n = 217)[a] with OR.

Variable	Negative	Positive	Total	OR	95% CI	Statistic
BAC (g/L)						
≤1.00	114	44	158	0.20	0.11–0.38	
1.01–1.50	8	6	14	1.23	0.41–3.66	
>1.50	12	33	45	6.71	3.37–13.34	χ^2 = 30.81, df = 2, p < 0.001
Sex						
Male	75	56	131	1.63	0.92–2.89	
Female	59	27	86	0.61	0.35–1.09	χ^2 = 2.83, df = 1, p = 0.092
Age (y)						
–14	33	13	46	0.57	0.28–1.15	
15–24	7	15	22	4.00	1.64–9.78	
25–34	12	14	26	2.06	0.91–4.66	
35–44	12	12	24	1.72	0.74–4.00	
45–54	24	13	37	0.85	0.41–1.78	
55–64	22	10	32	0.70	0.31–1.56	
65–74	13	5	18	0.60	0.21–1.73	
75-	11	1	12	0.14	0.02–0.81	χ^2 = 15.95, df = 7, p = 0.026
Another party involved						
No	110	64	174	0.74	0.37–1.45	
Yes	24	19	43	1.36	0.69–2.68	χ^2 = 0.80, df = 1, p = 0.370

χ^2 chi-squared test; OR odds ratio.
[a] All the classes of the variables are compared with each other within the variable.

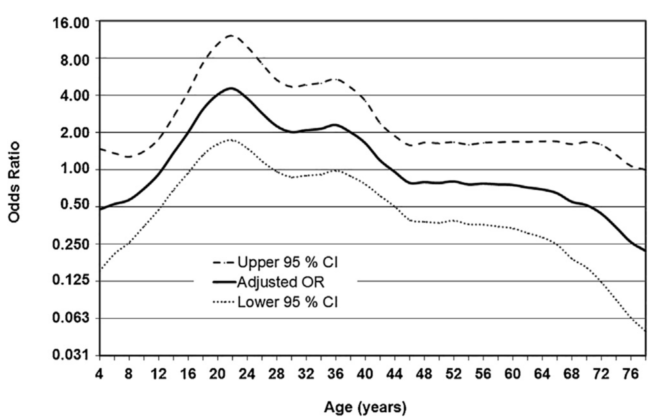

Fig. 3. Risk of head injury with 95% confidence intervals by age.

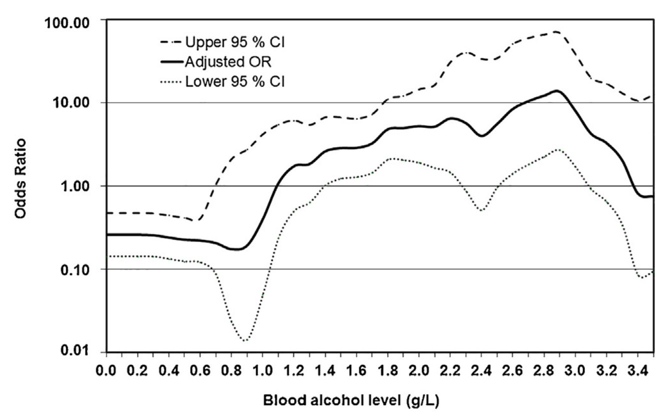

Fig. 4. Risk of head injury with 95% confidence intervals by blood alcohol level.

respect of the cost of work absence, the situation was the opposite (€1348 vs. €1770, respectively).

Discussion

Our main results demonstrated that one third of the injured cyclists were under the influence of alcohol at the time of attending the emergency hospital. Similar results were found in Tokyo [2] and Los Angeles, California [1]. According to a German database study, 57% of the cyclists involved in accidents had a BAC above 0.5 g/l, which is the maximum legal drink driving limit in Germany for a car or motorcycle [15]. The proportion of cycling fatalities for all road fatalities in the EU increased from around 6% to almost 8% between 2004 and 2013, and the highest figures were from 2010 to 2012 [16]. In 2014, approximately 26,000 people were killed in road accidents throughout the EU, and cycling fatalities made up 8.1% (n = 2112) of the total number of road accident fatalities [17].

In our present study, alcohol was a significantly more common factor in male than in female cycling accidents (p < 0.001). Similar results have been obtained in Germany [15], and also in a Dutch study in which cycling accidents were monitored over four nights in The Hague and Groningen [18].

According to Li et al. [19], a blood alcohol level of 0.2 g/L increased a cyclist's risk of injury by a factor of 6, and a blood alcohol level of 0.8 g/L and higher increased the risk of fatal or serious injury by a factor of up to 20 compared to a situation in which the cyclist was sober. In a Finnish study, the risk of head injury compared to the risk of injury to other parts of the body increased markedly when the blood alcohol level exceeded 1.5 g/L and was five times higher if the blood alcohol level was over 2.0 g/L [20]. In the present data, an alcohol level of more than 1.5 g/L and the age of 15 to 24 years were found to be risk factors for head injuries.

Our study showed that head injuries were more common in cycling accidents that involved alcohol (60%) than in accidents not involving alcohol (29%) (p < 0.001). Of the cyclists with AI, two thirds (64%) were not wearing a helmet, while the helmet use of the other cyclists remained unknown. Of the sober cyclists, however, 20% were provably wearing a helmet. Similar results have been presented previously [4,21,22]. According to a recent meta-analysis of 40 studies with data on more than 64,000 injured cyclists [23], the helmet use of cyclists involved in an accident or fall was associated with an odds reduction for head injury (OR = 0.49, 95% CI: 0.42–0.57), serious head injury (OR = 0.31, 95% CI: 0.25–0.37), facial injury (OR = 0.67, 95% CI: 0.56–0.81) and fatal head injury (OR = 0.35, 95% CI: 0.14–0.88) [23].

In Finland between 1991 and 2000, there were on average of 5000 new patients with brain injuries per year, and traffic accidents were the reason for 20% of these injuries [24]. Of all brain injuries sustained in traffic accidents, cyclists accounted for 36%, which was as much as the combined figure of brain injuries sustained by drivers and passengers in vehicular accidents [24]. About half of the patients who sustain minor or moderate brain damage recover within 3 to 6 months, beyond which some continue to have subjective symptoms that may last for more than a year [25,26]. Various symptoms may persist for up to 5 to 7 years, even after minor brain injuries [27]. Some patients who sustain a brain injury are left with permanent symptoms [28]. Moreover, according to a recent Finnish study involving a 10-year monitoring of 40,000 Finnish brain injury patients [29], the risk of serious or moderately severe brain injury was around twice as large as that of minor brain injury. The dementia risk was greater if the brain damage had been more serious. This observation particularly concerned middle-aged men [29].

In an Australian study (n = 1 787), the majority of cyclists returned to work 6 months (89%) and 12 months (92%) after the cycling accident [30]. However, only one third (32%) had a complete functional recovery as late as 6 months and less than half (42%) at 12 months [30]. This result is alarming considering the study was conducted in Victoria, where mandatory helmet laws were introduced in 1990 [31]. Police have the power to stop bicycle and scooter riders and issue a fine or a warning for not wearing an approved bicycle helmet [31].

Bicycle helmet usage has increased in Finland over the last decade and 43% of all cyclists were wearing a bicycle helmet in 2015 [32]. In the same year, there were 31 fatal cycling accidents and a total of 270 fatal traffic accidents in Finland (5.5 million inhabitants). Thus, fatal cycling accidents comprised 11.5% of the total number of road accident fatalities [33]. The corresponding proportion in the total EU area was lower (8.1%) in 2014 [16].

An interesting result was found in the present study. Sober cyclists had significantly more elbow/forearm and wrist/hand injuries and less head injuries than cyclists who were under the influence of alcohol. It seems that sober cyclists use their upper extremities during an accident to protect their head. According to Pang et al. [2008], the mechanism of injury of a cycling accident involves an outstretched arm [34]. A study from South Africa indicated that of all injured bicycle riders, around 60% of injuries were located in the upper limbs [35]. Furthermore, in a Belgian study (13,684 cyclist casualties from 1996 to 2008), 56% of all cyclists' injuries were located in the upper extremities [36]. It has also been reported that the shoulder is the most common injury site among cyclists [37]. In a study from Tel Aviv among 157 adult cyclists, 84% of the cyclists sustained shoulder injuries [38].

The present study shows that the total direct and indirect costs of bicycle-related injuries treated in ED were higher among sober cyclists than among cyclists with AI, and constituted a total of 1984 € per patient (at the 2017 price level). However, in a study from Tokyo, Japan (minor bicycle accidents involving 217 individuals aged ≥20 years, treated in ED), alcohol intoxication was independently associated with higher medical costs [2]. Two similar results from Arizona and New York indicated that the alcohol-positive cyclists were more seriously injured and their healthcare costs were higher than those of the sober cyclists [5,21].

Several EU countries have introduced blood alcohol concentration limits for cyclists. However, the four Nordic countries, Germany, the UK and Ireland have not (39, 40, Table 5). In these countries that have no BAC limit for cyclists, a sanction only takes place in cases in which cyclists are unable to control their cycling. For example, in Finland, thus far, cycling under the influence of alcohol is a criminal act if the cyclist causes danger to another person. In Finland (5.5 million inhabitants) in 2015 and 2016, there were only 43 such cases per year in which the cyclist was fined by the police [41]. According to Finnish legislation, the most severe punishment for this kind of act is three months in prison.

According to a survey conducted in Finland in 2017 [42], over a quarter (28%) of citizens had cycled under the influence of alcohol during the past five years. The survey also indicated that 45% of Finns consider drinking and cycling to be acceptable. It seems that our present law is not very effective.

Table 5
BAC limits and penalties for cycling in European countries [39,40].

Country	Alcohol limit [g/L]	Sanction [€]
Austria	0.8	≥ 800
Belgium	0.5	≥ 140
Britain	no limit[1]	≥ 35[2]
Croatia	0.5	≥ 65
Czech Republic	0.0	≥ 390
Denmark	no limit[1]	≥ 135[2]
Finland	no limit[1]	[2,3]
France	0.5	≥ 135
Germany	≥ 1.6	[4]
Ireland	no limit[1]	≤ 2000[2]
Italy	0.5	≥ 500
Luxemburg	0.5	≥145
The Netherlands	0.5	≥ 110
Norway	no limit[1]	[2,3]
Poland	0.2	≥ 145
Portugal	0.5	≥ 125
Slovakia	0.0	≥ 150
Spain	0.5	≥ 500
Sweden	no limit[1]	≥ 180[2,3]
Switzerland	0.5	≥ 110

[1] If a cyclist is under the influence of alcohol and cannot ride safely, the police will stop the cyclist from riding or advise the cyclist to walk with the bike.
[2] In individual cases, the police may issue a fine if a cyclist is under the influence of alcohol and cannot ride safely. In Finland, this will only happen if a drunken cyclist causes a risk to another person.
[3] The amount of the fine is determined by the person's income.
[4] Cycling under the influence of alcohol is punishable if the alcohol level is ≥ 1.6 g/L or if the cyclist cannot ride safely because of alcohol. This will result in 7 penalty points in the traffic register, and the cyclist will have to pay a fine of around one month's net salary. In addition, drunken cyclists (alcohol level ≥ 1,6 g/L) are subjected to a medical/psychological test and if they do not pass the test, they will lose their motor vehicle driving license. Persons who accumulate a total of 14 penalty points in the traffic register will lose their motor vehicle driving license.

Finally, cycling accidents under the influence of alcohol are considerably more common in Finland than might be judged from the official statistics [43]. Because of the inadequate coverage of the official statistics, minimal information is available on these accidents, and preventive measures are ineffective. Only one previous study on alcohol intoxication among cyclists in Finland has been conducted [44]. In Helsinki in 1986, every fourth cyclist injured was under the influence of alcohol [44]. Harmful alcohol use could be identified by submitting accident victims to a breath analyser test [45]. It has been shown that brief interventions at trauma units designed to reduce alcohol use and accidents are effective [46–48]. Even the testing that takes place in the ED itself represents an intervention that could make the cyclist rethink his/her alcohol use. Improving the compilation of accident statistics in emergency departments and using this information would significantly help to prevent cycling accidents and any kind of accident from occurring while under the influence of alcohol.

Unfortunately, in December 2013 in Finland, the Parliamentary Ombudsman issued a decision [49] in response to a citizen's complaint in which a citizen criticized the procedure of a health centre to test all accident victims in emergency rooms with a breath analyser. The decision stated that the healthcare unit had no right to systematically test all accident patients with a breath analyser because it would constitute interference with the patient's personal integrity and privacy. Measuring had to be medically justified within the individual patient situation as referred to in the Finnish Act on the Status and Rights of Patients and would have to be performed in agreement with the patient. However, establishing whether or not the patient is under the influence of alcohol is often justified, as it may be of great significance to proper diagnosis, treatment and follow-up treatment. Nonetheless, measurements simply cannot become the norm. [49] This decision complicates the research and prevention of alcohol-related accidents and injuries.

Strengths and limitations

No similar data collection or definition of serious injuries regarding cycling accidents has been conducted previously or ever since in Finland. Thus, the present data – though rather old – is unique. Furthermore, the data of the present study was manually checked and complemented by data on those patients who were also treated in the central or university hospital.

This was a single-centre study and therefore these results may not be generalized to other hospitals. However, the catchment area of our hospital is a typical area in Finland, with urban and rural municipalities, and injured patients were primarily asked to be treated in or were transferred to this level II hospital regardless of the severity of their injuries. Thus, the results can be generalized at least to an average urban and rural population in Finland.

Also, a limitation of the present study is the inability to ascertain the road conditions leading up to the accidents, e.g. lighting, quality of the road surface, or obstacles. The weather conditions also remained unclear. These factors were not included in the injury database although they would undoubtedly be important.

Further, we only counted the cost of acute hospital care and of sick leave. Costs following primary care and sick leave, e.g. cost of rehabilitation, visits to the outpatient department, transportation costs, and extra medication costs were not included.

Conclusion

The present study provides an important representative analysis of injuries occurring among sober cyclists and cyclists under the influence of alcohol in Finland. Due to the prevalence of cycling accidents involving alcohol and the increased risk of head injuries caused by cycling under the influence of alcohol, more effective measures, e.g. legislative amendments, should be considered in order to prevent this kind of behaviour. The high percentage of head injuries suggests that every cyclist should wear a bicycle helmet when riding a bicycle. As cycling continues to increase, it is important to monitor cycling accidents, improve the accident statistics and heighten awareness of the risks of head injuries when cycling under the influence of alcohol.

Conflict of interest

The authors declare that there are no financial and personal relationships with other people or organisations that could cause conflicts of interest.

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