Time of Injury and Relation to Alcohol Intoxication in Moderate-to-Severe Traumatic Brain Injury: A Decade-Long Prospective Study

Vera Vik Bjarkø[1], Toril Skandsen[2,4], Kent Gøran Moen[2,7], Sasha Gulati[2,5], Eirik Helseth[1,8], Tom I.L. Nilsen[3,6], Anne Vik[2,5]

■ BACKGROUND: **Knowledge about the causes and time of injury for traumatic brain injury (TBI) is important for the development of efficient prevention policies. We aimed to study time of injury and relation to alcohol intoxication for moderate-to-severe TBI in a level 1 trauma center in Norway.**

■ METHODS: **From October 2004 to September 2014, 493 consecutive patients (≥16 years) with moderate (Glasgow Coma Scale [GCS] score 9–13) and severe TBI (GCS score 3–8) were prospectively included in the Trondheim TBI Study (222 patients with moderate and 270 patients with severe TBI).**

■ RESULTS: **Mean age was 47 years (standard deviation 21 years). Positive blood alcohol concentration (BAC) was found in 29%, and median BAC was 41.5 mmol/L (interquartile range 28.7–54.3), equal to 1.91‰. Admissions were more frequent on Saturdays (relative risk [RR] 2.67, 95% confidence interval [CI] 1.87–3.80) and Sundays (RR 2.10, 95% CI 1.45–3.03) compared with Mondays, and positive BAC was more common on weekends than weekdays (43% vs. 16%). Furthermore, admissions were more frequent in June (RR 2.26, 95% CI 1.44–3.55), July (RR 2.07, 95% CI 1.31–3.28), and December (RR 2.07, 95% CI 1.31–3.28) compared with January. The number of patients with positive BAC was greatest in December (RR 5.75, 95% CI 1.99–16.63), and 70% of these were caused by falls.**

■ CONCLUSIONS: **Our findings demonstrate that moderate-to-severe TBI admissions display a clear weekly and seasonal variation and that alcohol is an important modifiable risk factor for moderate-to-severe TBI.**

INTRODUCTION

Traumatic brain injury (TBI) is a major cause of mortality and disability across all age groups and comes at a great socioeconomic cost to society and individuals.[1,2] In low- and middle-income countries, the incidence of moderate-to-severe TBI has been rising due to increasing motor vehicle use, whereas such accidents have been decreasing in high-income countries.[3-5] In contrast, an increase in elderly patients experiencing TBI due to falls has been observed in high-income countries.[6-9] Knowledge about when moderate-to-severe TBIs occur would be of value for the planning of appropriate prevention strategies for these injuries.

A recent study from Australia found that most general trauma admissions occur in the afternoons and more on weekends than on weekdays.[10] Alcohol intoxication is a known risk factor for injuries, and alcohol consumption on weekends may be a contributing cause for such weekly variation.[11] However, research is scarce. To our knowledge, no previous study has examined the time of injury patterns of moderate-to-severe TBI and whether alcohol may contribute to such a pattern. Hence, the aim of this study was to investigate time of injury, including

Key words
- Alcohol
- Epidemiology
- Prevention
- TBI
- Time of injury

Abbreviations and Acronyms
BAC: Blood alcohol concentration
CI: Confidence interval
CT: Computed tomography
GCS: Glasgow Coma Scale
RR: Relative risk
SD: Standard deviation
TBI: Traumatic brain injury

From the [1]Faculty of Medicine, Institute of Clinical Medicine, University of Oslo, Oslo; Departments of [2]Neuromedicine and Movement Science and [3]Public Health and Nursing, Norwegian University of Science and Technology (NTNU), Trondheim; Departments of [4]Physical Medicine and Rehabilitation and [5]Neurosurgery and [6]Clinic of Anesthesia and Intensive Care, St Olavs Hospital, Trondheim University Hospital, Trondheim; [7]Department of Medical Imaging, Levanger Hospital, Levanger; and [8]Department of Neurosurgery, Oslo University Hospital, Oslo, Norway

To whom correspondence should be addressed: Vera Vik Bjarkø, M.D. [E-mail: vbjarko@gmail.com]

Citation: World Neurosurg. (2019) 122:e684-e689. https://doi.org/10.1016/j.wneu.2018.10.122

*Journal homepage: **www.journals.elsevier.com/world-neurosurgery***

*Available online: **www.sciencedirect.com***

possible seasonal variations, and relation to alcohol intoxication in moderate-to-severe TBI in a level 1 trauma center in Norway.

METHODS

Study Region and Population

The study was conducted as a part of the Trondheim TBI studies.[12] During a 10-year period (October 1, 2004, to September 30, 2014), all patients 16 years or older with moderate-to-severe TBI admitted to St. Olavs Hospital, Trondheim University Hospital, Norway, were registered prospectively ($n = 493$). The hospital is 1 of 5 level 1 trauma centers in Norway and the only university hospital in the Central Norway region. The hospital covers 3 counties, with a total of approximately 670,000 inhabitants in 2004 and 700,000 in 2014. For 1 of these counties (306,000 inhabitants in 2014), all patients with moderate-to-severe TBI are admitted to the university hospital. In the 2 other counties, all patients with severe TBI (except for some of the oldest with poor prognosis) and most patients with moderate TBI are transferred to the university hospital, depending on their need of neurosurgical treatment, severity of computed tomography (CT) findings, or major extra-cranial injuries.

Inclusion Procedure

Residents in neurosurgery and neurology registered the patients prospectively and collected data for each patient. The data were subsequently quality checked by a research nurse. To ensure no missing patients, the trauma register of the university hospital's emergency department was regularly scanned for patients with TBI eligible for inclusion, and less than 3% were included in this manner. Only 4 (0.6%) patients did not consent to extensive study inclusion, and these were anonymously registered with age, sex, date of injury, and injury severity.

Injury Severity Classification of the TBI and Cause of Injury

Brain injury severity was assessed with the Glasgow Coma Scale (GCS). GCS scores 9–13 were defined as moderate TBI and GCS scores 3–8 as severe TBI.[2] Injury severity category was determined based on GCS score at arrival to the university hospital ($n = 168$). However, in patients with deterioration after admission, the worst category was used ($n = 31$). If the patient had been intubated before arrival at the university hospital, the unsedated GCS score closest in time to their arrival was used, ($n = 273$), either the GCS score at the scene or at the primary hospital. Because alcohol intoxication is known to influence the GCS score,[12] the severity was changed to the appropriate severity category in some patients, i.e., from severe to moderate ($n = 17$), when the GCS score was obviously too low due to intoxication during the first hours. Similarly, some intoxicated patients with initial GCS $\leq$13 were excluded as they were considered to have a mild TBI. This decision was based on a quick increase in GCS score and normal or modest CT findings. In 4 additional patients, exact GCS score was missing. In 1 of these patients, injury severity category also was missing. The causes of injury were classified as traffic accident (inside car, on moped/motorcycle/snow scooter or other motor vehicle, bike or pedestrian) fall, violent assault, gunshots, others, and unknown.

Blood Alcohol Concentration (BAC)

BAC was examined in 73% of patients ($n = 362$). Although BAC was included in the routine blood sampling, this was not always performed, especially in the older patients. Hence, BAC was examined in 82% of patients aged 16–50 years, 68% of patients 51–75 years, and 46% of patients >75 years. When calculating the percentage of patients with positive BAC, the total number of patients was used as the denominator, assuming that most patients not examined for BAC were sober. Clinical suspicion of alcohol intoxication was assessed by residents as a yes/no variable, based on information from the patient or other sources, such as smell. This variable was registered in 98% of patients.

Time and Seasonal Variables

The date and time of injury was registered. If the exact time of injury was unknown, it was estimated to the closest half-hour. In 88 patients (18%), the date of injury was known, whereas the exact time of injury was unknown and impossible to estimate. These patients were excluded in analyses regarding time of the day for injuries.

Night was defined as 00:00–6:00, morning as 6:00–12:00, afternoon as 12:00–18:00, and evening as 18:00–24:00. Monday night through Friday afternoon was defined as weekdays, and Friday evening through Sunday evening as the weekend.

Statistical Analysis

Patient and injury characteristics are presented as numbers with percentages; median with interquartile range; and mean with standard deviation (SD). The Pearson χ^2 test was used when comparing the proportion of BAC-positive patients between groups. The Student t test was used to compare mean age between the sexes. We used Poisson regression to calculate relative risks (RRs) with 95% confidence interval (CI) of injures between day of the week and calendar months, using Monday and January as reference, respectively. All analyses of calendar months were normalized to 30 days. The statistical significance level was set to $P < 0.05$ (2-sided). Statistical analyses were performed in SPSS 22.0 (IBM Corp., Armonk, New York, USA) and Stata 12 for Windows (StataCorp LT, College Station, Texas, USA).

Ethics Approval and Consent to Participate

The study was approved by the Regional Ethical Committee. Informed consent to study inclusion was given by the patients themselves or their next of kin. Use of data from deceased patients or patients not able to consent due to social circumstances was approved by the Norwegian Directorate of Health (before 2009) and the Regional Ethical Committee (since 2009).

RESULTS

Demographics and Cause of Injury

During the 10-year study period, 493 patients with TBI were admitted. Patient and injury characteristics, CT findings, and management are summarized in **Table 1**. The 10-year age group with the greatest number of patients were young adults from 16 to 25 years (25% of total). The mean age was significantly greater in women (53 years, SD 23) than in men (45 years, SD 20) ($P = 0.001$). The major causes of injury were falls (47%) and traffic

Table 1. Patient and Injury Characteristics, CT Findings, and Management of All Patients in the Moderate-to-Severe TBI Cohort

Variable	Patients (n = 493)
Age, years, mean (SD)	46.9 (21.3)
Age group, *n* (%)	
16–25 years	121 (25)
26–35 years	65 (13)
36–45 years	64 (13)
46–55 years	68 (14)
56–65 years	65 (13)
66–75 years	53 (11)
76–85 years	41 (8)
>85 years	16 (3)
Sex, male/female, *n* (%)	365/128 (74/26)
Injury mechanism, *n* (%)	
Fall	229 (47)
Traffic accident	209 (42)
Violent assault	18 (3.7)
Gunshots	6 (1.2)
Other	21 (4.2)
Unknown	7 (1.4)
If traffic accident, *n* (%)	
Car	115 (55)
Motorcycle/moped	30 (14)
Bicycle	31 (15)
Pedestrian	27 (13)
Other	4 (1.9)
Unknown	2 (1.0)
Injury severity category, *n* (%)*	
Severe TBI	270 (55)
Moderate TBI	222 (45)
GCS score, median (IQR)†	8 (4–12)
CT findings, *n* (%)‡	
Subdural hematoma	272 (55)
Epidural hematoma	70 (14)
Cortical contusion(s)	281 (57)
Subarachnoid/intraventricular hemorrhage	304 (62)
General edema	146 (30)
Fracture	279 (57)
Management, *n* (%)§	
ICP monitoring *n* (%)	
Moderate	41 (20)
Severe	165 (79)
Evacuation of mass lesion *n* (%)	
Moderate	34 (16)
Severe	77 (37)

Continues

Table 1. Continued

CT, computed tomography; TBI, traumatic brain injury; SD, standard deviation; GCS, Glasgow Coma Scale; IQR, interquartile range; ICP, intracranial pressure.
*One missing.
†Twenty-two missing.
‡Nine missing.
§Excluding patients who did not receive active treatment because they were considered unsalvageable (n = 35), patients not receiving active treatment due to age and/or comorbidity (n = 9), and patients who died within 24 hours due to extracranial injuries (n = 8). Four missing.

accidents (42%). Traffic accidents were the cause of injury in 64% of patients aged 16–25 years. Falls were the cause of injury in 67% of patients aged 51–75 years, and in 75% of patients >75 years.

Blood Alcohol Concentration

BAC was positive in 29% (n = 143). Another 3.3% (n = 17) were clinically suspected to be under the influence of alcohol but were not examined for BAC. Sixteen percent (n = 20) of women had positive BAC, compared with 34% (n = 123) of men (P < 0.001). In patients >75 years, 9% (n = 5) had positive BAC, and in patients aged 16–25 years, 43% (n = 52) had a positive BAC. Thirty-three percent of patients injured by falls had positive BAC compared with 26% of patients injured in traffic accidents (P = 0.11). In BAC-positive patients, median BAC was 41.5 mmol/L (interquartile range 28.7–54.3), equal to 1.91‰, and 90% had a BAC >17.4 mmol/L (0.8‰).

Time of Injury Patterns and Relation To BAC

Moderate-to-severe TBIs were more frequently sustained on Saturdays (RR 2.67, 95% CI 1.87–3.80; P < 0.001) and Sundays (RR 2.10, 95% CI 1.45–3.03; P < 0.001) compared with Mondays (Table 2 and Figure 1). Of all nighttime accidents, 70% were on Saturdays and Sundays (Figure 2). The proportion of patients with positive BAC was greater on weekends than weekdays (43% vs. 16%, P < 0.001). In the subgroup of patients with negative BAC (71%), there was no significant difference between the days of the week (P = 0.75).

Injuries were more common in June (RR 2.33, 95% CI 1.48–3.67; P < 0.001), July (RR 2.07, 95% CI 1.31–3.28; P = 0.002), and December (RR 2.07, 95% CI 1.31–3.28; P = 0.002), compared with January (Figure 3). Of all traffic-related TBI, 31% (n = 65) occurred in June and July. Of all bicycle, moped, and motorcycle accidents, 48% (n = 29) occurred in June and July. The number of patients with positive BAC varied throughout the year and was greatest in December (RR 5.75, CI 1.99–16.63, P = 0.001) compared with January (Table 2). In BAC-positive TBIs in December, 70% were caused by falls.

Table 2. Relative Risk of Overall and Alcohol-Related Moderate-to-Severe TBI According to Day of the Week and Month

	Overall TBI		BAC-Positive TBI	
Time Period	**RR**	**95% CI**	**RR**	**95% CI**
Day of the week				
Monday	1.00	Reference	1.00	Reference
Tuesday	1.36	0.91–2.02	1.20	0.37–3.93
Wednesday	1.50	1.02–2.22	1.60	0.52–4.89
Thursday	1.45	0.98–2.13	2.60	0.93–7.29
Friday	1.64	1.12–2.41	5.00	1.91–13.06
Saturday	2.67	1.87–3.80	11.20	4.49–27.96
Sunday	2.10	1.45–3.02	6.00	2.33–15.46
Month				
January	1.00	Reference	1.00	Reference
February	1.44	0.87–2.37	1.94	0.57–6.62
March	0.96	0.56–1.65	1.25	0.34–4.65
April	1.22	0.73–2.04	2.07	0.62–6.86
May	1.00	0.59–1.70	2.25	0.69–7.31
June	2.33	1.48–3.67	4.91	1.67–14.43
July	2.07	1.31–3.28	4.00	1.34–11.96
August	1.70	1.06–2.74	3.00	0.97–9.30
September	1.84	1.15–2.94	4.39	1.48–13.05
October	1.48	0.91–2.41	3.25	1.06–9.97
November	1.45	0.89–2.38	2.58	0.81–8.24
December	2.07	1.31–3.28	5.75	1.99–16.63

TBI, traumatic brain injury; BAC, blood alcohol concentration; RR, relative risk; CI, confidence interval.

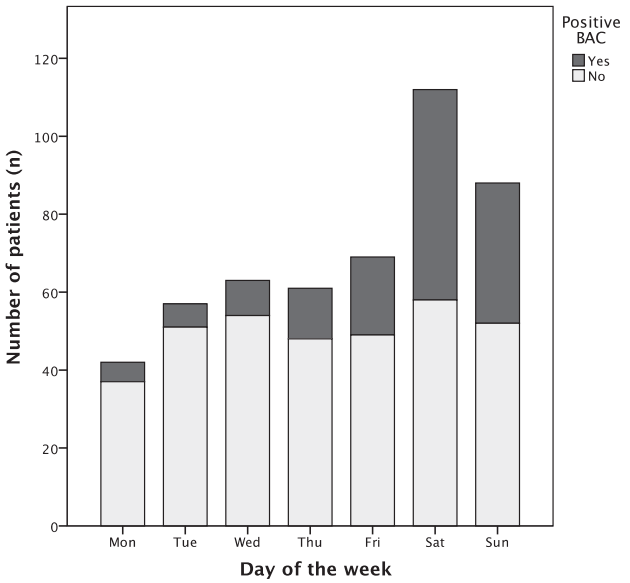

Figure 1. Moderate-to-severe traumatic brain injury (TBI) by day of the week and alcohol status. BAC, blood alcohol content.

DISCUSSION

In this 10-year prospective study of a complete cohort of patients with moderate-to-severe TBI admitted to a level 1 trauma center in a combined urban and rural region of Norway, we found a weekly and a seasonal pattern for moderate-to-severe TBI. Furthermore, high numbers of patients with elevated BAC coincided with the high numbers of accidents leading to such TBI on weekends. Finally, there seemed to be a relationship between alcohol intoxication and the observed seasonal variations.

Alcohol Intoxication

We found 29% of patients to have positive BAC and another 3% to have clinical suspicion of alcohol intoxication, without having measured their BAC. In BAC positive patients, 90% had a BAC greater than 0.8‰. Although Norway ranks at the lower levels of statistics on alcohol consumption in Western countries,[13] this finding shows that despite a low yearly consumption per capita, alcohol intoxication is an important modifiable risk factor for TBI.[14,15] Alcohol intoxication has been reported to be present in 25%–39% of patients in recent European studies on moderate-to-severe TBI; however, these did not report whether values were based on BAC or clinical suspicion.[7,16] One Finish retrospective study on moderate-to-severe TBI had information on BAC from 58% of included patients, whereof 56% were positive, and the median BAC was similar to the one observed in this study.[11] In our study as many as three quarters of the patients were examined for blood alcohol, and almost all were screened for clinical suspicion of alcohol. To our knowledge, no other studies have measured BAC in such a high percentage of patients with moderate-to-severe TBI.

The mean age and male to female ratio of the patients included in this study are comparable with the results of recent European studies.[7,16] We found teenagers and young adults aged 16–25 years to be the age group most affected by moderate-to-severe TBI, and in this group 43% of patients had positive BAC. In female subjects, there were only 16% of patients who were BAC positive. The female patients were also significantly older than the male patients, and BAC was not measured as often in older patients as in the younger. There was no difference in the percentage of BAC-positive patients that were injured by falls or traffic accidents.

Time of Week Variation

We observed a weekly pattern in the distribution of moderate-to-severe TBI, with more accidents on weekends. Interestingly, among sober patients there was no significant difference between TBI admissions on weekends and weekdays, whereas the difference was highly significant in the BAC-positive subgroup. Furthermore, we found that on weekends, accidents were more

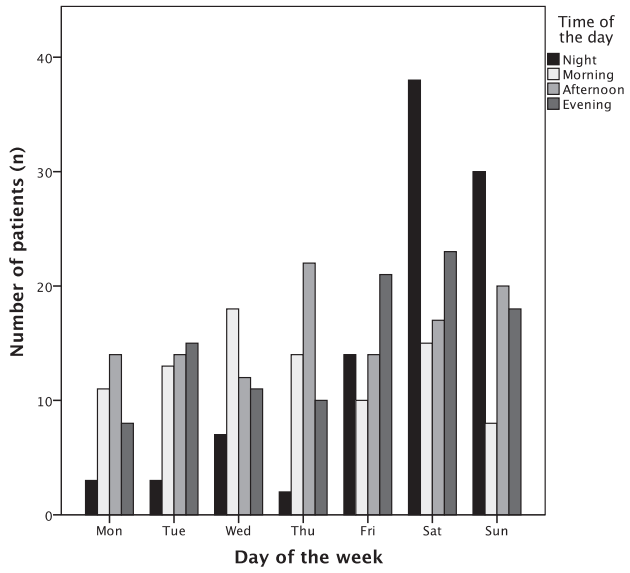

Figure 2. Injury time of moderate-to-severe traumatic brain injury (TBI) by day of the week and time of the day.

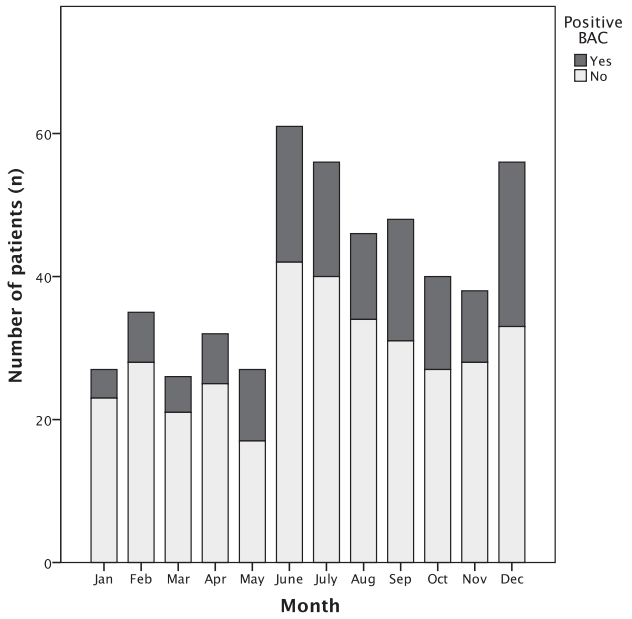

Figure 3. Moderate-to-severe traumatic brain injury (TBI) by month and alcohol status. BAC, blood alcohol content.

likely to occur in the evening and night time. We were not able to find any previous study that has examined the time of injury patterns of moderate-to-severe TBI. However, a Finnish study found similar results on the weekly distribution of alcohol-related head injuries, when also including mild and minimal TBI.[17] The weekly variation of alcohol-related TBI suggests that many of these injuries occur as a consequence of acute alcohol intoxication at times when alcohol consumption is considered to be socially appropriate, such as weekend evenings, suggesting that these injuries are not necessarily related to alcoholism. Thus, the weekly variation observed in our study will probably be representative for other countries where binge drinking on weekends is a typical drinking pattern in young individuals, such as in Europe and North America.[11,18,19]

Time of Year Variation

We found a clear seasonal variation in moderate-to-severe TBI. Whereas accident numbers were low in the first 5 months of the year, they were greater in the months of June, July, and in December. The high numbers of TBI caused by traffic accidents in June and July were particularly evident. Previous studies on the seasonal variation of road traffic accidents from other geographical regions have suggested that these increase during holidays and vacation months due to increased travel.[17,20] Furthermore, almost one half of all moped, motorcycle and bicycle accidents occurred in the months of June and July. These vehicles are likely more in use in the summer climate, suggesting that weather conditions also may play a role in this seasonal variation.

In December, there was a high number of patients with positive BAC, and most of these patients were injured by falls. Due to Christmas celebrations, December is a festive month with increased leisure activity, travel, and alcohol intake. A large cohort study on alcohol habits conducted in Central-Norway found December to be the month in which most persons reported that they had been drinking alcohol, which coincides with high national sales of alcohol in December.[21] This finding may be applicable to other countries in which Christmas celebrations are associated with increased alcohol intake, as well as to countries in which other holidays are associated with increased alcohol intake.

The seasonal pattern for moderate-to-severe TBI is an important and novel finding with clinical implications. The low numbers of moderate and severe TBI in certain months of the year demonstrate that many of the accidents causing these severe injuries, often resulting in long-lasting disabilities or even death, are avoidable. Furthermore, knowing at what time of the year accidents peak may be helpful for further prevention of injuries, and for the management of staff in emergency rooms, neurosurgery, and rehabilitation departments. A reduction in clinical activity during summer months is common. Seeing that moderate-to-severe TBIs often occur during the summer, one would have to question this practice.

Strengths and Limitations

This complete cohort of 493 patients with moderate-to-severe TBI was registered prospectively, and consecutive patients admitted to the university hospital were included in the study, minimizing the chances for selection bias. Although a very large percentage of patients were screened for BAC, ideally all patents should have been tested. However, only 17 patients not tested for BAC were clinically suspected of alcohol intoxication. Thus, it is unlikely that

many cases of alcohol intoxication were missed. Intoxication with other recreational drugs was not investigated.

We performed a careful consideration of patients who could have had a falsely low GCS score because of alcohol intoxication during the first hours after injury by excluding patients who obviously had a mild TBI. Furthermore, some patients were reclassified from severe to moderate TBI. However, we cannot exclude that still some patients were not correctly classified because of alcohol intoxication, which is always a challenge in TBI research.[22] This is also shown in a recent study based on part of the same cohort as in the present study, demonstrating that influence of alcohol significantly reduced the GCS score in a dose dependent manner in moderate and severe TBI patients with Rotterdam CT scores of 1–3 (i.e., mostly modest CT findings).[12]

CONCLUSIONS

This study shows that moderate-to-severe TBI admissions display a weekly and a seasonal pattern of distribution. Because the time of injury pattern investigated is likely to be tied to culture, weather, and timing of vacations and holidays, our results may not be directly applicable to all countries. However, our results show that TBI admissions are more frequent during vacation months and holidays, and this is likely to be relevant also for countries in which vacation time is set to different months. These findings may have implications not only for prevention strategies but also for the management of hospital departments that deal with these patients. Furthermore, we found that high numbers of TBI admissions on weekends and in vacation months coincided with high numbers of patients with elevated blood alcohol levels at the same times. These findings indicate that acute alcohol intoxication is an important modifiable risk factor for moderate-to-severe TBI.

ACKNOWLEDGMENTS

The authors thank residents and consultants at the neurosurgical department for their help with inclusion of patients to the study and the research nurses Beate M. Voll, Stine B. Lund, and Oddrun Sandrø for invaluable help with the Trondheim TBI studies.

REFERENCES

1. Sundstrom T, Sollid S, Wentzel-Larsen T, Wester K. Head injury mortality in the Nordic countries. *J Neurotrauma*. 2007;24:147-153.
2. Maas AI, Stocchetti N, Bullock R. Moderate and severe traumatic brain injury in adults. *Lancet Neurol*. 2008;7:728-741.
3. Colantonio A, Croxford R, Farooq S, Laporte A, Coyte PC. Trends in hospitalization associated with traumatic brain injury in a publicly insured population, 1992–2002. *J Trauma*. 2009;66:179-183.
4. Brazinova A, Rehorcikova V, Taylor MS, Buckova V, Majdan M, Psota M, et al. Epidemiology of traumatic brain injury in Europe: a living systematic review [e-pub ahead of print]. *J Neurotrauma*. 2016. https://doi.org/10.1089/neu.2015.4126. Accessed October 10, 2017.
5. Maas AIR, Menon DK, Adelson PD, Andelic N, Bell MJ, Belli A, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. *Lancet Neurol*. 2017;16:987-1048.
6. Hyder AA, Wunderlich CA, Puvanachandra P, Gururaj G, Kobusingye OC. The impact of traumatic brain injuries: a global perspective. *NeuroRehabilitation*. 2007;22:341-353.
7. Andelic N, Anke A, Skandsen T, Sigurdardottir S, Sandhaug M, Ader T, et al. Incidence of hospital-admitted severe traumatic brain injury and in-hospital fatality in Norway: a national cohort study. *Neuroepidemiology*. 2012;38:259-267.
8. Peeters W, van den Brande R, Polinder S, Brazinova A, Steyerberg EW, Lingsma HF, et al. Epidemiology of traumatic brain injury in Europe. *Acta Neurochir*. 2015;157:1683-1696.
9. Peeters S, Blaine C, Vycheth I, Nang S, Vuthy D, Park KB. Epidemiology of traumatic brain injuries at a major government hospital in Cambodia. *World Neurosurg*. 2017;97:580-589.
10. Cantwell K, Morgans A, Smith K, Livingston M, Spelman T, Dietze P. Time of day and day of week trends in EMS demand. *Prehosp Emerg Care*. 2015;19:425-431.
11. Puljula J, Makinen E, Cygnel H, Kortelainen ML, Hillbom M. Incidence of moderate-to-severe traumatic brain injuries after reduction in alcohol prices. *Acta Neurol Scand*. 2013;127:192-197.
12. Rundhaug NP, Moen KG, Skandsen T, Schirmer-Mikalsen K, Lund SB, Hara S, et al. Moderate and severe traumatic brain injury: effect of blood alcohol concentration on Glasgow Coma Scale score and relation to computed tomography findings. *J Neurosurg*. 2015;122:211-218.
13. Strand BH, Steiro A. Alcohol consumption, income and education in Norway, 1993–2000. *Tidsskr Nor Laegeforen*. 2003;123:2849-2853 [in Norwegian].
14. Makela P, Fonager K, Hibell B, Nordlund S, Sabroe S, Simpura J. Episodic heavy drinking in four Nordic countries: a comparative survey. *Addiction*. 2001;96:1575-1588.
15. Rossow I, Bogstrand ST, Ekeberg O, Normann PT. Associations between heavy episodic drinking and alcohol related injuries: a case control study. *BMC Public Health*. 2013;13:1076.
16. Andriessen TM, Horn J, Franschman G, van der Naalt J, Haitsma I, Jacobs B, et al. Epidemiology, severity classification, and outcome of moderate and severe traumatic brain injury: a prospective multicenter study. *J Neurotrauma*. 2011;28:2019-2031.
17. Puljula J, Savola O, Tuomivaara V, Pribula J, Hillbom M. Weekday distribution of head traumas in patients admitted to the emergency department of a city hospital: effects of age, gender and drinking pattern. *Alcohol Alcohol*. 2007;42:474-479.
18. Siliquini R, Colombo A, Berchialla P, Bert F, Group T-D. Binge drinking and psychoactive drug use in a cohort of European youths. *J Public Health Res*. 2012;1:83-88.
19. Reich RR, Cummings JR, Greenbaum PE, Moltisanti AJ, Goldman MS. The temporal "pulse" of drinking: tracking 5 years of binge drinking in emerging adults. *J Abnorm Psychol*. 2015;124:635-647.
20. Khorshidi A, Ainy E, Hashemi Nazari SS, Soori H. Temporal patterns of road traffic injuries in Iran. *Arch Trauma Res*. 2016;5:e27894.
21. Knudsen AK, Skogen JC. Monthly variations in self-report of time-specified and typical alcohol use: the Nord-Trondelag Health Study (HUNT3). *BMC Public Health*. 2015;15:172.
22. Stocchetti N, Pagan F, Calappi E, Canavesi K, Beretta L, Citerio G, et al. Inaccurate early assessment of neurological severity in head injury. *J Neurotrauma*. 2004;21:1131-1140.

Conflict of interest statement: K. G. Moen and T. Skandsen have, during the study period, received research grants from The Liaison Committee between the Central Norway Regional Health Authority (RHA) and The Norwegian University of Science and Technology (NTNU). This funding body did not play any role in the planning or execution of the study, nor in the decision to submit the article for publication.

Received 16 July 2018; accepted 19 October 2018

Citation: World Neurosurg. (2019) 122:e684-e689. https://doi.org/10.1016/j.wneu.2018.10.122

*Journal homepage: **www.journals.elsevier.com/world-neurosurgery***

*Available online: **www.sciencedirect.com***