

Characteristics of Alcohol-related Injuries in Adolescents Visiting the Emergency Department

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Alcohol is frequently a factor affecting emergency department patients, and alcohol consumption is more common among those who are injured. In Korea, the socioeconomic impact of alcohol has been enormous because of traditional permissive attitudes toward alcohol. Juvenile drinking has increased recently; consequently, an increase in alcohol-related injuries is likely in this population. Therefore, we compared the characteristics and severity of alcohol-related injuries in adolescents and adults. All injured patients seen at six EDs throughout 2007 were included. We obtained data from the 'Development of a model for an in-depth injury surveillance system based on the emergency department' surveillance. The proportion of adolescents who drank was 5.0%. No significant alcohol-related difference in injuries was found between male and female adolescents ($P = 0.14$), whereas in adults, being male was strongly related to alcohol consumption ($P < 0.001$). Among traffic accidents, motorcycle-related injuries were strongly associated with alcohol use in adolescents (odds ratio [OR] 2.52, 95% confidence interval [CI] 1.09-5.83). Results also indicated that alcohol-related injuries in adolescents showed poor outcomes (OR 2.36, 95% CI 1.47-3.81) as compared with those in adults (OR 1.42, 95% CI 1.26-1.59). Preventive strategy on alcohol-related injuries in adolescents should focus on reducing motorcycle accidents.

Key Words: Adolescent; Alcohols; Alcohol Drinking; Wounds and Injuries

INTRODUCTION

In Korea, the socioeconomic cost of drinking has been increasing annually. The total social cost of drinking was about 3.0% of the gross domestic product (GDP) in 2004, and this has since increased. The drinking problem is becoming grave, as drinking consumes 0.5%-2.7% of the GDP in most countries. There is a strong association between alcohol consumption and injuries leading patients to visit the emergency department (ED). Recently, the World Health Organization (WHO) reported that in 12 countries, 6%-45% of injuries in the ED were associated with alcohol (1). Korean culture has a generous attitude toward alcohol; hence, the drinking population exceeds 60% of the total. More than 40% of people drink more than once a week, and the drinking rate in women and teenagers has increased (2). Therefore, we predict that the incidence of injuries resulting from alcohol will increase. However, there has been little systematic collection and analysis of data on alcohol and injuries in Korea, so it is difficult to investigate the actual conditions of adolescent drinking.

The Statistics Korea reported officially that motor vehicle accidents and suicide are major causes of deaths in juvenile pop-

ulation (3). Comprehending the cause of injury is important for reducing these deaths, particularly among teenagers. However, as mentioned, the systematic collection of data on alcohol-related injuries is insufficient in general and is nonexistent for teens in Korea.

We investigated the epidemiologic characteristics of alcohol-related injuries and confirmed the severity of injuries in adolescents with the goal of preventing alcohol-related injuries in adolescents.

MATERIALS AND METHODS

We obtained data from the 'Development of a model for an in-depth injury surveillance system based on the emergency department'. This surveillance has been conducted under the supervision of the Korea Center for Disease Control and Prevention (KCDCP) to gather injury-related statistics and to establish policies regarding injury prevention. The emergency departments of six institutions, all tertiary, university-affiliated hospitals, were first designated in 2007, including three EDs located in Seoul, two in Gyeonggi-do, and one in Gangwon-do district. We investigated the epidemiologic characteristics of injured pa-

tients who visited these six EDs throughout 2007. We gathered basic information, such as sex, age, day and time of visit, and injury-related information, such as place, activity, mechanism, association with alcohol, and intent and result of emergency care. Self-reporting and the physician's diagnosis based on the smell of alcohol were both used to assess alcohol ingestion by the ED patients. We excluded an analysis of socioeconomic indices because of many omissions in the data.

In Korea, adolescence is legally defined as younger than 19 yr old. Pubs are restricted areas, and the sale of alcoholic beverages to adolescents is prohibited. Therefore, we compared injured patients from 13 to 18 yr of age with adults aged 19 yr and older.

Continuous variables are described as the mean and standard deviation and were compared using the t-test. Categorical variables were compared using the chi-square test, using SPSS 12.0. Logistic regression analysis was performed to examine the relationship between alcohol and the severity of injury. Differences were accepted as statistically significant if the *P* value was lower than 0.05.

Ethics statement

This study was approved by the Institutional Review Board of Ewha Womans University Mok Dong Hospital (ECT 231-2-47). Informed consent was exempted for review by the board because this study enrolled anonymous electronic data.

RESULTS

Demographic characteristics

During the study period, 70,523 injured patients were seen at the six EDs. We excluded patients whose alcohol-related information was unknown and children younger than 12 yr (Fig. 1). There were 4,729 (11.0%) juvenile patients, with a mean age of 15.7 ± 1.9 yr. Of these, 236 (5.0%) were intoxicated, and their mean age was 17.2 ± 1.3 yr, which was significantly higher than that of the non-drinking group ($P < 0.001$).

For both adolescents and adults, the proportion of male patients was significantly higher than that of females. But in teenagers, unlike adults, similar proportions of male and female patients had been drinking ($P = 0.14$). This showed that the alcohol behavior of girls is the points to be specially considered to formulate policy for alcohol prevention in adolescents (Table 1).

Factors associated with alcohol-related injuries

Alcohol-related injuries in adolescents were more numerous in summer, on weekends and holidays, and after midnight (Table 2). Traffic accidents, falls, and poisoning were significant mechanisms of injury associated with juvenile alcohol consumption. Among traffic accidents, motorcycle injuries were highly related to alcohol in adolescents (odds ratio [OR] 2.52, 95% confidence interval [CI] 1.09-5.83), unlike in adults, for whom pedestrian injuries were the most common injuries associated with alcohol (Table 3). A more detailed analysis of traffic accidents showed that alcohol-related passenger injuries increased gradually from 16 yr of age and steeply after 20 and were highest in patients in their 20s and 30s. In comparison, alcohol-related motorcycle injuries increased gradually from 14 yr and were highest in late teens and the early 20s (Fig. 2).

The roadway (public highways, streets, or roads), outdoors, and commercial areas were the main sites of alcohol-related injuries. In addition, alcohol-related injuries occurred when teenagers were working or traveling or during their leisure hours. Intentional injuries associated with alcohol, especially self-injury and suicide, increased disproportionately compared with unintentional injuries (Table 4).

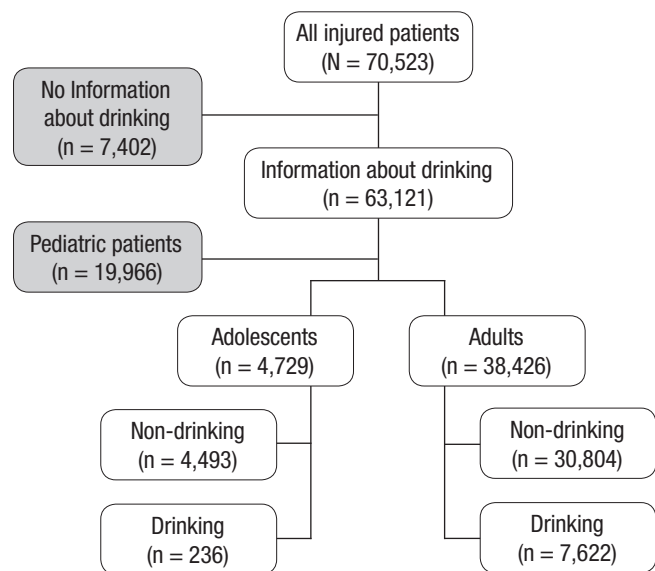


Fig. 1. Selection of patients.

Table 1. Demographic characteristics

	Adolescents (n = 4,729)			Adults (n = 38,426)		
	Non-drinking No. (%)	Drinking No. (%)	<i>P</i>	Non-drinking No. (%)	Drinking No. (%)	<i>P</i>
Age (yr)	15.6 ± 1.8	17.2 ± 1.3	< 0.001	43.7 ± 16.9	38.5 ± 13.0	< 0.001
Sex						
Male	3,119 (95.3)	153 (4.7)	0.14	17,283 (74.8)	5,814 (25.2)	< 0.001
Female	1,374 (94.3)	83 (5.7)		13,521 (88.2)	1,808 (11.8)	
Total	4,493 (95.0)	236 (5.0)		30,804 (80.2)	7,622 (19.8)	

Injury severity associated with alcohol

Based on the ED disposition, 4,061 (86.0%) mild and 473 (10.0%) moderate injuries occurred among adolescent patients. Of these, 187 (4.0%) adolescents were severely injured, including those who were admitted to the intensive care unit, underwent emergency surgery or died in the ED. This rate was lower than that in adults (Table 5).

A significant difference in severity was observed between the drinking and nondrinking groups in adolescents and adults. The relationship with alcohol was lower in cases of moderate injury (OR 0.78 and 0.64 in adults and adolescents, respectively) and

higher in cases of severe injury, especially in adolescents (OR 1.39 and 2.47 in adults and adolescents, respectively) (Table 5). The relationship between alcohol and severity was still high after adjusting for other factors (OR 1.42 and 2.36 in adults and adolescents, respectively) (Table 6).

DISCUSSION

Previous studies have reported an association between alcohol consumption and patients visiting the ED; the mechanisms of injury include traffic accidents, falls, burns, and assaults (4, 5).

Table 2. Epidemiological characteristics associated with alcohol-related injuries

Factors	Adolescents				Adults			
	Total No.	Drinking No. (%)	OR	95% CI	Total No.	Drinking No. (%)	OR	95% CI
Sex*								
Male	3,272	153 (4.7)	0.81	0.62-1.07	23,097	5,814 (25.2)	2.52	2.38-2.66
Female	1,457	83 (5.7)	1.00	-	15,329	1,808 (11.8)	1.00	-
Season†								
Spring	979	50 (5.1)	1.00	-	8,650	1,821 (21.1)	1.00	-
Summer	1,300	78 (6.0)	1.14	0.79-1.63	10,924	2,119 (19.4)	0.90	0.84-0.97
Autumn	1,386	52 (3.8)	0.69	0.47-1.03	10,672	1,965 (18.4)	0.85	0.79-0.91
Winter	1,047	53 (5.1)	0.95	0.64-1.40	8,179	1,717 (21.0)	0.99	0.93-1.07
Day of visit								
Weekday	2,975	130 (4.4)	1.00	-	21,934	4,372 (19.9)	1.00	-
Saturday	693	43 (6.2)	1.45	1.02-2.07	6,570	1,384 (21.1)	1.07	1.00-1.15
Sunday	816	50 (6.1)	1.43	1.02-1.99	7,708	1,473 (19.1)	0.95	0.89-1.01
Holiday	245	13 (5.3)	1.23	0.68-2.20	2,214	393 (17.8)	0.87	0.77-0.97
Time of visit‡								
07:00-17:59	2,156	63 (2.9)	1.00	-	16,960	1,642 (9.7)	1.00	-
18:00-20:59	870	14 (1.6)	0.54	0.30-0.98	5,755	579 (10.1)	1.04	0.94-1.15
21:00-23:59	927	28 (3.0)	1.04	0.66-1.63	6,330	1,393 (22.0)	2.63	2.43-2.84
24:00-06:59	774	131 (16.9)	6.78	4.95-9.27	9,360	4,002 (42.8)	6.95	6.51-7.42

*Significant differences between the non-drinking and drinking groups were found for all patients ($P < 0.001$), except for the sex differences in adolescents ($P = 0.14$); †No information on season was available for 17 adolescent patients and one adult patient. Among these, three and zero patients drank alcohol, respectively; ‡We could not obtain information about the time of visit for two adolescents and 21 adults. These included zero and six patients who drank alcohol, respectively.

Table 3. Mechanism associated with the alcohol-related injuries*

Factors	Adolescents				Adults			
	Total No.	Drinking No. (%)	OR	95% CI	Total No.	Drinking No. (%)	OR	95% CI
Injury mechanism								
Struck by person or object	1,650	78 (4.7)	1.00	-	8,868	2,474 (27.9)	1.00	-
Traffic accident	959	56 (5.8)	1.25	0.88-1.78	7,501	887 (11.8)	0.35	0.32-0.38
Fall	176	11 (6.3)	1.35	0.70-2.58	2,415	453 (18.8)	0.60	0.53-0.67
Slipped	577	18 (3.1)	0.65	0.39-1.10	6,085	1,372 (22.5)	0.75	0.70-0.81
Cut or pierced	464	25 (5.4)	1.15	0.72-1.83	4,825	963 (20.0)	0.65	0.59-0.70
Machine/firearm/burn	99	0 (0.0)	-	-	1,424	75 (5.3)	0.14	0.11-0.18
Submergence	5	0 (0.0)	-	-	21	6 (28.6)	1.03	0.40-2.67
Poisoning	76	7 (9.2)	2.05	0.91-4.61	1,070	398 (37.2)	1.53	1.34-1.75
Choking or hanging	5	0 (0.0)	-	-	107	23 (21.5)	0.71	0.45-1.13
Other/unspecified	718	41 (5.7)	1.23	0.83-1.81	6,110	971 (15.9)	0.49	0.45-0.53
Traffic accidents								
Passenger	187	7 (3.7)	1.00	-	4,335	405 (9.3)	1.00	-
Pedestrian	212	10 (4.7)	1.27	0.48-3.41	1,390	244 (17.6)	2.07	1.74-2.45
Bicycle	200	8 (4.0)	1.07	0.38-3.02	690	69 (10.0)	1.08	0.82-1.41
Motorcycle	348	31 (8.9)	2.52	1.09-5.83	984	154 (15.7)	1.80	1.47-2.20
Other/unspecified	12	0 (0.0)	-	-	102	15 (14.7)	1.67	0.96-2.92

* $P < 0.001$.

Further studies of injuries to adolescents reported that alcohol was associated not only with death, but also with health risk behavior. Teenagers who drink heavily commit sex crimes, smoke, and fight more frequently than nondrinking teenagers (6).

In our series, the proportion of adolescents visiting the ED with injuries who had been drinking was 5.0%; this proportion



Fig. 2. Age distribution of alcohol-related traffic accidents according to the type of vehicle.

was similar in boys and girls. This differed from the percentages for adults, in whom the proportion of men was twice that of women. Other studies have also found no gender difference in drinking by teenagers (6, 7). Consequently, these distinct features of adolescent behavior compared with adult behavior should be considered when planning education programs for students designed to reduce alcohol consumption.

Many studies have reported that specific mechanisms of injury, such as motor vehicle accidents, falls, and fire injuries, were strongly associated with alcohol (8-11). Nevertheless, the relationship between alcohol consumption and injury severity is controversial, and some studies have found no association between alcohol ingestion and severity or outcome (12-15), whereas others emphasize the impact of alcohol on the severity and mortality of injuries (16-20). In our investigation, juvenile drinking was linked to several mechanisms of injury: motor vehicle accidents, falls, poisoning, and cutting or piercing. Of these mechanisms, traffic accidents associated with alcohol resulted in severe injuries, and constituted the most common cause of juvenile death. Therefore, prevention of traffic accidents under the influence of alcohol should be a focus as a measure for preventing injuries to juveniles. From our data, however, we could

Table 4. Event characteristics associated with alcohol-related injuries*

Factors	Adolescents				Adults			
	Total No.	Drinking No. (%)	OR	95% CI	Total No.	Drinking No. (%)	OR	95% CI
Place of occurrence								
Home/Place of residence	1,376	42 (3.1)	1.00	-	14,360	2,132 (14.8)	1.00	-
School	938	8 (0.9)	0.27	0.13-0.59	437	38 (8.7)	0.55	0.39-0.76
Sports area	314	4 (1.3)	0.41	0.15-1.15	1,391	44 (3.2)	0.19	0.14-0.25
Roadway/Outdoors	1,734	120 (6.9)	2.36	1.65-3.38	13,799	2,922 (21.2)	1.54	1.45-1.64
Working area	41	1 (2.4)	0.79	0.11-5.91	2,492	84 (3.4)	0.20	0.16-0.25
Commercial area	292	59 (20.2)	8.04	5.29-12.23	5,350	2,242 (41.9)	4.14	3.85-4.44
Other/unspecified	34	2 (5.9)	1.99	0.46-8.56	597	160 (26.8)	2.10	1.74-2.53
Activity when injured [†]								
Vital activity	2,543	94 (3.7)	1.00	-	20,891	3,708 (17.7)	1.00	-
Work	459	43 (9.4)	2.69	1.85-3.92	9,982	1,736 (17.4)	0.97	0.92-1.04
Education	438	1 (0.2)	0.06	0.00-0.43	128	18 (14.1)	0.76	0.46-1.25
Sports & Exercise	314	1 (0.3)	0.08	0.01-0.60	1,213	41 (3.4)	0.16	0.120-0.22
Leisure/Traveling	946	91 (9.6)	2.77	2.06-3.74	5,741	1,946 (33.9)	2.37	2.22-2.53
Other/unspecified	29	6 (20.7)	6.80	2.70-17.09	471	173 (36.7)	2.67	2.20-3.25
Intent								
Unintentional	3,985	154 (3.9)	1.00	-	33,716	5,213 (15.5)	1.00	-
Self-injury/suicide	104	15 (14.4)	4.19	2.37-7.42	1,211	555 (45.8)	4.62	4.11-5.20
Assault/homicide	598	65 (10.9)	3.03	2.24-4.11	3,004	1,660 (55.3)	6.75	6.25-7.30
Other/unspecified	42	2 (4.8)	1.24	0.30-5.19	495	194 (39.2)	3.50	2.91-4.21

*P < 0.001; [†]We could not obtain information about the activity for 23 adult patients. This included nine patients who drank alcohol.

Table 5. Bivariate logistic regression of injury severity associated with alcohol among adolescents and adults*[†]

Severity	Adolescents				Adults			
	Total No.	Drinking No. (%)	OR	95% CI	Total No.	Drinking No. (%)	OR	95% CI
Mild	4,061	198 (4.9)	1.00	-	31,152	6,224 (20.0)	1.00	-
Moderate	473	15 (3.2)	0.64	0.38-1.09	5,070	822 (16.2)	0.78	0.72-0.84
Severe	187	21 (11.2)	2.47	1.53-3.97	2,115	546 (25.8)	1.39	1.26-1.54

*P < 0.001; [†]We could not obtain information about the ED results for eight adolescents and 89 adults. This included two and 30 patients who drank alcohol, respectively.

Table 6. Multivariate logistic regression of the injury severity associated with alcohol among adolescents and adults*^{†‡}

Severity	Adolescents				Adults			
	Total No.	Drinking No. (%)	OR	95% CI	Total No.	Drinking No. (%)	OR	95% CI
Mild	4,061	198 (4.9)	1.00		31,152	6,224 (20.0)	1.00	
Moderate	473	15 (3.2)	0.57	0.33-0.98	5,070	822 (16.2)	0.94	0.85-1.03
Severe	187	21 (11.2)	2.36	1.47-3.81	2,115	546 (25.8)	1.42	1.26-1.59

* $P < 0.001$; [†]Adjusted for sex, season, day and time of visit, injury mechanism, place where injury occurred, activity when injured, and intent; [‡]We could not obtain information about the ED results for eight adolescents and 89 adults. This included two and 30 patients who drank alcohol, respectively.

not determine the diagnosis or anatomical findings of the patients. Therefore, we cannot comment on any association between juvenile alcohol consumption and detailed indices of severity, such as the Glasgow Coma Scale (GCS), Injury Severity Score (ISS), or Revised Trauma Score (RTS).

Among traffic accident injuries, motorcycle accidents showed a marked relationship with alcohol in adolescents. In Korea, a person must be 16 yr old to get a motorcycle license, but 18 yr to get an automobile driver's license. As the percentage of traffic accidents involving alcohol is constant, the age requirements for obtaining a license should be raised. Williams et al. (21) investigated the variation in the rate of traffic accidents from state to state and reported that the accident rate for all passenger, bicycle, and pedestrian accidents was 6.5 times lower in Connecticut, which has an age requirement of 17 yr for a driver's license, than in New Jersey, where the requirement is 16 yr. They reported that simply raising the age limit from 16 to 17 yr old resulted in an approximately 65 to 75% reduction in traffic accidents.

We surveyed intentional injuries linked to alcohol. Intentional injuries were more strongly associated with alcohol than were unintentional injuries in both teens and adults. This was especially remarkable in juveniles for intentional injuries such as self-injury and suicide. Our results showed that injuries grouped as self-injury and suicide (OR = 4.19) were strongly associated with alcohol use in teens than were those categorized as assault and homicide (OR = 3.03), whereas the latter were more strongly associated with alcohol in adults. A recent international study of adolescent alcohol consumption and self-harm reported that teens with moderate- or high-risk alcohol behavior had a greater risk of self-injury and suicide (22). Similarly, juvenile intentional injuries that are not severe could result in more dangerous outcomes in the future. Therefore, any alcohol prevention education program for teenagers should include an examination of the motivation and methods underlying injuries and interventions focused on risky behaviors.

We also examined the relationship between alcohol and the severity of injury based on the disposition in the ED. Overall, severe injuries constituted a small percentage of all injuries, but the percentage was greater in adolescents than in adults. Because many injuries to adolescents were caused in traffic accidents, especially motorcycle accidents, more of the outcomes were likely fatal. Recent research on blunt trauma related to juvenile alcohol consumption reported that drunken patients

tended to have lower GCS scores and higher ISS, a greater need for emergency surgery or admissions to the intensive care unit, longer hospital stays, and higher mortality compared with non-drinking adolescents (23). Like a previous report, we found that juvenile injuries had poorer outcomes, although they were similar to injuries in adults, because teens lack a sense of mortality and perform more risky behavior, such as ignoring regulations or failing to wear protective devices (24-26).

This study had some limitations because the data were obtained from the 'Development of a model for an in-depth injury surveillance system based on the emergency department.' First, the final outcomes and information on socioeconomic status, such as occupation, educational background, and economic levels, were not identified due to deficiency in the records. Therefore, we could not examine the associations between alcohol and socioeconomic status reported in previous studies. Second, the rate of "others" and "unspecified" was quite high for each survey item, so considerable amounts of data were missing. Finally, we could not analyze the link between alcohol behavior and injury because typical alcohol behavior, in contrast to drinking that was reported or observed at the time of injury, was not investigated. Despite these limitations, however, it is important to note that our study investigated the characteristics and severity of adolescent alcohol-related injuries in nearly 5,000 cases involving injured juveniles. Future research should include a broader analysis of the risks of alcohol, including the association between alcohol behavior and injury and that between alcohol-related injuries and socioeconomic factors.

We investigate adolescent alcohol-related injuries and associated factors for injured teenagers visiting six emergency departments. We found that juvenile alcohol-related injuries had unique features. First, there were no significant alcohol-related differences between injuries in male and female adolescents, unlike the case in adults, for whom male patients showed higher rates of alcohol consumption. Second, among traffic accidents, motorcycle-related injuries were closely associated with alcohol consumption in adolescents. Perhaps for this reason, alcohol-related injuries in adolescents had poorer outcomes compared with injuries in adults. In conclusion, the preventive strategy on alcohol-related injuries in adolescents should focus on reducing motorcycle accidents.

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AUTHOR SUMMARY**Characteristics of Alcohol-related Injuries in Adolescents Visiting the Emergency Department**

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Alcohol drinking-associated accident is one of the most frequent causes of emergency cases. We compared the characteristics and severity of alcohol-related injuries in adolescents and adults. All injured patients seen at six EDs throughout 2007 were included. We obtained data from the 'Development of a model for an in-depth injury surveillance system based on the emergency department' surveillance. The proportion of adolescents who drank was 5.0%. No significant alcohol-related difference in injuries was found between male and female adolescents ($P = 0.14$), whereas in adults, being male was strongly related to alcohol consumption ($P < 0.001$). Among traffic accidents, motorcycle-related injuries were strongly associated with alcohol use in adolescents (odds ratio [OR] 2.52, 95% confidence interval [CI] 1.09–5.83). Results also indicated that alcohol-related injuries in adolescents showed poor outcomes (OR 2.36, 95% CI 1.47–3.81) as compared with those in adults (OR 1.42, 95% CI 1.26–1.59). Preventive strategy on alcohol-related injuries in adolescents should focus on reducing motorcycle accidents.