Risk Management and Healthcare Policy

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ORIGINAL RESEARCH

Effect of Lowering the Blood Alcohol Concentration Limit to 0.03 Among Hospitalized Trauma Patients in Southern Taiwan: A Cross-Sectional Analysis

This article was published in the following Dove Press journal:
Risk Management and Healthcare Policy

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Background: In June 2013, the legal blood alcohol concentration (BAC) limit for driving was lowered from 0.05 to 0.03 mg/mL in Taiwan. Thus, this study aimed to assess the epidemiological changes in terms of drinking among drivers in southern Taiwan before and after the law was imposed.

Methods: Only patients who had undergone the BAC test at the emergency room were included in the study. The patients during the study period before (n = 2735) and after (n = 2413) the implementation of the law were selected for comparison. Drunk patients were defined as those who had a BAC ≥0.005 and were considered as driving under the influence (DUI) of alcohol. Meanwhile, driving while intoxicated (DWI) was defined as a BAC ≥0.05, which was the level adopted in the new law.

Results: Since the BAC limit lowered to 0.03, the number of DUI patients significantly decreased from 340 (12.4%) to 171 (7.1%), and that of DWI patients significantly reduced from 273 (10.0%) to 146 (6.1%) based on the alcohol test. In addition, after the implementation of the law, the number of associated injuries did not significantly decrease from that before the law was implemented in patients involved in alcohol-related crashes.

Conclusion: After lowering the legal BAC limit from 0.05 to 0.03, responsiveness to the change in law was observed among the studied population. However, such responsiveness may not be observed in some citizens who may need special interventions to help reduce their behavior of drinking and driving.

Keywords: alcohol, blood alcohol concentration, BAC, driving under the influence (DUI) of alcohol, driving while intoxicated, DWI, alcohol-related crashes, law sanction, mortality

Background

Drinking is one of the major risk factors of traffic crashes. Approximately one-third of individuals who died from traffic crashes are intoxicated.[1] The association between blood alcohol concentration (BAC) and driving skill had been widely studied. A significant decrease in driving skills was noted in drivers with a BAC of 0.05 g/dL in a review of 112 studies.[2] In single-vehicle crashes, the relative risk for fatality in drivers with BACs of 0.05–0.079 is 7–21 times higher than those with a BAC of 0.00.[3] The risk of fatal traffic accidents among drivers with BAC between 0.021 and 0.05 was 3.8 times higher than that of drivers with a BAC of 0.00.[4] Laboratory studies have also revealed that impaired driving increased with elevated

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submit your manuscript | www.dovepress.com
DovePress
http://doi.org/10.2147/RMHP.S250734

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alcohol level, beginning at a BAC of 0.01 up to a BAC of 0.24.[5] In motor vehicle accidents, drivers with a BAC=0.01 are 46% more likely to be blamed for a crash than sober drivers.[5] One large-scale study on traffic crashes in the United States has found that even minimally buzzed drivers (BAC=0.01) are significantly more dangerous than those who are sober.[6]

In the United States, the legal BAC limit is generally 0.08. However, the value varies per state and has changed over the years.[7] In most countries worldwide, the legal limit of BAC is 0.05.[8,9] While Japan and Poland have a legal BAC limit of 0.03,[9,10] Norway, Sweden, and Russia have a legal BAC limit of 0.02,[11,12] and Vietnam even has a zero tolerance for drivers of all motorized vehicle except motorcyclists.[13] A number of studies had shown a reduction in the BAC level at which individuals can legally drive to effectively reduce alcohol-related traffic crashes.[3,8,10,14-17] The lowering of the illegal level of BAC from 0.10 to 0.08 resulted in reductions in alcohol-related crashes and fatalities up to 5%–16%.[3,8] After lowering the BAC legal limit from 0.08 to 0.05, the fatal crashes involving drunk drivers decreased to at least 5%–8% and up to 18% in other countries,[17–20] and the number of fatalities reduced from approximately 100 to 64 after implementing the law in France,[21] and an overall 9.4% decrease in alcohol-related crashes was observed in Austria.[18] Furthermore, the lowering of the legal BAC limit from 0.05 to 0.03 in Japan led to a reduction in alcohol-related crashes by 50% and 52% in adult men and women, respectively, as well as by 64% in teenagers.[10]

In Taiwan, a series of amendments were made in relation to the Road Traffic Management and Penalty Act, Road Traffic Security Rules, and Article 185 of the Criminal Law[22] in 2013 to lower the BAC legal limit from 0.05 to 0.03. Furthermore, the penalties were increased from New Taiwan Dollars (NTD) 15,000–-60,000 (~$500–2000) to NTD 15,000–90,000 (~$500–-3000) according to the BAC and the type of vehicle used (motorcycle, car, or bus). Driving with a BAC of 0.05 or higher is considered a criminal act, and some administrative penalties, such as license suspension or revocation, may be imposed. According to the national traffic statistics, the number of casualties from drunk driving reduced after implementing these sanctions.[22] Moreover, after the BAC limit change, airbag use in car crashes (OR: 0.30, 95% CI 0.10 to 0.88, p=0.007) and helmet use in motorcycle crashes (OR: 0.20, 95% CI 0.15 to 0.26, p<0.001) was lower in DUI patients than non-DUI patients.[23] However, data about the effectiveness of lowering the legal BAC limit on injuries and mortality among drunk drivers involved in alcohol-related crashes are not available. Using the registered trauma data from the hospital, this study aimed to assess the epidemiological change in the behavior of drunk drivers in southern Taiwan before (from July 2009 to December 2012) and after (from July 2013 to December 2016) the implementation of the law.

Methods

The institutional review board (IRB) of the Kaohsiung Chang Gung Memorial Hospital, a level I regional trauma center in southern Taiwan,[24–26] had approved this study (reference number: 201600001B0). Due to the retrospective nature of the study that used registered data from a trauma database, the need for informed consent waived off according to the regulation of the IRB. The study protocol conforms to the ethical guidelines of patient data confidentiality and compliance with 1975 Declaration of Helsinki. This study included all patients with trauma who had been suspected with drunk driving and admitted for treatment. Only the patients who had undergone the BAC test at the emergency room were included. Those with incomplete data were excluded. This study was designed to compare the occurrence of drunk driving during the 2-year study period before and after the law was imposed. Implementation of the revised part of the Road Traffic Act in Taiwan that lowered the legal limit for drivers from a BAC level of 0.05 to 0.03 with increased penalties was executed in June 13, 2013. In this study, due to some minor revisions during the propaganda that occurred approximately 6 months before the legislation, the patients were selected based on the two time periods for comparison: from January 1, 2011 to December 31, 2012 (a 2-year period before imposing the law) as well as from July 1, 2013 to June 30, 2015 (a 2-year period after imposing the law). Drunk patients were defined as those who had a BAC ≥ 0.005 and were considered as driving under the influence (DUI) of alcohol. Meanwhile, driving while intoxicated (DWI) was defined as a BAC ≥ 0.05, which was the level adopted in the new law. The term alcohol-related crashes indicated a traffic accident involving DUI or DWI patients. Those with a BAC < 0.005 were not considered drunk. The following data about the patients were obtained: age; sex; trauma mechanism (driver or passenger; motor vehicle or motorcycle); BAC at the emergency room; Glasgow Coma Scale (GCS) score; abbreviated injury scale (AIS) score and associated injuries in six body regions; injury severity score (ISS); length of stay (LOS) in the hospital; rates of admission in the intensive care unit (ICU); in-hospital mortality; and the expenditure in total and per patient, including cost of operation (operation and operation supplies), cost of examination (physical examination, hematology test, pathological examination, radiography, electrocardiography, echography, endoscopy, electromyography, cardiac catheterization, and electroencephalography), cost of medicines (medicine and medicine services), and cost of other fees (administrative fees).

We used the Statistical Package for the Social Sciences software version 22.0 (IBM Corp., Armonk, NY) for statistical analysis. In-hospital mortality was the primary outcome; LOS in the hospital and the rates of ICU admission were the secondary outcomes. The odds ratios (ORs) with 95% confidence intervals (CIs) of the associated conditions of the patients were presented. For continuous variables, the Levene's test was used to estimate the homogeneity of variance, and the one-way analysis of variance with Games–Howell post hoc test was performed to assess the differences between the groups. Continuous data were expressed as mean ± standard deviation. The ISS was expressed as median and interquartile range (IQR: Q1–Q3). A p value < 0.05 was considered statistically significant.

Results

Characteristics of the Injury and Patients Who Underwent BAC Measurement

A total of 2735 and 2413 patients underwent the BAC test from January 1, 2011 to December 31, 2012 (a 2-year period before implementing the law) and from July 1, 2013 to June 30, 2015 (a 2-year period before implementing the law), respectively (Table 1). After implementing the law, in vehicle crashes, the number of male patients was significantly lower, and that of old patients was higher. No significant difference was observed in terms of trauma mechanism, with motorcycle drivers accounting for most of the patients in this trauma population. The number of DUI patients significantly decreased from 340 (12.4%) to 171 (7.1%), and that of DWI patients significantly reduced from 273 (10.0%) to 146 (6.1%) based on the alcohol test. However, in terms of BAC, no significant difference was observed before and after implementing the law among DUI patients (BAC ≥ 0.005) or DWI patients (BAC ≥ 0.05). After the law was imposed, the percentage of injuries to body regions, such as the head/neck and extremity, but not to the other body regions, significantly decreased. No significant change was observed in terms of the GCS score and ISS after implementing the law. After implementation, a significantly longer LOS in the hospital (10.7 days vs 9.4 days, respectively; p < 0.001) and a higher rate of admission in the ICU (24.0% vs 20.7%, respectively; p = 0.005) were observed in patients who underwent the alcohol test. However, no significant difference was observed in terms of mortality rate (1.7% vs 1.6%, respectively; p = 0.338) among patients who underwent the alcohol test.

Characteristics of the Injury and DUI Patients

A total of 340 and 171 patients were drunk and driving under the influence of alcohol (ie BAC ≥ 0.005) during the 2-year study period before and after implementing the law (Table 2). After the law was imposed, no significant changes were observed in terms of gender, age, GCS score, AIS score, and ISS. However, the percentage of injuries to the extremity significantly decreased. After implementing the law, no significant difference was observed in the LOS in the hospital (12.8 days vs 12.0 days, respectively; p = 0.464) and mortality rate (7.6% vs 4.7%, respectively; p = 0.224) of DUI patients. A higher rate of ICU admission (54.4% vs 40.0%, respectively; p = 0.003) was found after implementing the law.

Characteristics of Injury and DWI Patients

A total of 273 and 146 DWI patients (ie BAC ≥ 0.05) were recorded during the 2-year study period before and after implementing the law (Table 3). After the law was imposed, no significant changes in terms of gender, age, GCS score, AIS score, and ISS were found. However, the percentage of injuries to the extremity significantly decreased. After implementing the law, no significant difference was observed in the LOS in the hospital (13.0 days vs 11.9 days, respectively; p = 0.385), the rate of admission in the ICU (51.4% vs 41.0%, respectively; p = 0.050), and mortality rate (4.8% vs 4.8%, respectively; p = 1.000) among DWI patients.

Associated Injuries in DUI and DWI Patients

The associated injuries in the body regions of DUI (Table 4) patients with trauma and DWI (Table 5) before and after

Table 1 Characteristics of Injury and Patients with Trauma Who Underwent Measurement of Blood Alcohol Concentration (BAC) at the Emergency Room During the 2-Year Study Period Before and After the Law Was Imposed

Variables	After Law n=2413		Before Law n=2735		p
Gender, n (%)					0.006
Male	1347	(55.8)	1631	(59.6)	
Female	1066	(44.2)	1104	(40.4)	
Age (years)	43.3	±19.4	41.7	±18.8	0.002
Trauma mechanism					
Driver of motor vehicle	65	(2.7)	92	(3.4)	0.168
Passenger of motor vehicle	45	(1.9)	58	(2.1)	0.550
Driver of motorcycle	2153	(89.2)	2418	(88.4)	0.376
Passenger of motorcycle	150	(6.2)	167	(6.1)	0.908
Patients with DUI, n (%)	171	(7.1)	340	(12.4)	<0.001
DWI Patients, n (%)	146	(6.1)	273	(10.0)	<0.001
BAC in patients with DUI (mg/dl)	157.7	±88.0	151.4	±93.5	0.465
BAC in DWI patients (mg/dl)	181.8	±71.1	183.7	±74.3	0.795
GCS	14.2	±2.5	14.2	±2.4	0.887
AIS					
Head/Neck	736	(30.5)	963	(35.2)	<0.001
Face	561	(23.2)	693	(25.3)	0.085
Thorax	400	(16.6)	477	(17.4)	0.414
Abdomen	181	(7.5)	233	(8.5)	0.182
Extremity	1721	(71.3)	2024	(74.0)	0.033
ISS (median, IQR)	9	(4–13)	9	(4–13)	0.887
<16	1936	(80.2)	2199	(80.6)	0.888
16–24	303	(12.6)	359	(13.1)	0.559
≥25	174	(7.2)	177	(6.5)	0.319
LOS in hospital (days)	10.7	±11.0	9.4	±9.9	<0.001
ICU admission, n (%)	579	(24.0)	566	(20.7)	0.005
Mortality, n (%)	47	(1.9)	43	(1.6)	0.338

Abbreviations: AIS, abbreviated injury scale; BAC, blood alcohol concentration; CI, confidence interval; DUI, driving under influence of alcohol; DWI, driving while intoxicated; GCS, Glasgow Coma Scale; ISS, injury severity score; IQR, interquartile range; ICU, intensive care unit; LOS, length of stay.

implementing the law are listed. After the law was imposed, the odds for subdural hematoma (SDH), subarachnoid hemorrhage, and mandibular fracture were significantly higher. However, those for hemothorax in DUI patients were low (Table 6). In DWI patients, the odds for SDH, mandibular fracture, and femoral fracture were significantly higher after the law was imposed (Table 7).

Expenditure for DUI and DWI Patients

After the law was imposed, as the number of DUI (Table 8) and DWI (Table 9) patients was lower, the total expenditure had decreased to 41.6% and 38.1%, respectively, compared to that before the law was imposed. In addition, the cost for operation, examination, and medicines decreased by approximately 30%–50%. However, no difference was observed in terms of expenditure, including the cost of operation, examination, and medicines per person before or after the law was imposed in DUI or DWI patients.

Discussion

This study was conducted for a period of 2 years before and after the implementation of the 0.03 BAC legislation in 2013 in Taiwan to determine the effect of the law on the rates and outcomes of hospitalized patients with trauma due to alcohol-related crashes. Since the introduction of the 0.03 BAC law, the number of DUI and DWI patients who underwent the alcohol test significantly decreased, and as a result, the total expenditure for DUI and DWI patients decreased by 41.6% and 38.1%, respectively. However, for DUI and DWI patients, no significant

Table 2 Characteristics of Injury and Patients with Trauma Who Were Driving Under the Influence of Alcohol (BAC ≥ 0.005) at the Emergency Room Before and After the Law Was Imposed

Variables	After Law n=171		Before Law n=340		Odds Ratio (95% CI)		p
Gender, n (%)							0.333
Male	145	(84.8)	299	(87.9)	0.8	(0.45–1.30)	
Female	26	(15.2)	41	(12.1)	1.3	(0.77–2.22)	
Age (years)	41.3	±13.3	39.6	±14.0	–		0.173
GCS	12.1	±3.6	12.3	±3.9	–		0.485
AIS							
Head/Neck	110	(64.3)	198	(58.2)	1.3	(0.88–1.89)	0.213
Face	80	(46.8)	144	(42.4)	1.2	(0.83–1.73)	0.347
Thorax	38	(22.2)	83	(24.4)	0.9	(0.57–1.37)	0.659
Abdomen	19	(11.1)	55	(16.2)	0.6	(0.37–1.13)	0.143
Extremity	84	(49.1)	217	(63.8)	0.5	(0.38–0.79)	0.002
ISS (median, IQR)	15.3	±9.4	14.6	±12.1	–		0.520
<16	93	(54.4)	204	(60.0)	0.8	(0.55–1.15)	0.254
16–24	44	(25.7)	83	(24.4)	1.1	(0.73–1.64)	0.746
≥25	34	(19.9)	53	(15.6)	1.3	(0.84–2.16)	0.261
LOS in hospital (days)	12.8	±13.5	12.0	±11.1	–		0.464
ICU admission, n (%)	93	(54.4)	136	(40.0)	1.8	(1.23–2.59)	0.003
Mortality, n (%)	13	(7.6)	16	(4.7)	1.7	(0.78–3.55)	0.224

Abbreviations: AIS, abbreviated injury scale; BAC, blood alcohol concentration; CI, confidence interval; GCS, Glasgow Coma Scale; ISS, injury severity score; IQR, interquartile range; ICU, intensive care unit; LOS, length of stay.

Table 3 Characteristics of Injury and DWI Patients with Trauma (BAC ≥ 0.05) at the Emergency Room Before and After the Law Was Imposed

Variables	After Law n=146		Before Law n=273		Odds ratio (95% CI)		p
Gender, n (%)							0.334
Male	126	(86.3)	245	(89.7)	0.7	(0.39-1.33)	
Female	20	(13.7)	28	(10.3)	1.4	(0.75-2.56)	
Age, (years)	41.0	±11.9	39.1	±13.2	–		0.127
GCS	12.2	±3.6	12.0	±4.0	–		0.724
AIS							
Head/Neck	93	(63.7)	165	(60.4)	1.1	(0.76-1.74)	0.529
Face	71	(48.6)	119	(43.6)	1.2	(0.82-1.83)	0.354
Thorax	29	(19.9)	65	(23.8)	0.8	(0.49-1.30)	0.391
Abdomen	16	(11.0)	43	(15.8)	0.7	(0.36-1.22)	0.189
Extremity	74	(50.7)	173	(63.4)	0.6	(0.40-0.89)	0.013
ISS (median, IQR)	14.4	±8.5	14.7	±12.5	–		0.771
<16	86	(58.9)	162	(59.3)	1.0	(0.65-1.48)	1.000
16-24	37	(25.3)	70	(25.6)	1.0	(0.62-1.56)	1.000
≥25	23	(15.8)	41	(15.0)	1.1	(0.61-1.84)	0.887
LOS in hospital (days)	13.0	±13.6	11.9	±11.0	–		0.385
ICU admission, n (%)	75	(51.4)	112	(41.0)	1.5	(1.01-2.28)	0.050
Mortality, n (%)	7	(4.8)	13	(4.8)	1.0	(0.39-2.58)	1.000

Abbreviations: AIS, abbreviated injury scale; BAC, blood alcohol concentration; CI, confidence interval; DWI, driving while intoxicated; GCS, Glasgow Coma Scale; ISS, injury severity score; IQR, interquartile range; ICU, intensive care unit; LOS, length of stay.

Table 4 Associated Injuries in the Body Regions of Patients with Trauma Who Had a Blood Alcohol Concentration ≥ 0.005 mg/mL at the Emergency Room During the 2-Year Study Period Before and After the Law Was Imposed

Variables	After Law n=171		Before Law n=340		Odds Ratio (95% CI)		p
Head trauma, n (%)							
Cranial fracture	37	(21.6)	62	(18.2)	1.2	(0.78–1.95)	0.406
Epidural hematoma (EDH)	31	(18.1)	42	(12.4)	1.6	(0.95–2.61)	0.083
Subdural hematoma (SDH)	54	(31.6)	64	(18.8)	2.0	(1.31–3.04)	0.001
Subarachnoid hemorrhage (SAH)	50	(29.2)	66	(19.4)	1.7	(1.12–2.63)	0.014
Intracerebral hematoma (ICH)	13	(7.6)	13	(3.8)	2.1	(0.94–4.57)	0.087
Cerebral contusion	18	(10.5)	33	(9.7)	1.1	(0.60–2.01)	0.876
Cervical vertebral fracture	4	(2.3)	3	(0.9)	2.7	(0.60–12.16)	0.230
Maxillofacial trauma, n (%)							
Orbital fracture	16	(9.4)	22	(6.5)	1.5	(0.76–2.92)	0.284
Nasal fracture	5	(2.9)	11	(3.2)	0.9	(0.31–2.64)	1.000
Maxillary fracture	30	(17.5)	67	(19.7)	0.9	(0.54–1.40)	0.633
Mandibular fracture	22	(12.9)	17	(5.0)	2.8	(1.45–5.44)	0.002
Thoracic trauma, n (%)							
Rib fracture	25	(14.6)	50	(14.7)	1.0	(0.59–1.67)	1.000
Hemothorax	4	(2.3)	36	(10.6)	0.2	(0.71–0.58)	0.001
Pneumothorax	4	(2.3)	16	(4.7)	0.5	(0.16–1.47)	0.233
Hemopneumothorax	5	(2.9)	9	(2.6)	1.1	(0.37–3.36)	1.000
Lung contusion	9	(5.3)	11	(3.2)	1.7	(0.68–4.09)	0.333
Abdominal trauma, n (%)							
Intra-abdominal injury	5	(2.9)	23	(6.8)	0.4	(1.16–1.11)	0.098
Hepatic injury	11	(6.4)	28	(8.2)	0.8	(0.37–1.58)	0.489
Splenic injury	4	(2.3)	11	(3.2)	0.7	(0.23–2.28)	0.601
Renal injury	1	(0.6)	4	(1.2)	0.5	(0.06–4.46)	0.669
Lumbar vertebral fracture	1	(0.6)	2	(0.6)	1.0	(0.09–11.04)	1.000
Extremity trauma, n (%)							
Scapular fracture	3	(1.8)	12	(3.5)	0.5	(0.14–1.75)	0.289
Clavicle fracture	19	(11.1)	42	(12.4)	0.9	(0.50–1.58)	0.773
Humeral fracture	5	(2.9)	15	(4.4)	0.7	(0.23–1.83)	0.478
Radial fracture	11	(6.4)	25	(7.4)	0.9	(0.42–1.81)	0.721
Ulnar fracture	10	(5.8)	12	(3.5)	1.7	(0.72–4.01)	0.251
Pelvic fracture	9	(5.3)	15	(4.4)	1.2	(0.52–2.81)	0.825
Femoral fracture	28	(16.4)	37	(10.9)	1.6	(0.94–2.72)	0.091
Patella fracture	6	(3.5)	16	(4.7)	0.7	(0.28–1.92)	0.647
Tibial fracture	15	(8.8)	23	(6.8)	1.3	(0.67–2.61)	0.475
Fibular fracture	9	(5.3)	18	(5.3)	1.0	(0.44–2.26)	1.000

difference was observed in their BAC level before and after the law was imposed. The mortality rate did not differ in individuals who underwent BAC measurement, DUI patients, and DWI patients before and after the law was imposed. After the introduction of the law, a significantly longer LOS in the hospital was noted in patients who underwent BAC measurement, and a higher rate of ICU admission was observed in those who underwent BAC measurement and DUI patients. Furthermore, after the law was imposed, the associated injuries were not significantly reduced but the odds for subdural hematoma and mandibular fracture were significantly higher in those patients with DUI and DWI after the implementation of the law, and the average expenditure per person was not significantly different from that before the law was implemented in patients involved in alcohol-related crashes.

Laws that consider driving with a high BAC as illegal is the most successful intervention among all efforts in reducing alcohol-related driving, and it decreases the associated injuries in individuals in developed countries.[27]

Table 5 Associated Injuries in the Body Regions of Patients with Trauma Who Had a Blood Alcohol Concentration ≥ 0.05 mg/mL at the Emergency Room During the 2-Year Study Period Before and After the Law Was Imposed

Variables	After Law n=146		Before Law n=273		Odds Ratio (95% CI)		p
Head trauma, n (%)							
Cranial fracture	30	(20.5)	52	(19.0)	1.1	(0.67–1.82)	0.796
Epidural hematoma (EDH)	26	(17.8)	37	(13.6)	1.4	(0.80–2.39)	0.254
Subdural hematoma (SDH)	43	(29.5)	52	(19.0)	1.8	(1.11–2.83)	0.020
Subarachnoid hemorrhage (SAH)	39	(26.7)	58	(21.2)	1.4	(0.85–2.16)	0.225
Intracerebral hematoma (ICH)	12	(8.2)	10	(3.7)	2.4	(0.99–5.59)	0.064
Cerebral contusion	13	(8.9)	28	(10.3)	0.9	(0.43–1.71)	0.732
Cervical vertebral fracture	4	(2.7)	2	(0.7)	3.8	(0.69–21.09)	0.189
Maxillofacial trauma, n (%)							
Orbital fracture	15	(10.3)	20	(7.3)	1.4	(0.72–2.92)	0.354
Nasal fracture	3	(2.1)	10	(3.7)	0.6	(0.15–2.04)	0.402
Maxillary fracture	28	(19.2)	59	(21.6)	0.9	(0.52–1.42)	0.614
Mandibular fracture	19	(13.0)	13	(4.8)	3.0	(1.43–6.25)	0.004
Thoracic trauma, n (%)							
Rib fracture	20	(13.7)	37	(13.6)	1.0	(0.56–1.82)	1.000
Hemothorax	2	(1.4)	10	(3.7)	0.4	(0.08–1.69)	0.230
Pneumothorax	3	(2.1)	12	(4.4)	0.5	(0.13–1.64)	0.278
Hemopneumothorax	4	(2.7)	6	(2.2)	1.3	(0.35–4.52)	0.744
Lung contusion	6	(4.1)	8	(2.9)	1.4	(0.48–1.47)	0.573
Abdominal trauma, n (%)							
Intra-abdominal injury	5	(3.4)	18	(6.6)	0.5	(0.18–1.38)	0.188
Hepatic injury	8	(5.5)	22	(8.1)	0.7	(0.29–1.53)	0.427
Splenic injury	3	(2.1)	7	(2.6)	0.8	(0.20–3.13)	1.000
Renal injury	1	(0.7)	4	(1.5)	0.5	(0.05–4.19)	0.662
Lumbar vertebral fracture	1	(0.7)	1	(0.4)	1.9	(0.12–30.21)	1.000
Extremity trauma, n (%)							
Scapular fracture	2	(1.4)	11	(4.0)	0.3	(0.07–1.51)	0.154
Clavicle fracture	16	(11.0)	35	(12.8)	0.8	(0.45–1.57)	0.640
Humeral fracture	5	(3.4)	12	(4.4)	0.8	(0.27–2.23)	0.797
Radial fracture	10	(6.8)	16	(5.9)	1.2	(0.52–2.67)	0.832
Ulnar fracture	9	(6.2)	9	(3.3)	1.9	(0.75–4.97)	0.207
Pelvic fracture	8	(5.5)	11	(4.0)	1.4	(0.54–3.51)	0.623
Femoral fracture	26	(17.8)	27	(9.9)	2.0	(1.10–3.53)	0.022
Patella fracture	6	(4.1)	13	(4.8)	0.9	(0.32–2.30)	0.812
Tibial fracture	14	(9.6)	18	(6.6)	1.5	(0.73–3.12)	0.334
Fibular fracture	7	(4.8)	15	(5.5)	0.9	(0.35–2.18)	0.823

Table 6 Associated Injuries in the Body Regions of Patients with Trauma Who Were Driving Under the Influence of Alcohol (BAC ≥ 0.005) at the Emergency Room During the 2-Year Study Period Before and After the Law Was Imposed

Variables	After Law n=171		Before Law n=340		Odds Ratio (95% CI)		p
Subdural hematoma (SDH)	54	(31.6)	64	(18.8)	2.0	(1.31–3.04)	0.001
Subarachnoid hemorrhage (SAH)	50	(29.2)	66	(19.4)	1.7	(1.12–2.63)	0.014
Mandibular fracture	22	(12.9)	17	(5.0)	2.8	(1.45–5.44)	0.002
Hemothorax	4	(2.3)	36	(10.6)	0.2	(0.71–0.58)	0.001

Table 7 Associated Injuries in the Body Regions of DWI Patients with Trauma (BAC ≥ 0.05) at the Emergency Room During the 2-Year Study Period Before and After the Law Was Imposed

Variables	After Law n=146		Before Law n=237		Odds Ratio (95% CI)		p
Subdural hematoma (SDH)	43	(29.5)	52	(19.0)	1.8	(1.11–2.83)	0.020
Mandibular fracture	19	(13.0)	13	(4.8)	3.0	(1.43–6.25)	0.004
Femoral fracture	26	(17.8)	27	(9.9)	2.0	(1.10–3.53)	0.022

Table 8 Expenditure in US Dollars During Hospitalization in Patients with Trauma Who Were Driving Under the Influence of Alcohol (BAC ≥ 0.005) at the Emergency Room Before and After the Law Was Imposed

	After Law n=171			Before Law n=340			Decrease (%)	p
	Total	Average		Total	Average		Total	Average
Expenditure	766,399	4482	±5440	1,313,330	3863	±4998	41.6↓	0.200
Cost of operation	126,977	743	±1040	199,865	588	±758	36.5↓	0.085
Cost of examination	41,082	240	±360	83,611	246	±384	50.9↓	0.873
Cost for pharmaceuticals	55,369	324	±669	106,003	312	±939	47.8↓	0.881

Table 9 Expenditure in US Dollars During Hospitalization in DWI Patients with Trauma (BAC ≥ 0.05) at the Emergency Room Before and After the Law Was Imposed

	After Law n=146			Before Law n=237			Decrease (%)	p
	Total	Average		Total	Average		Total	Average
Expenditure	646,437	4428	±5327	1,044,796	3827	±4826	38.1↓	0.257
Cost of operation	107,905	739	±1004	161,089	590	±786	33.0↓	0.121
Cost of examination	31,108	213	±316	65,438	240	±341	52.5↓	0.435
Cost for pharmaceuticals	40,08	279	±474	83,498	306	±754	51.2↓	0.654

A study in Turkey has revealed that the mean BAC for private vehicle drivers is 0.05, which was significantly higher than that of drivers of public transport, commercial, and official vehicles as well as taxis who are subjected to a zero alcohol level (52.60 mg/dL vs 10.76 mg/dL, respectively, $p < 0.001$).[28] However, a significant effort in reducing alcohol-related crashes and fatalities cannot be achieved all the time with just lowering the BAC legal limit. In Japan, the enactment of a 0.03 legal BAC legal limit law in 2002 resulted in significant decreases in the rate of alcohol-related crashes.[10] In Chile, lowering the BAC legal limit for drivers from 0.05 to 0.03 and increasing license suspension periods for offenders lead to a significant decrease in alcohol-related crashes by 32% after the law was implemented and by 15% after 3 years. However, the reduction in alcohol-related crashes had no significant effects on mortalities.[14] In Sweden, after the introduction of lowering the BAC legal limit from 0.05 to 0.02 in 1990, a reduction in fatal crashes, single-vehicle crashes, and all crashes by 9.7%, 11%, and 7.5% were observed, respectively,[29] and the interrupted time series analysis has revealed a 15% reduction in overall traffic fatalities.[30] In Norway, the enactment of the BAC legal limit from 0.05 to 0.02 in 2001 did not lead to any reduction in single-vehicle nighttime accidents, weekend personal injury, and fatal crashes compared with the situation 6 years before and after the decrease in the legal limit.[12] The zero tolerance law was implemented to reduce the odds of an alcohol-impaired fatal crash by over 24% in a review covering 16 years of statistics in the United States.[31] However, a study on zero tolerance laws did not result in a reduction of nighttime single-vehicle crashes in Texas compared to a decrease as much as 36% in Maine, 40% in Oregon, or as low as 5% in Florida.[32]

In this study, the legislation of lowering the legal BAC limit to 0.03 resulted in a statistically significant decrease in the number of hospitalized patients with trauma due to alcohol-related crashes on the road in Southern Taiwan. However, although the lowering in the legal BAC limit affects drivers at all levels of drinking, from the lighter to the heaviest drinkers, the reduced risk was not accompanied by a significant reduction in the mortality rates nor the BAC level in DUI and DWI patients, and this result indicates a responsiveness to the change in BAC limit among the studied population. However, such responsiveness may not be observed in some citizens. In 1011 nationally representative sample of licensed drivers in the United States, 63.9% of the respondents to a questionnaire survey indicated that the lowering of BAC limit to 0.05 would not have any effect on their decisions to drink and drive.[33] Nearly 60% of the respondents did not know the accurate limit for BAC in their state, of which 14% reported a higher value and 7% reported a value lower than 0.08, and the rest did not know the limit.[33] In general, the respondents also underestimated the number of drinks (approximately three drinks for a woman and four for a man) it would take to reach a BAC level of 0.08.[33] Despite the laws and penalties for drunk driving, the drivers have a low perception regarding the chances of being caught and penalized by the police.[13] In this study, the percentage of injuries to the head/neck of the patients underwent measurement of BAC was significantly decreased after the law was imposed. However, the odds of associated injuries as subdural hematoma, subarachnoid hemorrhage, and mandibular fracture were significantly higher in those patients with DUI (Table 6) and the odds of subdural hematoma, mandibular fracture, and femoral fracture were significantly higher in those patients with DWI (Table 7) after the implementation of the law. The results imply that, after lowering the legal BAC limit from 0.05 to 0.03, responsiveness to the change in law was observed among the studied population but not in all citizens. Those patients who were accustomed to alcohol drinking may still not obey to the new law. Therefore, the assumption that drunk drivers will comply with the lower limit by reducing the amount of alcohol consumed prior to driving may not be fit for all drivers. In this study,

The effects of lowering the legal BAC limit depend on the public's compliance with the law. Several factors can influence compliance, which include the level of enforcement, fines, adjudication, public acceptance, and willingness to comply.[34] The compliance behavior of drivers was found to be sensitive to the benefits of the policy of lowering BAC in different kinds of scenarios.[34] The extent and limits of the benefits achieved by lowering the legal BAC limits may vary in terms of strategies in the reduction of alcohol-impaired driving.[34] Thus, to effectively reduce the fatal outcomes from alcohol-related crashes, attention along with special actions may be applied to drivers who are less complaint to the prohibition of drinking prior to driving. However, the strategies should not only rely on lowering the BAC legal limit. For example, the frequency of sobriety checkpoints must be increased, and alcohol ignition interlocks should be required for all alcohol-impaired driving offenders, which is one of the most supported strategies for reducing alcohol-impaired driving.[35] The enforcement with random breath testing is associated with a significant reduction in the rate of alcohol-related crashes.[36] Immediate roadside prohibitions, which aimed to increase the efficiency of police and courts for processing drinking drivers, significantly reduced fatal and injury crashes than non-alcohol-related crashes.[37] Furthermore, mass media are effective in the reduction of alcohol-related crashes.[38] The reduction of the risk of traffic crashes by changing the behaviors of drinking and driving would lead to people's support for the new law.[39–41]

The present study had some limitations that should be acknowledged. First, we only included hospitalized patients. Some drivers involved in alcohol-related crash may not require admission in the hospital. Since the legal BAC limit did not significantly affect the number of drivers with fatal injuries who were legally hit,[42] therefore, some selection bias may exist, and the effect of lowering BAC cannot be estimated in those who drank and drive but were not hurt. Motorcycle accidents accounted for almost 95% of the accidents, and the rate was obviously higher than that in our previous reports, and this bias could also be found in this study.[24,25,43] In addition, the fatality rate from car or motorcycle accidents differed. For motorcycle riders, an exponential increase was noted in the associated risk for crash even from a relatively low BAC.[44] Second, the retrospective study design may cause a bias for outcome measurement. Third, the patients declared dead at the scene of the accident or upon arrival to the hospital were not included in the Trauma registry database, and selection bias on mortality assessment may exist. Fourth, the traffic accident recording system is not capable of showing detailed causative factors, such as driving skills, features of the road and vehicles, and the used protection apparatus. Finally, this study was limited to a regional level I trauma center, and the observation or conclusion may not be generalized to other areas, considering that there is a wide geographic variation in terms of alcohol drinking.

Conclusion

After lowering the legal BAC limit from 0.05 to 0.03, responsiveness to the change in law was observed among the studied population. However, such responsiveness may not be observed in some citizens who may require special intervention to reduce their behavior of drinking and driving.

Acknowledgments

We would like to thank the statistical analyst from Biostatistics Center, Kaohsiung Chang Gung Memorial Hospital.

Funding

This research was supported by a grant from Chang Gung Memorial Hospital (CMRPG8H0271).

Disclosure

The authors declare that they have no competing interests associated with this article.

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