Mitsui Sumitomo Insurance Welfare Foundation 2018 Traffic Safety Research Report

Study period：2019.01~2019.12

Title： Population-based case–control study of the effect of sun glare on pedestrian fatalities in Taiwan

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Abstract

Objectives Sun glare is a serious driving hazard and increases crash risks. Relatively few studies have examined the effects of sun glare on pedestrian fatalities, given that a crash has occurred. The primary objective of this study was to investigate the effect of sun glare on pedestrian fatalities. Design A population-based case–control study. Setting Taiwan. Participants Using the Taiwan National Traffic Crash Data and sunrise and sunset data from the National Oceanic and Atmospheric Administration for the period 2003 to 2016, 100 411 pedestrians involved in crashes were identified. Of these crashes, 13 355 and 87 056 were glare-related (case) and non-glare-related (control) crashes, respectively. Methods To account for unobserved heterogeneity, mixed logit models were estimated to identify the determinants of pedestrian fatalities. Main outcome measures Pedestrian fatalities. Results Pedestrians involved in glare-related crashes were more likely to be fatally injured than those in non-glare-related crashes (β=0.527; t=3.21). Other contributory factors to fatal injuries among pedestrians were older pedestrians (β=0.553; t=2.33), male drivers (β=0.324; t=2.33), older

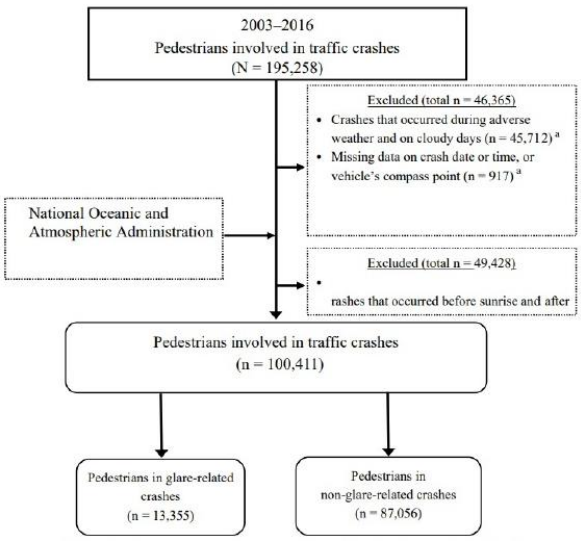
drivers (β=0.218; t=2.14), intoxicated motorists (β=0.606; t=2.85), rural roadways (β=0.985; t=3.92), overtaking manoeuvres (β=0.472; t=3.58), heavy vehicle crash partners (β=0.248; t=2.78) and sunset hours (β=0.274; t=3.08). Walking against traffic appeared beneficial for decreasing injury severity (β=−0.304; t=−2.76). Conclusions Sun glare is associated with pedestrian fatalities. Older pedestrians, male drivers, older drivers and intoxicated motorists are prevalent determinants of pedestrian fatalities in glare-related crashes.

Aim of Research

The primary research hypothesis of the present study was that pedestrian injury severity increases as visibility decreases (ie, during sun glare). This study therefore investigated whether sun glare is associated with pedestrian fatalities. This study also examined the determinants of pedestrian fatalities in crashes related to sun glare.

Method of Research & Progression

In the existing database, this study controlled the weather in terms of the environment, distinguishing between sunny days and other poor climates to ensure the influence of sun glare. It also analyzes the direction of sunlight incidence from the seasons, and confirms that sunlight affects the sight of driving at a controlled time. The original traffic accident data will be combined later to analyze the serious injury rate.



Results of Research

Table 1 Distribution of pedestrian injury severity according to a set of variables for the period 2003 to 2016

		Fatality	Injury	χ^2 test
	N	n (%)	n (%)	P value
Total	100411	1925 (1.92)	98486 (98.08)	
Sun glare				
Yes	13355 (13.30)	329 (2.46)	13026 (97.54)	<0.01
No	87056 (86.70)	1596 (1.83)	85460 (98.17)	
Pedestrian gender				
Male	50942 (50.73)	1015 (1.99)	49927 (98.01)	0.08
Female	49469 (49.27)	910 (1.84)	48559 (98.16)	
Driver gender				
Male	53351 (53.13)	1132 (2.12)	52219 (97.88)	<0.01
Female	47060 (46.87)	793 (1.69)	46267 (98.31)	
Pedestrian age (years)				
<18	3644 (3.63)	67 (1.84)	3577 (98.16)	<0.01
18–40	25851 (25.75)	154 (0.60)	25697 (99.40)	
41–64	31283 (31.15)	352 (1.13)	30931 (98.87)	
≥65	39633 (39.47)	1352 (3.41)	38281 (96.59)	
Driver age (years)				
<18	4458 (4.44)	103 (2.31)	4355 (97.69)	<0.01
18–40	25808 (25.70)	295 (1.14)	25513 (98.86)	
41–64	32523 (32.39)	474 (1.46)	32049 (98.54)	
≥65	37622 (37.47)	1033 (2.75)	36589 (97.25)	
Driver licence				
Licensed	86007 (85.65)	1609 (1.87)	84398 (98.13)	0.01
Unlicensed	14404 (14.35)	316 (2.19)	14088 (97.81)	
Alcohol use for driver				
No	86322 (85.97)	1512 (1.75)	84810 (98.25)	<0.01
Yes	14089 (14.03)	413 (2.93)	13676 (97.07)	
Seasons				
Spring/summer	47671 (47.48)	914 (1.92)	46757 (98.08)	0.99
Autumn/winter	52740 (52.52)	1011 (1.92)	51729 (98.08)	
Crash location				
Rural	10475 (10.43)	352 (3.36)	10123 (96.64)	<0.01
Urban	89936 (89.57)	1573 (1.75)	88363 (98.25)	
Crash partner				
Motorcycle	33221 (33.09)	643 (1.94)	32578 (98.06)	<0.01
Car	45963 (45.77)	801 (1.74)	45162 (98.26)	
Taxi	9655 (9.62)	208 (2.15)	9447 (97.85)	
Heavy vehicle	11572 (11.52)	356 (3.08)	11216 (96.92)	
Pedestrian movement				
Facing traffic	9704 (9.66)	172 (1.77)	9532 (98.23)	<0.01
Back to traffic	24584 (24.48)	623 (2.53)	23961 (97.47)	
Crossing	66123 (65.85)	1130 (1.71)	64993 (98.29)	
Car manoeuvre				
Straight	50636 (50.63)	862 (1.70)	49974 (98.30)	<0.01
Changing lane	15625 (15.56)	257 (1.64)	15368 (98.36)	
Overtaking	21339 (21.25)	601 (2.82)	20738 (97.18)	
Turning	12611 (12.56)	205 (1.63)	12406 (98.37)	
Sunset				
Sunset	8325 (8.29)	214 (2.57)	8109 (97.41)	<0.01
Other times	87056 (86.70)	1596 (1.83)	85460 (98.17)	
Sunrise	5030 (5.01)	115 (2.29)	4915 (97.71)	
Weekdays				
Weekday	70366 (70.08)	1267 (1.80)	69099 (98.20)	<0.01
Weekend	30045 (29.92)	658 (2.19)	29387 (97.81)	

Table 2 Mixed logit model estimation results for pedestrian injury severity during the period 2003 to 2016* (n=100 411)

Variable	Parameter	SE	t value
Fatal injury			
Fixed parameters			
Constant	−0.531	0.215	−2.47
Glare-related crash	0.527	0.164	3.21
Pedestrian facing traffic	−0.304	0.110	−2.76
Pedestrian aged 65+ years	0.553	0.237	2.33
Motorist aged 65+ years	0.218	0.102	2.14
Rural roadway	0.985	0.251	3.92
Intoxicated motorist	0.606	0.213	2.85
Weekend	0.134	0.053	2.53
Overtaking manoeuvre	0.472	0.132	3.58
Sunset	0.162	0.074	2.19
Random parameters			
Male motorist	0.324	0.139	2.33
SD of distribution	0.389	0.163	2.39
Heavy vehicle partner	0.274	0.110	2.49
SD of distribution	0.622	0.290	2.14

Table 3 Mixed logit estimation results for pedestrian injury severity with interaction terms of glare-related crashes and other variables* (n=100 411)

Variable	Parameter	SE	t value
Fatal injury			
Fixed parameters			
Constant	−0.324	0.139	−2.33
Male motorist	0.193	0.069	2.80
Sunset	0.274	0.089	3.09
Pedestrian facing traffic × glare crash	−0.439	0.126	−3.48
Pedestrians aged 65+ years	0.533	0.210	2.54
Motorists aged 65+ years × glare crash	0.432	0.143	3.02
Rural roadways × glare crash	0.684	0.190	3.60
Intoxicated motorist	0.461	0.154	2.99
Weekend	0.157	0.075	2.09
Overtaking manoeuvre	0.329	0.121	2.72
Random parameter			
Heavy vehicle as crash partner	0.248	0.089	2.78
SD of distribution	0.526	0.211	2.49

Future Areas to Take Note of, and Going Forward

Educational efforts can be directed towards drivers of heavy vehicles regarding driver susceptibility to sun glare, particularly on roadways with pedestrians. Sun glare is a combined spatiotemporal factor. To broaden our collective understanding of factors of pedestrian safety, collecting spatial and temporal data whenever possible is paramount. The empirical results obtained in this study may be unique to Taiwan because of its unique sunrise and sunset times and orientations.

Means of Official Announcement of Research Results

We will publish findings on BMJ.