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PII: S0379-0738(18)30670-4
DOI: https://doi.org/10.1016/j.forsciint.2018.08.037
Reference: FSI 9461

To appear in: *FSI*

Received date: 4-4-2018
Revised date: 3-7-2018
Accepted date: 25-8-2018

Please cite this article as: Sonja Sassi, Helinä Hakko, Esa Räty, Pirkko Riipinen, Light motor vehicle collisions with heavy vehicles — psychosocial and health related risk factors of drivers being at-fault for collisions, Forensic Science International https://doi.org/10.1016/j.forsciint.2018.08.037

Light motor vehicle collisions with heavy vehicles – psychosocial and health related risk factors of drivers being at-fault for collisions

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Highlights

- Increasing trend in suicides by head-on collisions with heavy vehicles was observed in 2002-2011.
- Of all fatal head-on collisions with heavy vehicles, one third was confirmed suicides.
- Fitness-to-drive of psychiatric patients should alarm mental health professionals.

Abstract

Background: Fatal head-on collisions between passenger cars and trucks are sometimes thought as self-inflicted death of the passenger car drivers.

Methods: A total of 378 Finnish drivers of light motor vehicles (LMV) died in collisions with heavy vehicles between the years 2002-2011. These male and female drivers, who were considered as being at fault, and whose collisions with heavy vehicles occurred in the oncoming vehicle's lane, were explored in relation to information on their socio-demographics, physical and mental health condition and driving-related factors.

Results: Cause of death of at-fault LMV drivers, as defined in medico-legal examination, was most commonly accidental (51%), followed by suicide (32%), undetermined intent (17%) and acute illness (0.3%). Ten-year time trend in rates of LMV drivers has remained stable (Annual Percentage Change, APC = -0.03; p = 0.983), the annual proportion varying between 14%-21%. However, a statistically significantly increasing time trend was observed in fatal accidents due to suicides (APC = 5.31, p = 0.028). Generally, at-fault LMV drivers were characterized as having mental health problems susceptibility to risk (44%), personal relationship problems (33%), long-term physical illness (68%) or medication (35%) or driving under influence of alcohol (24%). Male LMV drivers, compared to women, were more commonly unmarried, farm/wood/industrial workers and drove alone and without a planned destination. Female LMV drivers were, more commonly than men, widowed, third degree students, skilled workers, had long term mental illnesses/disturbances, drove with family member(s) and their fatal accidents occurred in winter.

Conclusion: The findings give support to the recommendation that suicidal ideation must be considered when assessing fitness-to-drive.

Keywords: fatal motor vehicle accident, suicide, head-on collision, mental health, physical health

1. Introduction

Among the general population, fatal collisions between passenger cars and trucks are sometimes perceived as self-inflicted deaths by the passenger car driver. Öhberg and workgroup [1] reported that driver suicides were usually head-on collisions into another vehicle with a large weight disparity. In a Swedish study, 8% of heavy vehicle collisions were estimated to be suicides. This was two times higher than the proportion of suicides in all fatal motor vehicle accidents [2]. In general, the prevalence of driver suicides has ranged from 2% to 9% of all fatal motor vehicle accidents [1-4]. Exact figures on traffic suicide rates for drivers are, however, difficult to compare due to the methodological differences in establishing suicidal intent.

Several studies have revealed characteristics and risk factors which commonly identify drivers killed in traffic accidents; these include male gender, young age and use of alcohol and drugs [2,5]. The use of benzodiazepines have associated with a significantly increased risk of traffic accidents [6-8]. Other factors, such as weather, car and road conditions, or time and season of day of accident, are also known to contribute to traffic deaths [9].

Psychiatric disorders of drivers killed in heavy vehicle collisions remain a relatively unstudied topic. A recent study by Kujansuu and workgroup [10] showed that death rates of drivers with psychiatric disorder have increased, whereas those for drivers without psychiatric disorder have decreased. Depression is reported to be common in driver suicides [11]. Thus, a more detailed evaluation of driver-related characteristics, potentially associating to driving performance and risk of suicide in traffic, is required for planning preventive strategies.

The first aim of the current study was to analyse time trends in rates of light motor vehicle (LMV) drivers killed in collision with heavy vehicles in Finland during the 10-year period 2002-2011. The focus was on drivers defined as being at fault for the accident. Gender differences in socio-demographic, psychosocial characteristics, mental and physical health condition and travel-related factors were evaluated. For this purpose, we had access to large national registers for road traffic accidents and causes of death.

2. Materials and methods

2.1. Sample selection

Our initial study population consisted of all Finnish drivers killed in fatal motor vehicle accidents in Finland during the years 1990-2011 (n = 4810). For the purpose of the current study we selected a subsample of 378 Finnish light motor vehicle (LMV) drivers who were considered to be at fault in collisions with heavy vehicles. Sample selection is illustrated in Figure 1.

2.2. Data sources

2.1.1. Fatal motor vehicle accidents

The data was obtained from the Finnish database of road and cross-country traffic accidents, maintained by the Finnish Crash Data Institute (OTI). This database is formed on the base of systematic and structured investigation reports from the twenty independent Road Accident Investigation Teams (RAITs). The RAIT teams have been responsible for investigating all fatal motor vehicle accidents in Finland since 1968, and this procedure is followed for traffic safety purposes. Each team includes specialists from various disciplines,

including police, medicine, vehicle technology, road maintenance and behavioural sciences. In addition to comprehensive traffic accident investigations, members of the RAIT teams interview the people involved, such as eyewitnesses and next-of-kin. The RAIT teams are also entitled to acquire information from various national registers to complement investigations. A detailed description of the investigation method of RAIT teams is described by Salo and workgroup [12]. See also the website of The Finnish Motor Insurers' Centre 2006 [13]. The Finnish Crash Data Institute provided us with the main data for this study and approved its use (16, October, 2013).

2.2.1. Cause of death register

Official cause of death information was obtained from the national cause of death register provided by Statistics, Finland. All drivers killed in motor vehicle accidents are examined by forensic medicine specialist physicians and an official death certificate is completed following the comprehensive medico-legal examination of the deceased driver.

2.3. Study variables

Information was based on the reports of the RAIT teams if not otherwise stated.

2.3.1. Accident and car type

In the current study, the focus was head-on collisions. Each vehicle's initial course before the crash was determined, and only cases in which passenger car drivers drove or swerved to the opposite line and were considered to be at fault for the collision with the heavy vehicle were

included in our analyses. Information on each car's initial course before the accident was recorded from 2002 onwards, which limited our study to the years 2002 to 2011.

Light motor vehicles (LMV) mean passenger cars, motorcycles and vans. According to EU classification of vehicle categories, a passenger car is classified as a car with a curb weight less than 3.5 ton, including vans and trailers. In order to be included in the LMV group, motorcycles and light motorcycles must have a maximum engine capacity of 125 cc.

Heavy vehicles involved in collisions, included in our study, include trucks, trucks with a trailer, and buses. Following the EU classification of vehicles, heavy vehicle means a motor vehicle with a weight exceeding 3.5 tons.

2.3.2. Cause of death

Cause of death, as recorded on the official death certificates obtained from the Finnish cause-of-death register, was determined by a forensic pathologist after a comprehensive medico legal examination. Motor vehicle accidents (recorded as cause of death) were recorded as being due to either: acute illness, accident, suicide, or with undetermined intent.

2.3.3. Socio-demographic characteristics of drivers

The socio-demographic characteristics of the deceased drivers analysed in our study were: driver's age (in years) and marital status (unmarried, married or cohabiting, divorced or separated, widowed), basic education and employment status. Education was categorized as comprehensive school (elementary/junior high), second degree student (student in vocational/upper secondary school), vocational degree (graduated), third degree student (student in university/university of applied sciences), third degree (graduated) and other.

Employment status was classified into: entrepreneur, managership, driver, skilled worker, farm/wood/industrial worker, pensioner, student, or unemployed.

2.3.4. Use of alcohol and medication

Use of alcohol was based on blood alcohol concentration (BAC, ‰) measured using either blood or breathalyzer tests (breath samples can be taken if driver did not die immediately as a result of their motor vehicle accident). BAC was categorized as: no alcohol/unknown, presence of alcohol (BAC<0.5‰), driving under the influence of alcohol (DUI) (BAC between 0.5‰-1.19‰), aggravated DUI (BAC ≥ 1.2‰). Information on the long-term medication (yes/no) and medication affecting driving performance (yes/no) was based on data gathered in medico-legal examinations.

2.3.5. Adverse life events

Information regarding recent adverse life events and physical/emotional state of the drivers were gathered from the people involved or the drivers' next-of-kin. The following concerns/problems (yes/no) were assessed: financial problems, health problems, work problems/stress, illness/death of close relative, and personal relationship problems. Each driver's physical/emotional state at the time of the accident was evaluated as being normal, angry/agitated, depressed/distressed/withdrawn, happy/riotous, defiant, or other/not known.

2.3.6. Physical and mental health condition

The driver's long term physical and mental health conditions prior their accident were also evaluated. Information on mental health conditions (yes/no) covered mental problems (susceptibility to risk), mental illness/disturbances, depression, and suicidal thoughts/attempts. Long-term physical health conditions (yes/no) included physical illnesses in general and, separately, the three most common conditions (cardiovascular disease, cerebrovascular disease and epilepsy/convulsions).

2.3.7. Season of accident

A season of accident was derived from the date of each accident. Months of accident were categorized as winter (from December to February), spring (from March to May), summer (from June to August) and autumn (from September to November).

2.3.8. Passengers and main purpose of driving

The type of passengers involved in the passenger car collisions with heavy vehicles were categorised as follow: no passengers, family member(s), other persons. The main purpose of driving included categories for work related driving, running errands, leisure drive to a planned destination, leisure drive without a planned destination, and other purpose.

2.4. Statistical analyses

Group difference in categorical variables was examined with Pearson chi-square or Fisher's Exact test and, in continuous variables, using Student's t-test. Time trend in rates of LMV collisions with heavy vehicle were assessed using Joinpoint Regression analysis

(National Cancer Institute, 2015). All statistical tests were two-tailed and a limit for statistical significance was set at $p < 0.05$. Statistical analyses were performed using IBM SPSS version 22 for Windows.

3. Results

A total of 378 at-fault light motor vehicle (LMV) drivers died in collisions with heavy vehicles in Finland between the years 2002 and 2011. Of them, 303 (80%) were male and 75 (20%) female. The mean (SD) age of the LMV drivers at the time of death did not differ between genders (p=0.737), being 39.6 (17.2 SD) years for men and 40.2 (14.7 SD) years for women

3.1. Overall trend in rates of at-fault LMV drivers killed in collisions with heavy vehicles

The rate of LMV drivers killed in collisions with heavy vehicle, as a proportion of all drivers killed in motor vehicle accidents during the years 2002-2011, varied from between 14.3% and 21.1% (Figure 2). The overall time trend in these deaths has remained relatively stable (Annual Percentage Change [APC] = -0.03; Confidence Interval [CI] = [-3.11, 3.15]; p = 0.983).

3.2. Trend in rates by cause of death among at-fault LMV drivers

Cause of death, as defined in the medico-legal examination, was most commonly accidents (192, 50.8%), followed by suicides (121, 32.0%), undetermined intent (64, 16.9%) and acute illness (1, 0.3%). When analysing time trends in the cause of death categories (Figure 3), an increasing trend was found in suicides (APC = 5.31; CI = [-0.25, 11.18]; p = 0.028), but

not in accidents (APC = -1.31; CI = [-5.87, 3.48]; p = 0.522) or collisions with undetermined intent (APC = -6.79; CI = [-18.27, 6.31]; p = 0.218).

3.3. Socio-demographic characteristics of the study population

The socio-demographic characteristics of the at-fault LMV drivers are presented in Table 1. Male drivers, compared to female, were significantly more often unmarried and farm/wood/industrial workers, while female drivers were widowed, third degree students or skilled workers.

3.4. Mental health condition and adverse life events of drivers

As Table 2 shows, the at-fault LMV drivers were characterised as having long-term mental health problems that might increase risk-taking behaviour leading to accidents (44%), depression (28%), personal relationship problems (32%) and having normal emotional state (28%) prior to their collision. A total of 55 (17%) of the drivers did also have previous suicidal thoughts or attempts, according to the RAIT team reports, but showing an equal prevalence in men and women. A statistically significant gender difference with female preponderance was observed only in the presence of long term mental illnesses/disturbance (p=0.020).

3.5. Physical health condition, BAC and use of medications

Table 3 shows that, from all at-fault LMV drivers, the majority (68%) had a long term physical illness, the most common being cardiovascular disease (15.0%). BAC level exceeded

the legal limit of 0.5‰ in 87 (23.6%) of the deceased drivers. Further, medication use at the time of death was detected in 119 (34.8%) drivers and 16.1% of drivers used products affecting driving performance. No statistically significant gender difference was observed in any of these characteristics.

3.6. Season of accident, type of passengers and purpose of the journey

There was a statistically significant difference between male and female at-fault LMV drivers in the season when fatal collisions occurred (overall difference, p = 0.016) (Figure 4). Fatal accidents occurred more commonly during the winter season in female drivers, compared to male (p = 0.002).

In collisions with heavy vehicles, the majority (90%) of at-fault LMV drivers were driving without passengers. Female drivers, compared to men, more commonly had family member(s) as passengers, whereas male drivers were more likely to be driving alone at the time of the accident than female drivers (p=0.002). The most common reasons for the journey were for leisure with (22%) and without (21%) a planned destination. Female drivers were more likely to be running errands (p=0.052), while male drivers were driving without a planned destination (p=0.011).

4. Discussion

Globally suicide is more common in men than women. The worldwide age-standardized suicide rate per 100000 population is 15.0 for men and 8.0 for women. In wealthy countries, three times as many men die of suicide than women [14]. In Europe, death rates from suicides are four times higher in men than in women [15]. In our study, a gender difference was not

found, since one third of both male and female at-fault LMV drivers had suicide recorded as their cause of death in collisions with heavy vehicles. However, the time trend in suicides of at-fault LMV drivers is increasing, as observed in traffic suicides [11] and traffic deaths of psychiatric patients [10].

In our study population, about 17% of at-fault LMV collisions with heavy vehicles were classified as undetermined by drivers' intent. Several studies have noted difficulties in classifying a fatal motor vehicle crash as a suicide or with unintentional intent [2,5,11]. It is very possible that driver suicide rates are underestimated [4,11,16,17]. Therefore, in our study, suicidal intention as the reason for LMV drivers' collision with heavy vehicles might be even higher than the observed 32%,

The seasonal distribution of fatal accidents among at-fault LMV drivers differed between genders, showing female excess during the winter season. Seasonal variation has been documented in admissions and symptom assessments of bipolar disorder [18]. It is also characteristic of seasonal affective disorder (SAD) [19], which, in clinical trials, is reported to be more common in women than in men [20-21]. Peak incidence is also found in postpartum depression, where women giving birth in the last quarter of the year were shown to be at higher risk of postpartum depression both 6 weeks and 6 months after delivery [22-23].

In our study, women were twice as likely to have long term psychiatric illnesses compared to male at-fault LMV drivers. The meta-review by Chesney and workgroup [24] revealed excess risks of mortality and suicide in all mental disorders, and in women specifically, in depression and bipolar disorder. Female drivers in our study were more likely to have passengers in their car, most commonly family members. This raises a question as to whether some of fatal accidents were familicide or extended suicide. In Finland, the number of children killed as a result of familicide is high when compared to other western world countries [25].

In Finland, the doctor examination procedure for getting a driving licence is concentrates on persons' somatic condition. For mental health condition, the procedure contains only information about the mental disorders (yes/no), or problems with substance abuse (yes/no) based on the verbal information given by the driving licence candidate. Secondly, the medical doctors can give verbal driving bans to psychiatric patients. In addition, they are required to notify the police of any deterioration in the state of health of a driver. But, unfortunately, it is not known the number of verbal bans or notifications sent to the police in the cases of drivers with serious mental illnesses. These are the reasons why we think our study has an important role in future when assessing the psychiatric patient's fitness-to-drive affecting to public safety.

A major strength of our study is the use of comprehensive national registers, which allowed examination of all LMV drivers killed in collisions with heavy vehicle in Finland during a 10-year study period. The database of road and cross-country traffic accidents is gathered by multidisciplinary investigation teams, using structured investigation methods, which provides a unique opportunity to study various characteristics relating to victims of road traffic accidents in Finland. The cause-of-death register is widely acknowledged as a reliable source of information for scientific purposes [26-27]. The linkage between these two registers was possible using unique personal identification codes given to all Finnish residents. A limitation is that, although the medicolegal autopsy procedure contains the alcohol, drug, and medication analyses (National Institute for Health and Welfare, Forensic Toxicology, 2015), we did not have access to pharmacological data of medications and substances other than alcohol. Therefore, the exact pharmacological profile of the driver at the time of fatal accident remained open. Further, the age(s) and other information about family members and other car occupants were not available.

5. Conclusions

The overall time trend, during 2002-2011, in death rates for light motor vehicle drivers at fault for collisions with heavy vehicle has remained stable, but has markedly increased for those drivers having suicidal intent recorded as the reason for the collision. Our study findings warrant further studies to analyse, in more detail, the mental health characteristics of deceased LMV drivers. Psychiatric patients' fitness-to-drive should be a key consideration among mental health professionals.

Authors contribution:

All authors have contributed equally to the design, execution, analyses, and to writing of the paper and that they have seen and approved the final version of the paper.

Acknowledgements

This study was financially supported with grants from the Finnish Crash Data Institute (Sassi). The authors would like to thank the Finnish Crash Data Institute (OTI), and Statistics Finland for providing the data used in this study.

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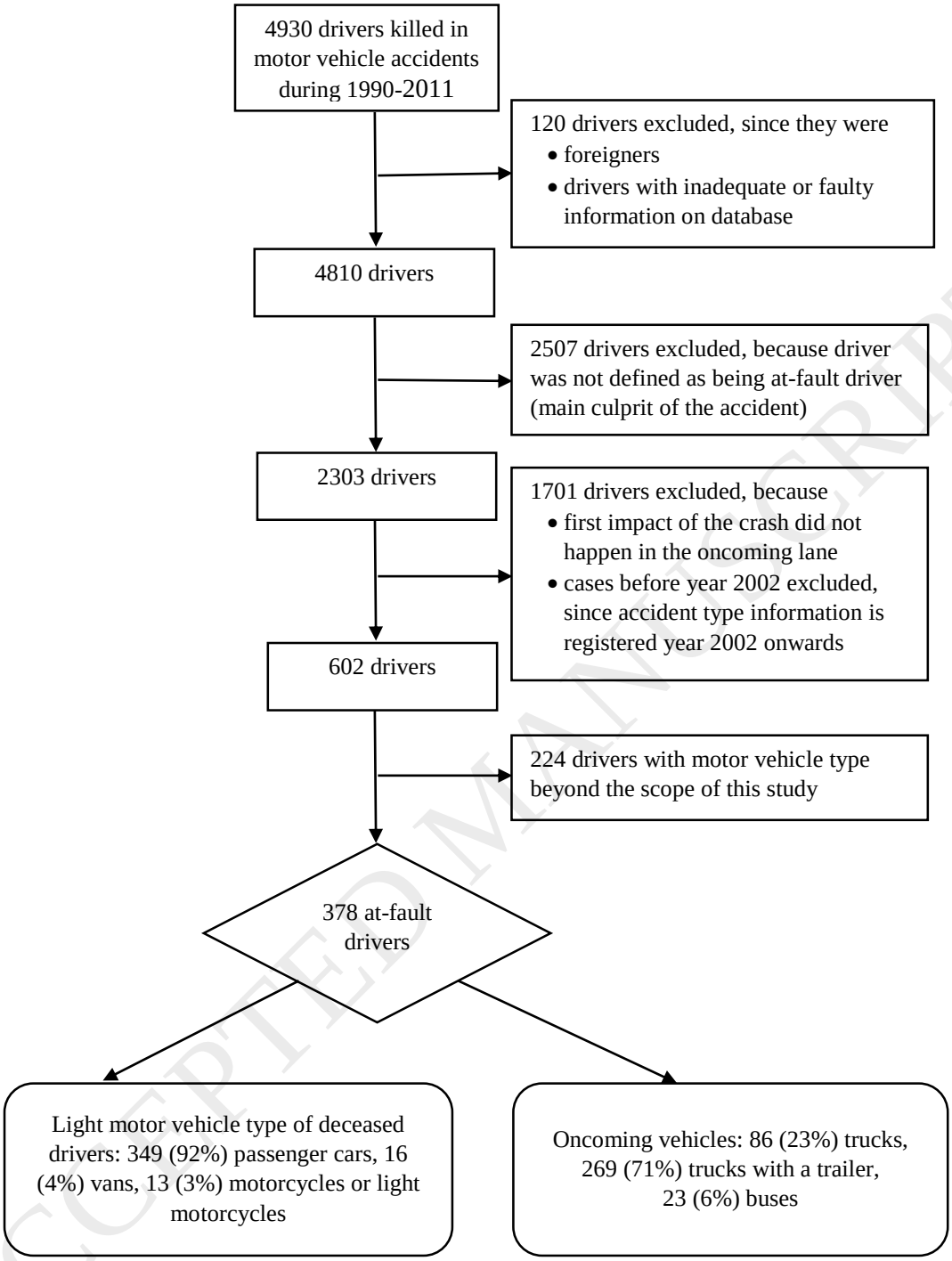

Fig. 1. A flow chart showing the sample selection for the current study.

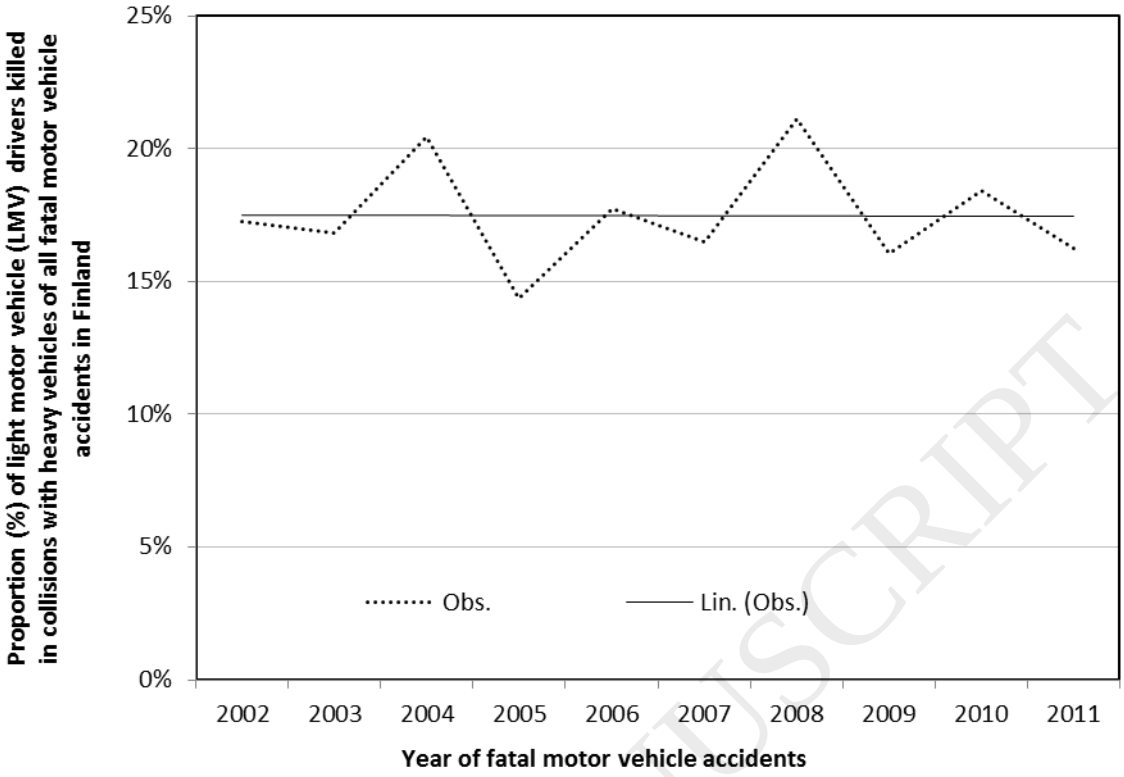

Fig. 2. Proportion (%) of at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles in relation to all drivers killed in motor vehicle accidents during the years 2002-2011, Finland.

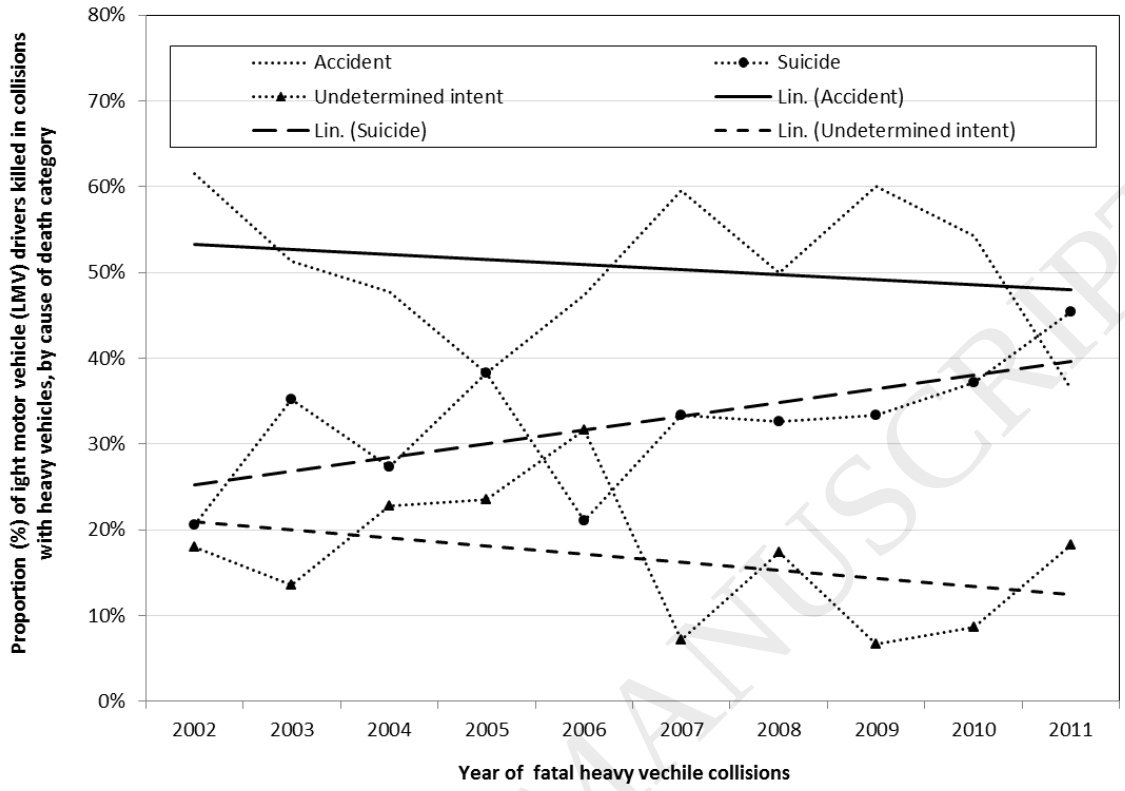

Fig. 3. Trend in rates of at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles, by cause of death category, during the years 2002-2011, Finland.

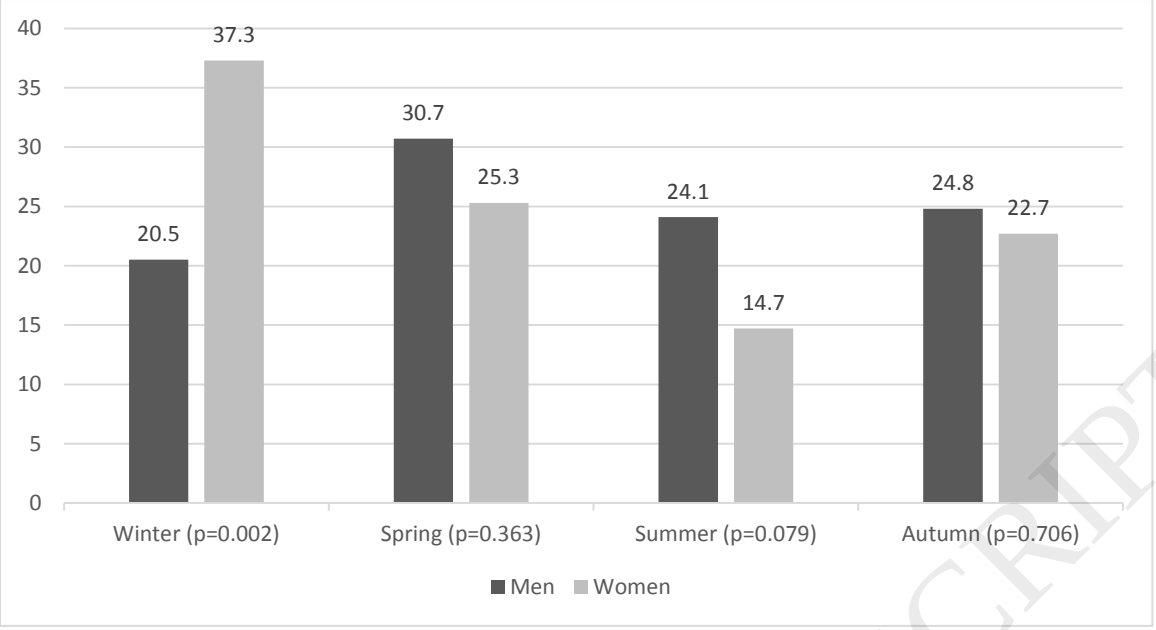

Fig. 4. Season of accidents among at-fault light motor vehicle (LMV) car drivers in collisions with heavy vehicles, by gender.

Table 1

Socio-demographic characteristics of at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles, by gender.

	Total (N = 378)	Male (N = 303)	Female (N = 75)	*p* value
	n (%)	n (%)	n (%)	
Age (in years) at time of accident				
< 24	96 (25.4)	83 (27.4)	13 (17.3)	0.073
25-29	36 (9.5)	28 (9.2)	8 (10.7	0.706
30–39	75 (19.8)	55 (18.2)	20 (26.7)	0.098
40–49	72 (19.0)	56 (18.5)	16 (21.3)	0.573
50–59	53 (14.0)	45 (14.9)	8 (10.7)	0.350
60–69	25 (6.6)	17 (5.6)	8 (10.7)	0.123
≥70	21 (5.6)	19 (6.3)	2 (2.7)	0.274
Marital status				
Unmarried	124 (38.9	109 (42.6)	15 (23.8)	0.006
Married or cohabiting	146 (45.8)	112 (43.8)	34 (54.0)	0.145
Divorced or separated	37 (11.6)	29 (11.3)	8 (12.7)	0.761
Widowed	12 (3.8)	6 (2.3)	6 (9.5)	0.016
Educational level				
Comprehensive school	67 (23.9)	58 (25.9)	9 (16.1	0.123
Second degree student	49 (17.5)	40 (17.9)	9 (16.1	0.753
Vocational degree	85 (30.4)	65 (29.0)	20 (35.7)	0.330
Third degree student	15 (5.4)	8 (3.6)	7 (12.5)	0.015
Third degree	55 (19.6)	45 (20.1)	10 (17.9)	0.707
Other	9 (3.2)	8 (3.6)	1 (1.8)	0.693
Employment status				
Entrepreneur/managership	59 (17.1)	49 (17.6)	10 (14.7)	0.566
Driver	33 (9.5)	23 (8.3)	10 (14.7)	0.106
Skilled worker	50 (14.5)	32 (11.5)	18 (26.5)	0.002
Farm/Wood/Industrial worker	62 (17.9)	58 (20.9)	4 (5.9)	0.004

Pensioner	50 (14.5)	41 (14.7)	9 (13.2)	0.750
Student	71 (20.5)	58 (20.9)	13 (19.1)	0.749
Unemployed	21 (6.1)	17 (6.1)	4 (5.9)	1.000

Note: Number of cases in analyses may vary due to missing values in variables

Table 2

Long term mental health condition and recent adverse life events of at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles, by gender

	Total (N = 378)	Male (N = 303)	Female (N = 75)	*p* value
	n (%)	n (%)	n (%)	
Long-term mental health condition *				
Mental health problems (susceptibility to risk)	142 (44.4)	110 (42.3)	32 (53.3)	0.121
Long term mental illnesses/disturbances	44 (13.7)	30 (11.5)	14 (23.0)	0.020
Depression	90 (28.0)	71 (27.3)	19 (31.1)	0.548
Suicidal thoughts or attempts	55 (17.1)	45 (17.3)	10 (16.4)	0.865
Recent adverse life events				
Financial problems	40 (13.8)	34 (14.3)	6 (11.3)	0.564
Health problems	56 (19.4)	46 (19.5)	10 (18.9)	0.917
Workplace issues/stress at work	34 (11.8)	29 (12.3)	5 (9.4)	0.560
Next of kin illness/death	15 (5.2)	10 (4.2)	5 (9.4)	0.162
Personal relationship problems	94 (32.5)	77 (32.6)	17 (32.1)	0.938
Other	60 (20.8)	48 (20.3)	12 (22.6)	0.709
Emotional state prior to FMVA				
Normal	107 (28.3)	88 (29.0)	19 (25.3)	0.523
Irritated, angry, excited	34 (9.0)	28 (9.2)	6 (8.0)	0.737
Depressed, distressed, absent-minded	66 (17.5)	54 (17.8)	12 (16.0)	0.710
Happy, boisterous, enthusiastic	8 (2.1)	7 (2.3)	1 (1.3)	1.000
Defiant, a “never mind” attitude	5 (1.3)	5 (1.7)	0 (0)	0.588
Other/not known	158 (41.8)	121 (39.9)	37 (49.3)	0.140

Note: Number of cases in analyses may vary due to missing values in variables
* Long-term mental health condition is assessed by the doctor member of the RAIT team.

Table 3

Long term physical health conditions and use of intoxicants and medication among at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles, by gender

	Total (N = 378)	Male (N = 303)	Female (N = 75)	*p* value
	n (%)	n (%)	n (%)	
Long term physical condition *				
Long term physical illnesses	218 (68.1)	178 (68.5)	40 (66.7)	0.788
Cardiovascular disease	48 (15.0)	42 (16.2)	6 (10.0)	0.229
Cerebrovascular disease	4 (1.3)	4 (1.5)	0 (0)	1.000
Epilepsy	3 (1.3)	3 (1.6)	0 (0)	1.000
DUI at time of FMVA				
No alcohol	266 (72.1)	208 (70.3)	58 (79.5)	0.117
Alcohol present (BAC< 0.5‰)	16 (4.3)	14 (4.7)	2 (2.7)	0.748
DUI (BAC, 0.5‰- 1.19‰)	22 (6.0)	19 (6.4)	3 (4.1)	0.588
Aggravated DUI (BAC ≥ 1.20‰)	65 (17.6)	55 (18.6)	10 (13.7)	0.327
Medication				
Long-term medication	119 (34.8)	95 (34.4)	24 (36.4)	0.766
Medication affecting driving performance	59 (16.1)	49 (16.8)	10 (13.3)	0.468

Note: Number of cases in analyses may vary due to missing values in variables. DUI = Driving under the influence of alcohol. BAC = Blood alcohol concentration.

* Long-term mental health condition is assessed by the doctor member of the RAIT team.

Table 4

Type of passengers and main purpose of the journey among at-fault light motor vehicle (LMV) drivers killed in collisions with heavy vehicles, by gender.

	Total (N = 378)	Male (N = 303)	Female (N = 75)	*p* value
	n (%)	n (%)	n (%)	
Passengers				
No passengers	335 (89.6)	276 (92.0)	59 (79.7)	0.002
Family member(s)	21 (5.6)	11 (3.7)	10 (13.5)	0.003
Other persons/not known	18 (4.8)	13 (4.3)	5 (6.8)	0.369
Main purpose of the journey				
Related to work	47 (16.2)	40 (17.2)	7 (12.1)	0.339
Running errands	50 (1.2)	35 (15.1)	15 (25.9)	0.052
Leisure drive to a planned destination	63 (21.7)	49 (21.1)	14 (24.)	0.618
Leisure drive without a planned destination	60 (20.7)	55 (23.7)	5 (8.6)	0.011
Other purpose	70 (24.1)	53 (22.)	17 (29.3)	0.303

Note: Number of cases in analyses may vary due to missing values in variables