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The Impact of Aggressive Behaviour, Sleeping, and Fatigue on Road Traffic Crashes as Comparison between Minibus/Van/Pick-up and Commercial Taxi Drivers

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Abstract: No study has been conducted to determine the relationship between RTC (road traffic crashes) and depression, anxiety and stress scale (DASS-21), tiredness, fatigues and sleeping. The aim of the present study was to examine the effect of aggressive driver behaviour, fatigue and sleeping on RTC comparison between commercial taxi and minibus/van/pick-up cars drivers. A cross-sectional study included a representative sample of 2,300 drivers of which 1,786 drivers (77.6%) agreed to participate. The Manchester DBQ (Driver Behaviour Questionnaire) was used to measure the aberrant driving behaviours leading to accidents. The study is based on the measurement using the depression anxiety stress scales (DASS-21). Participants completed a DASS-21 questionnaire with items related to socio-demographic information, BMI (body mass index), driving experience, fatigue , sleeping, adherence to traffic laws (including speed limits and wearing seat belt), and drivers' driving records. Univariate and multivariate statistical analyses were performed. In a representative sampling, the age distribution of the participants ranged from 25 to 65 years with the mean age 38.3±10.2 and the mean annual mileage (km) per month was 14,587±1,741 ($p < 0.001$). There was a significant difference found between both group minibus/van/pick-up and commercial taxi drivers regarding of their age group ($p < 0.001$), education ($p = 0.003$), history of accident ($p = 0.003$), seat belt use ($p = 0.022$) time of accident ($p = 0.005$); crossing red light ($p < 0.001$), excessive speed limits ($p = 0.002$), BMI group ($p = 0.022$), physical activity ($p = 0.003$), annual mileage in km ($p < 0.001$), number of working days ($p = 0.010$) and hours ($p = 0.030$); number of sleeping hours ($p = 0.025$), CD music listening ($p = 0.010$), mobile phone use ($p = 0.001$), soft drinking ($p = 0.002$) and cigarette smoking habit ($p < 0.001$). When the history of RTC was assessed, minibus/van/pick-ups were more likely to be involved in accidents compared to commercial taxi drivers and there was a highly statistically significant difference between both groups. Furthermore, minibus/van/pick-up drivers have more sleeping disorders and fatigue severity compared to commercial taxi drivers. This study revealed that minibus/van/pick-up drivers exhibited more depression, anxiety and stress symptoms compared to commercial taxi drivers. DASS-21 variables were found to contribute significantly to the explanation of the RTC involvement rate. Chronic fatigue and acute sleepiness, and overtime or heavy work-load on car drivers significantly increases the risk of a car crash which a car occupant can be injured or killed. Reductions in RTC may be achieved if fewer people drive when they have fatigue or are sleepy or have been deprived of sleep or drive during rush hours.

Key words: Aggressive behavior, sleeping fatigue, violation, driving accident.

1. Introduction

Road traffic safety and accidents are a major public health problem everywhere worldwide [1-6]. However, regional differences in traffic safety between countries are considerable. Despite the large regional differences in traffic safety, factors contributing to different accident risk figures in different countries and regions have remained largely unstudied. Sleepiness and fatigue in drivers are widely believed to be an important causes and risk factors of RTC (road traffic crashes) and fatalities. Therefore, estimating their contribution to RTC crashes is important for the development and prioritization of interventions to prevent those crashes and injuries. Reported the proportion of crashes attributable to sleepiness vary from one country to another country in the United State is 1% to 3% [1], in France is 10% [2, 3], and in Australia is 33% [3]. The prevalence of driver sleepiness, fatigue and tiredness and their impact on the incidence of RTC and road traffic injuries are documented well [4-7]. The pattern of acute tiredness, fatigue, chronic sleepiness, sleep disorders, and heavy workload have been associated with decreased performance in psychomotor tests and driving simulators [7-10] and with increased rates of RTC, injuries and fatalities in selected populations [5].

The Manchester DBQ (Driver Behaviour Questionnaire) [9] is one of the most widely used instruments in traffic psychology for measuring self-reported driving style and investigating the relationship between driving behaviour and accident involvement.

In New Zealand, Connor et al. [5-6] assessed the relationship between driver sleepiness and the risk of car accidents in a population-based case-control study that compared 571 car drivers involved in crashes in which at least one occupant was admitted to hospital or killed with 588 representative drivers recruited while driving on public roads. In Fiji, the population attributable risk for crashes associated with driving while not fully alert or sleepy was 34%, and driving after less than 6 h sleep in the previous 24 h was 9% [8]. Study in Fiji showed that driver sleepiness is an important contributor to injury-involved four-wheel motor vehicle crashes. In fact, driver sleepiness and fatigue are now considered to be important factors contributing to RTC [11-15]. Estimates of the proportion of car crashes attributable to driver sleepiness vary between 6% and 20% in western countries according to the type of roads and countries. More recently, two French epidemiological studies confirmed that sleepiness at the wheel was associated with a higher risk of RTC [4, 5]. They also identified insomnia and mental disorders as new factors associated with an increased risk of RTC. Several studies have shown that impaired daytime alertness induces lateral deviations during driving accident involvement. Among these factors, age, mental illness, fatigue, sleeping and speed have been found to be one of the highest correlates of accident involvement [2, 13-15].

The aim of the present study was to examine the effect of aggressive driver behaviour, fatigue and sleeping on RTC comparison between commercial taxi and minibus/van/pick-up cars drivers.

2. Subjects and Methods

2.1 Participants Driver Sample

A cross-sectional survey was conducted during the period of July, 2015 to December, 2015 in Istanbul, Turkey. A multi-stage stratified cluster sampling design was developed using an administrative division of Istanbul with approximately equal size in terms of number of inhabitants. In order to ensure a representative sample of the study population, the sampling plan was stratified with proportional allocation according to stratum size. Stratification was based upon geographical location and with 2.5% error

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bound, 99% confidence limits the required sample size computed to be 2,300. These were considered the target sample from the population. RTC data with socio-demographic information (age, educational level, occupation), driving history (driving experience, type of car, frequency of seatbelt usage, reasons for not wearing seat belt, speed choice on different roads, annual mileage, traffic offences, history of crash and injury involvement) and other activities while driving (like eating, using mobile phone and smoking) were collected by face-to-face interview with drivers by well trained researcher. A representative sample of 2,300 Turkish drivers was selected from both minibus/van/pick-up and commercial taxi drivers aged between 25 and 65 years. A total number of 1,786 drivers (response rate = 77.6%) took part in the study and were included in the statistical analysis. The sample included 1,283 minibus/van/pick-up drivers and 503 commercial taxi drivers. All participants possess valid driving licenses and were assured of anonymity and confidentiality

2.2 Aberrant Driver Behaviours

Manchester Driver Behaviour Questionnaire (DBQ) with extended violations was used to measure aberrant driver behaviours [9]. The DBQ questionnaire includes 10 items of ordinary violations ;8 items of lapses; and 8 items of errors [9]. The DBQ questionnaire has 26 behaviours on a six-point scale (0 = never, 1= hardly ever, 2 = occasionally, 3 = quite often, 4 = frequently, and 5 = nearly all the time) and the research assistants asked the participants to indicate how often they have committed every behaviour in the previous year.

2.3 Fatigue Measure and Design of Scale

Fatigue is highly prevalent and has a negative impact on quality of life and performance in a variety of disorders. The 9-item FSS (fatigue severity scale) is one of the most commonly used self-report questionnaires to measure fatigue [13]. The fatigue scale is composed of nine statements (items) that describe fatigue symptoms commonly seen in subjects. A list of nine questions were generated by various experts in the field to reflect physical and mental fatigue. The FSS is a self-administered questionnaire with nine items (questions) investigating the severity of fatigue in different situations. Grading of each item ranges from 1 to 7, where 1 indicates strong disagreement and 7 strong agreement, and the final score represents the mean value of the nine items [13].

2.4 Measures of Driver Sleepiness

The current study is based on Epworth sleepiness scale to measure chronic or usual daytime sleepiness among drivers and this is a self rating scale, to determine progressive steps in acute sleepiness [16, 17]. In this scale, the respondents can choose one of the seven hierarchical statements that most closely described their level of alertness immediately before the crash or survey. The Epworth sleepiness scale rated the likelihood (never, slight, moderate, or high) that they would fall asleep in each of the eight common situations, giving a total Epworth score in the range of 0-24: < 10 is considered normal; 10-15 indicates moderate impairment, and 16-24 indicates severe impairment. The Epworth sleepiness scale has been validated primarily in obstructive sleep apnea, though it has also shown success in detecting narcolepsy and idiopathic hypersomnia [16, 17]. It is used to measure excessive daytime sleepiness and is repeated after the administration of treatment to document improvement of symptoms [17] an it is worth to note that the Epworth sleepiness scale has both a high specificity (100%) and sensitivity (93.5%).

2.5 Outcome Measures—The Depression Anxiety Stress Scale (DASS-21)

The DASS-21 is a brief 21-item version of the full DASS-21 (depression anxiety stress scale), which originally consisted of 42 items. Each of the three

DASS-21 scales contains seven items representing the dimensions of depression, anxiety and stress [18-20]. The DASS-21 consists of three self report scales that have been designed to measure the negative emotional scales of depression, anxiety and stress. Each question has three subscales ranging between 0 to 3 and the rating scale is as follows: 0 for "did not apply to me at all", 1 for "applied to me to some degree, or some of the time", 2 for "applied to me to a considerable degree, or a good part of the time", and 3 for "applied to me very much, or most of the time". Scores for the DASS-21 sub-scales of depression, anxiety and stress were derived by totaling the scores for each sub-scale and multiplying by 2. We classified drivers according to the recommended scoring system using cut-off values to classify participants into the following categories [20]: normal (0-9 for depression and 0-7 for anxiety), mild (10-13 for depression and 8-9 for anxiety), moderate (14-20 for depression and 10-14 for anxiety), severe (21-27 for depression and 15-19 for anxiety), and extremely severe (≥ 28 for depression and ≥ 20 for anxiety). Analysis is based on this dichotomy (i.e., "normal range" versus "mild to extremely severe" symptoms). A score of DASS ≥ 10 was used to distinguish driver suffering from depression, a score of DASS ≥ 8 for anxiety disorders and a score of DASS ≥ 15 for stress [18-20].

The SPSS (Statistical Package for Social Science) statistical package was used to carry out the statistical analyses. The student-t test was used to ascertain the significance of differences between mean values of two groups. The Chi-square and Fisher's exact tests (two-tailed) were performed to test for differences in proportions of categorical variables between two or more groups. OR (odds ratios) and their 95% CI (confidence intervals) were calculated by using Mantel-Haenszel test. One way ANOVA (analysis of variance) was employed for comparison of several group means and to determine the presence of significant differences between group means. The level $p < 0.05$ was considered as the cut-off value for significance.

3. Results

In a representative sampling, the age distribution of the participants ranged from 25 to 67 years with the mean age 38.39±10.21 and the mean annual mileage (km) per-month was 14,587±1,741 ($p < 0.001$). Table 1 gives the socio-demographic of studied subjects by minibus/van/pick-up and commercial taxi driver. There was a significant difference found between both group of drivers age group ($p < 0.001$), education ($p = 0.003$), history of accident ($p = 0.003$), seat belt use ($p = 0.022$), time of accident ($p = 0.005$), crossing red light ($p < 0.001$) and excessive speed limits ($p = 0.002$).

Table 2 compares the lifestyle characteristics of studied subjects by minibus/van/pick-up and commercial taxi driver. There was a significant difference found between both group of drivers age ($p < 0.001$), BMI (body mass index) group ($p = 0.022$), physical activity ($p = 0.003$ annual mileage in km ($p < 0.001$)), number of working days ($p = 0.010$) and hours ($p = 0.030$); number of sleeping hours ($p = 0.025$), CD music listening ($p = 0.010$), mobile phone use ($p = 0.001$), soft drinking ($p = 0.002$) and cigarette smoking habit ($p < 0.001$). When the history of RTC was assessed, minibus/van/pick-up were more likely to be involved in accidents compared to commercial taxi drivers and there was a highly statistically significant difference between both groups (Fig. 1). Even though most of the minibus/van/pick-up drivers were involved in single vehicle accidents, rear and hit, nose tail, hit fixed object, overturn skid and crash road sign show statistical significant difference when compared to commercial taxi drivers.

Table 3 presents the means and standard deviation of the minibus/van/pick-up and commercial taxi drivers regarding sleepiness and fatigue. As can be seen from this table, minibus/van/pick-up drivers have more sleeping disorders and fatigue severity compared to commercial taxi drivers.

Table 1 The socio-demographic of studied subjects by minibus/van/pick-up and commercial taxi driver (*N* = 1,786).

Variable	Total (1,786) n (%)	Minibus/van/pick-up (*n* = 1,283) n (%)	Commercial taxi (*n* = 503) n (%)	*p*-value
Age group in years				
< 30 years old	421 (23.6)	344 (26.8)	77 (15.3)	0.001
30-39 years old	649 (36.3)	461 (35.9)	188 (37.4)	
40-50 years old	598 (33.5)	395 (30.8)	203 (40.4)	
> 50 years old	118 (6.6)	83 (6.5)	35 (7.0)	
Education Level				
Elementary	370 (20.8)	257 (20.0)	115 (22.9)	0.003
Intermediate	446 (25.0)	328 (25.6)	118 (23.5)	
Secondary	583 (32.6)	444 (34.6)	139 (27.6)	
University	385 (21.6)	254 (19.8)	131 (26.0)	
Driving experience				
<5 years	242 (13.5)	165 (12.9)	77 (15.3)	0.097
5-10 years	468 (26.2)	362 (28.2)	106 (21.1)	
10 -20 years	391 (21.9)	286 (22.3)	105 (20.9)	
>20 years	685 (38.4)	479 (36.6)	215 (42.7)	
Seat belt use				
Never	671 (37.6)	492 (38.3)	179 (35.6)	0.538
Seldom	256 (14.3)	176 (13.7)	80 (15.9)	
Frequently	539 (30.2)	383 (29.9)	156 (31.0)	
Always	320 (17.9)	232 (18.1)	88 (17.5)	
History of accident				
Yes	617 (34.5)	470 (36.6)	147 (29.2)	0.003
No	1,169 (65.5)	813 (63.4)	356 (60.8)	
History of injury				
Yes	515 (28.8)	396 (30.9)	119 (23.7)	0.002
No	1,271 (71.2)	887 (69.1)	384 (76.3)	
Time of accident				
00:00-05:59 a.m.	186(10.4)	118 (9.2)	68 (13.5)	0.005
06:00-12:00 noon	645 (36.1)	490 (38.1)	155 (30.8)	
12:00-05:59 p.m.	453 (25.4)	333 (26.0)	120 (23.9)	
06:00-12:00 p.m.	502 (28.1)	342 (25.7)	160 (31.8)	
Crossing red light				
Yes	614 (34.4)	402 (31.3)	212 (42.1)	0.001
No	1,172 (65.6)	881 (68.7)	291 (57.9)	
Speed limits				
< 60 km/h	300 (16.8)	190 (14.8)	110 (21.9)	0.002
60~80 km/h	655 (36.6)	515 (40.1)	140 (27.8)	
80~100 km/h	503 (28.2)	350 (27.3)	153 (30.4)	
> 100 km/h	328 (18.4)	228 (17.87)	100 (19.9)	

Table 2 The lifestyle characteristics of studied subjects by minibus/van/pick-up and commercial taxi driver (*N* = 1,786).

Variable	Total (1,786) *n* (%)	Minibus/van/pick-up (*n* = 1,283) *n* (%)	Commercial taxi (*n* = 503) *n* (%)	*p*
Age in years				
(Mean ± St. Dev.)	37.62±7.75	36.73±7.99	38.51±7.51	0.001
BMI group				
< 25 kg/m^2	443 (24.8)	296 (23.3)	147(29.2)	
25~30 kg/m^2	828 (46.4)	604 (47.1)	224 (44.5)	0.022
> 30 kg/m^2	515 (28.8)	383 (29.9)	132 (26.2)	
Physical activity				
Yes	497 (27.8)	332 (25.9)	165 (32.8)	0.003
No	1,289 (72.2)	951 (74.1)	338 (67.2)	
Annual km per month	14,587±1,741	15,012±1,850	14,162±1,632	0.001
No. of working hours	9.06±1.42	9.28±1.52	8.85±1.32	0.010
No. of working days	5.60±0.49	5.73±0.43	5.50±0.54	0.030
No of sleeping hours	6.23±1.06	6.36±1.06	6.15±1.07	0.025
Mobile phone use				
Never	417 (23.3)	312 (24.3)	105 (20.9)	
Seldom	350 (19.6)	223 (17.4)	127 (25.2)	0.001
Frequently	401 (22.5)	283 (22.1)	118 (23.5)	
Always	618 (34.6)	465 (36.2)	153 (30.4)	
Soft drinking				
Never	479 (26.8)	328 (25.6)	151 (30.0)	
Seldom	376 (21.1)	246 (19.2)	130 (25.8)	0.002
Sometimes	499 (27.9)	379 (29.5)	120 (23.9)	
Often	432 (24.2)	330 (25.7)	102 (20.3)	
Cigarette smoking habits				
Never	1175 (65.8)	818 (63.8)	357 (71.0)	
Ex-smoker	154 (8.6)	104 (8.1)	50 (9.9)	0.001
Current smoker	457 (25.6)	361 (28.1)	96 (19.1)	
Epworth Sleepiness Severity				
Normal	462 (25.9)	317 (24.7)	145 (28.8)	
Mild	373 (20.9)	261 (20.3)	112 (22.3)	0.006
Moderate	395 (22.1)	275 (21.4)	120 (23.9)	
Severe	556 (31.1)	430 (33.5)	126 (25.0)	
DBQ Items	Mean ± SD	Mean ± SD	Mean ± SD	
DBQ violations	13.5±7.0	15.3±7.5	11.6±6.5	0.001
DBQ errors	9.4±5.7	10.9±6.1	7.9±5.3	0.001
DBQ lapses	9.5±5.5	10.7±5.8	8.2±5.2	0.001
Total DBQ scores	32.4±11.8	37.0±12.9	27.8±10.7	0.001

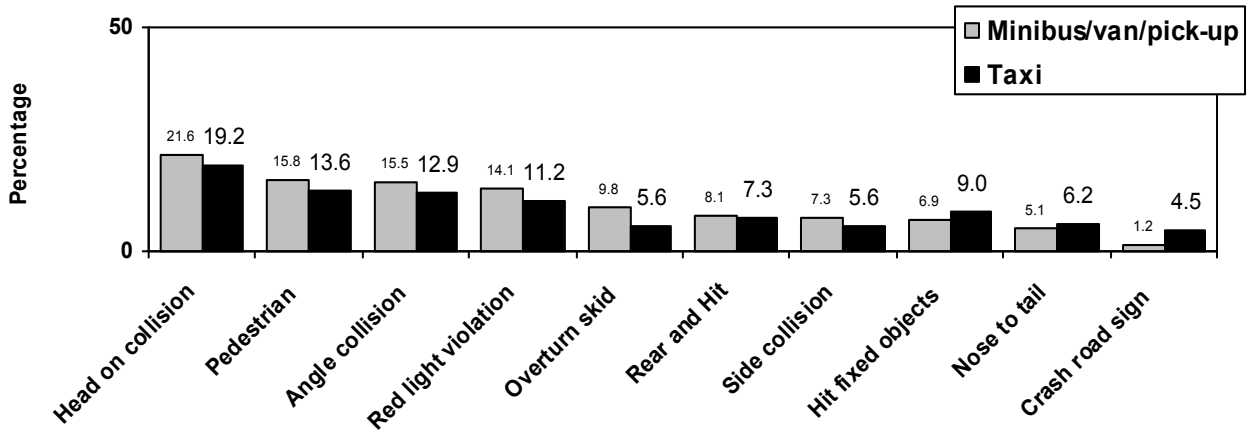

Fig. 1 History of RTC with injury among studied subjects according to minibus/van/pick-up and commercial taxi drivers.
Note: $P < 0.001$.

Table 3 The means and standard deviation of the minibus/van/pick-up and commercial taxi drivers regarding sleepiness and fatigue.

Variables	Minibus/van/pick-up drivers $N = 1,283$ Mean ± SD	Commercial taxi drivers $N = 503$ Mean ± SD	p-value significance
Epworth sleepiness scale severity			
1. Sitting and reading	1.73±1.00	1.49±0.85	0.001
2. Watching TV	1.77±0.95	1.71±1.04	0.889
3. Sitting inactive in a public place (in a meeting)	1.68±1.05	1.62±1.05	0.316
4. Being in a car for an hour as a passenger (without break)	1.67±0.95	1.52±0.89	0.003
5.Lying down to rest in the afternoon (when possible)	1.63±0.92	1.52±0.83	0.035
6. Sitting an chatting to someone	1.66±0.95	1.53±0.90	0.006
7. Sitting quietly after lunch	1.70±1.09	1.58±1.01	0.019
8. In a car when you stop in traffic for a few minutes	1.71±1.05	1.51±0.95	0.005
Total Epworth sleepiness score	13.48±4.66	12.54±4.21	0.001
Fatigue severity scale			
1. My motivation is lower when I am fatigued	4.34±2.09	3.45±1.84	0.001
2. Exercise brings on my fatigue	4.21±2.01	3.85±1.91	0.001
3. I am easily fatigued	4.57±1.89	3.54±1.86	0.001
4. Fatigue interferes with my physical functioning	3.87±1.99	3.50±2.21	0.035
5. Fatigue causes frequent problems for me	3.91±2.05	3.88±2.01	0.821
6. My fatigue prevents sustained physical functioning	3.89±2.07	3.81±2.13	0.453
7. Fatigue interferes with carrying out certain duties and responsibilities	3.64±1.97	3.96±2.16	0.030
8. Fatigue is among my most disabling symptoms	3.98±2.03	3.87±1.99	0.389
9. Fatigue interferes with my work, family or social life	3.90±1.97	3.74±2.09	0.118
Total fatigue score	3.59±0.62	3.36±0.57	0.001
Global fatigue scale 0 being worst and 10 being normal	4.87±2.37	3.95±2.45	0.002
Tiredness severity scale survey			
1. Do you think tiredness/fatigue problem for you when drive	2.08±1.10	1.96±1.05	0.044
2. Do you think tiredness/ fatigue a problem for other	2.06±1.13	2.28±1.16	0.010
3. Do you think tiredness/fatigue is dangerous on the road	2.07±1.07	1.95±1.08	0.028
4. Do you think tiredness/fatigue invites the road injuries	2.10±1.08	2.28±1.11	0.002

Note: Sleeping scale chance of dosing: 0 = none; 1 = slight; 2 = moderate; 3 = high;
Fatigue severity scale describe: 1 = indicates strongly disagree; 7 = indicates strongly agree;
Tiredness scale: 0 = none; 1 = slight; 2 = moderate; 3 = high.

Table 4 Prevalence of depression, anxiety and stress symptoms (DASS-21) among minibus/van/pick-up and commercial taxi drivers.

	Minibus/van/pick-up drivers N = 1,283 Mean ± SD	Commercial taxi drivers N = 503 Mean ± SD	OR	95% CI	p[a]
Depression[b]					
Moderate and severe	294 (22.9)	80 (15.9)	1.0		
Normal and mild	989 (77.1)	423 (84.1)	1.57	1.19~2.16	< 0.001
Anxiety[c]					
Moderate and severe	219 (17.1)	46 (11..5)	1.0		
Normal and mild	1,064 (82.9)	445 (88.5)	1.99	1.42~2.79	0.004
Stress[d]					
Moderate and severe	287 (22.4)	79 (15.7)	1.0		
Normal and mild	996 (77.6)	424(84.3)	1.54	1.17~2.03	0.002

[a]Mantel Haenszel test x^2 test;

[b]Depression was scored as per: normal (0-9), mild (10-13), moderate (14-20) severe (≥21);

[c]Anxiety scored as per: normal (0-7), mild (8-9), moderate (10-14), severe (≥15);

[d]Stress scored as per: normal (0-14), mild (15-18), moderate (19-25), severe (≥26).

Table 4 shows the prevalence of depression, anxiety and stress symptoms (DASS-21) among minibus/van/pick-up and commercial taxi drivers. This study revealed that minibus/van/pick-up drivers committed more depression, anxiety and stress symptoms compared to commercial taxi drivers. DASS-21 variables were found to contribute significantly to the explanation of the RTC involvement rate.

4. Discussion

The RTC remain a global major neglected health problem [6-7] and the challenge of traffic psychology is to provide better understanding of those factors that are linked with an increased probability of RTC and to identify whether these factors are viable targets for effective countermeasures. This study has evaluated the differences in driving behavior and driving skills among minibus/van/pick-up and commercial taxi drivers in relation to RTC. Among the studied minibus/van/pick-up drivers, young drivers of the age group below 39 years which were over 56% involved with higher risk of having RTC. Young drivers are at a higher risk of crashing than drivers of older age groups for reasons including attitudes and risk taking behaviour. This is consistent with few previous studies [21, 22]. The high accident risk of young drivers is a worldwide problem.

Though fatigue and sleepiness at the wheel are well known risk factors for RTC [3-7, 13, 16, 17, 23, 24], many drivers combine sleep deprivation and driving. Working under sleep deprivation increases fatigue and risk of driver behavioral errors and violation [6-10, 25, 26]. RTCs from work to home is one of the major causes of injury and deaths among drivers [3-7, 13] because of these conflicts between physiological needs and social or professional activities [27], understanding the human limits of fatigue and sleep deprivation are becoming key issues in accident prevention.

Studies largely conducted in high-income and middle income countries suggest driver sleepiness is a significant contributor to the burden of RTI (road traffic injuries) [1-6], with a three to six-fold increased risk of road crashes [2, 3, 13, 14], and population attributable estimates as high as 22% [5, 24].

Although over 90% of RTI-related deaths occur in low and middle-income countries, the few epidemiological studies examining driver sleepiness as a risk factor for crashes and related injuries in this context have primarily focused on truck drivers [5, 7, 28-30]. The high prevalence of driving while

drowsy among Argentinean (44%) [7], and Brazilian bus/truck drivers (22%) [29], and Thai (75%) [30], suggests the contribution of this factor to RTI in less resourced settings may be under-appreciated. A study among Thai commercial bus/truck drivers attributed 23% of crashes to driver sleepiness [30], while another study among Brazilian truck drivers reported significant proportions of crashes or near-miss crashes could be accounted for by excessive daytime sleepiness (18%), snoring (24%), and driver sleepiness (16%) [7]. A case control study from Shenyang, China—the only aetiological study focusing on car drivers that we are aware of, found a two-fold increase in crashes among drivers with chronic but not acute sleepiness [31].

Sleepiness also increased across the day after sleep deprivation. A previous study [8, 13] performed in a driving simulator showed that when subjects were regularly questioned about their sleepiness during the drive, there was a relationship between instantaneous level of sleepiness and driving impairment. These results consistent very well with previous reported studies showing a link between fatigue, tiredness, sleepiness and driver performance decrement [4, 6, 8, 9].

4.1 What Is Already Known on This Topic

The driver aggressive behaviour, sleepiness and fatigue are considered to be potentially important risk factors for RTC and related injuries. Published estimates of the proportion of car crashes attributable to driver sleepiness and fatigues are vary from about 5% to 30%.

4.2 What This Study Adds

The current study revealed that driving while feeling fatigue, tiredness or sleepy, driving after eight hours or less of sleep, were associated with a substantial increase in the risk of a car crash resulting in serious road injury or fatality. Reduction in the prevalence of these three behaviours fatigue-tiredness, sleepy and overtime works may reduce the incidence of RTC and car related injury by up to 20% or 25%.

4.3 Methodological Limitations

The data were based solely on drivers' self-reports of behavior and some observations were made. However, several studies have indicated that self-reports of driving correspond well to actual driving behavior. It is also possible that some respondents embellished their answers about positive and aggressive driving. It should be noted, however, the respondents completed the questionnaires anonymously and could not gain anything by giving embellished responses. The measurement of accident involvement was based on a self-report of all past road traffic crashes. Simply because of forgetting to report some crashes, some respondents may have underestimated the number of crashes in which they had been involved.

5. Conclusions

Chronic fatigue and acute sleepiness, and overtime or heavy work-load in car drivers significantly increases the risk of a car crash in which a car occupant can be injured or killed. Reductions in RTC may be achieved if fewer people drive when they have fatigue or are sleepy or have been deprived of sleep or drive during rush hours.

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