MMJ

REVIEW ARTICLE

Prevalence and associated factors of road crash involvement (RCI) among medical doctors: Systematic review and meta analysis

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Background

There have been vague reports on road crash involvement (RCI) affecting medical doctors with limited studies on its' prevalence. The aim of this study is to determine the prevalence and associated factors of RCI among medical doctors.

Methods

Four databases, SCOPUS, PubMed, EMBASE and Medline were systematically searched from their inception date till October 2020. Eligible studies including cross sectional studies, review articles and press reports in English underwent a systematic search to determine which articles reported on the prevalence and associated factors of RCI amongst medical doctors. Two sets of 2 independent reviewers screened the references in two steps: abstract screening, followed by full text review. The checklist Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) was used for quality assessment of the studies.

Results

599 articles were retrieved, of which 27 articles were removed after duplicate screening. The remaining 572 articles were further assessed and only 4 articles fulfilled the inclusion criteria. The RCI prevalence among medical doctors worldwide ranged from 7.9%-24.6%. Factors associated with increased risk of RCI include lack of sleep and fatigue related to long working hours. Other associated factors include number of years in residency, number of weekly working hours, weight gain, tendency to fall asleep while driving, hypertension, absence of breaks, inadequate rest facilities, tolerance towards shiftwork, capacity to overcome sleepiness, and quantity of night shifts worked per month.

Conclusion

The prevalence of RCI among medical doctors is high. Further studies are needed to evaluate this emerging public health issue.

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BACKGROUND

A significant number of lives are lost each year due to road traffic crashes causing significant losses to individuals and the economy.[1-2] Road crash involvement (RCI) is an international public health burden involving commuting accidents of workers to and from work as the majority of workers tend to travel by road.[3-4] Commuting accidents comprise 15% of work-related accidents in Europe compared to a much higher rate of 47.6% in Malaysia with an alarming increase in the prevalence over the years.[3]

Healthcare workers are among those that are at risk of such injuries. A study among Japanese nurses reported that, among other work-related injuries, traffic accidents contributed approximately 3%.[5] Work-related accidents were presumed to be due to shift work and lack of sleep.[5-6] Another healthcare personnel that is at risk are ambulance drivers, due to the nature of their work.[7-8] Eksi et al suggested that these occurrences are due to time and speed factors.[8] There are limited published studies on healthcare workers on RCI as a whole. The current focus is on medical doctors, with recent RCI reporting that have raised concerns among the public and medical fraternity.[3,6,9-13]

To compound the issues further, there has been reported shortage of healthcare workers including medical doctors in the workforce and this shortcoming has added new impetus to improve measures to prevent work-related injuries among these healthcare personnel.[14-15] There are many factors predisposing medical doctors towards RCI including fatigue and sleep deprivation in addition to the long working hours and heavy workload.[12-13,16]

Despite these observations, there is still a lack of concerted effort to address this problem. Medical doctors work hard to save the lives of others, but are simultaneously exposed to the dangers of their own jobs. Therefore, the objective of this study was to determine the prevalence and associated factors of RCI among medical doctors.

METHODS

Search strategy

Four databases, SCOPUS, PubMed, EMBASE, Medline were systematically searched from their inception date till October 2020 with the following search terms: (risk OR risk factor OR factor) and (doctor OR physician) and (road accident OR traffic accident) and (prevalence OR incidence). Combinations of expanded MeSH term and free-text searches that were applied are shown in Appendix 1. In addition, reference lists of relevant articles were also screened for its suitability.

Inclusion criteria

Any studies that report prevalence and risk factors for road crash involvement among doctors and fulfilled the following criteria were entered into the analysis: (1) prevalence and risk factors were reported as the primary results; (2) journal articles written in English. The authors also identified other relevant studies through reverse-forward citation tracking and reference lists of the selected articles.

Study selection

We imported the articles identified through the databases into EndNote© X9 version after performing de-duplication. There were two teams of reviewers, one team consisting of two reviewers (KI and AAR) and (NKD and FM) who screened through the titles and abstract of the remaining articles in pairs. If there was a lack of information on the prevalence of RCI in the title and/or abstract, the full text was then retrieved to identify the relevant data. Discussions were also held before reaching a final consensus.

Quality assessment and data extraction

The checklist Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) for cross sectional study was used to assess the quality of the retrieved articles by two independent investigators. The tool consists of 22 items that assesses vital components in observational studies. If the information provided was not enough to assist in making a judgement for the items, we agreed to grade the item with a '0'. This means "high risk of bias". Each article's quality was graded as 'good' if the STROBE score is more or equal 14 out of a maximum score of 22 and graded poor if otherwise. Only studies with a STROBE score ≥ 14 were included in the analysis. The scoring of the selected articles is shown in Appendix 2.

One of the reviewers recorded the data from the selected studies into the extraction form in the Excel sheet, while the second reviewer verified its accuracy. The characteristics of the selected studies were extracted as follows: first author, year of publication, title of study, country, study design, study population, gender, mean age, sample size, number of accidents, and the prevalence of RCI. The outcome measures extracted were the prevalence of road traffic accident and its risk factors.

Data analysis

A random-effects (DerSimonian and Laird method) meta-analysis was used to determine the pooled prevalence and odds ratio (OR) from the individual studies and was reported with a 95% confidence interval (CI). Heterogeneity across studies was assessed using the I2 index (low is < 25%, moderate 25–50%, and high > 50%), that indicated the percent of total discrepancy due to variation in the studies. Subgroup analysis based on the study design was also performed. OpenMeta[analyst] was employed for statistical analysis. The prevalence of RCIs worldwide was analyzed by performing subgrouping of the study setting.

RESULTS

Description of included studies

We identified 599 manuscripts in our initial search as shown in Fig. 1. After de-duplication (*n*=27), 572 studies were then retrieved for further review. After evaluation of the inclusion and exclusion criteria, a total of 4 studies that were performed from 1996-2017 and had a STROBE score of ≥14 was included in this systematic review and meta-analysis.

Characteristics of included studies

Out of the 4 included studies, two were cross sectional studies (Marcus et al., 1996, Fruchtman et al., 2011), and the other two were cohort studies (Steele et al.,1999, Barger et al., 2005). 11,17-19 These studies had a population group mean of 910 participants with the mean age of 30.6 years. This includes 2061 males and 1737 females. All the studies involved doctors in different departments. One study involved doctors in the emergency department (Steele et al.,1999), another from the pediatric department (Marcus et al., 1996), and two involved a combination of many departments (Fruchtman et al., 2011, Barger et al., 2005). 11,17-19 Among the four studies, three were conducted in Unites States of America (Marcus et al., 1996, Steele et al.,1999, Barger et al., 2005), and one in Israel (Fruchtman et al., 2011). Overviews of the studies characteristics are shown in Table 1.11,17-19

The overall pooled prevalence of RCI was 12.3 (95% CI=8.1, 16.4, I2=87.54) (Fig. 2). Figure 2 shows the prevalence of RCI across the study population. The pooled prevalence of RCI analyzed by subgroup analysis was 18.9% (95% CI= 6.7, 31.2, I2=73.16%) among cross sectional study and 10.3% (95% CI= 5.8, 14.8, I2=94.43%). The prevalence of RCI by study population was highest in Pediatric residents at John Hopkins Hospital (24.6%). The lowest prevalence of RCI was in Emergency Medicine Residents in the USA (7.9%).

Figure 1: PRISMA flow diagram of the literature screening process

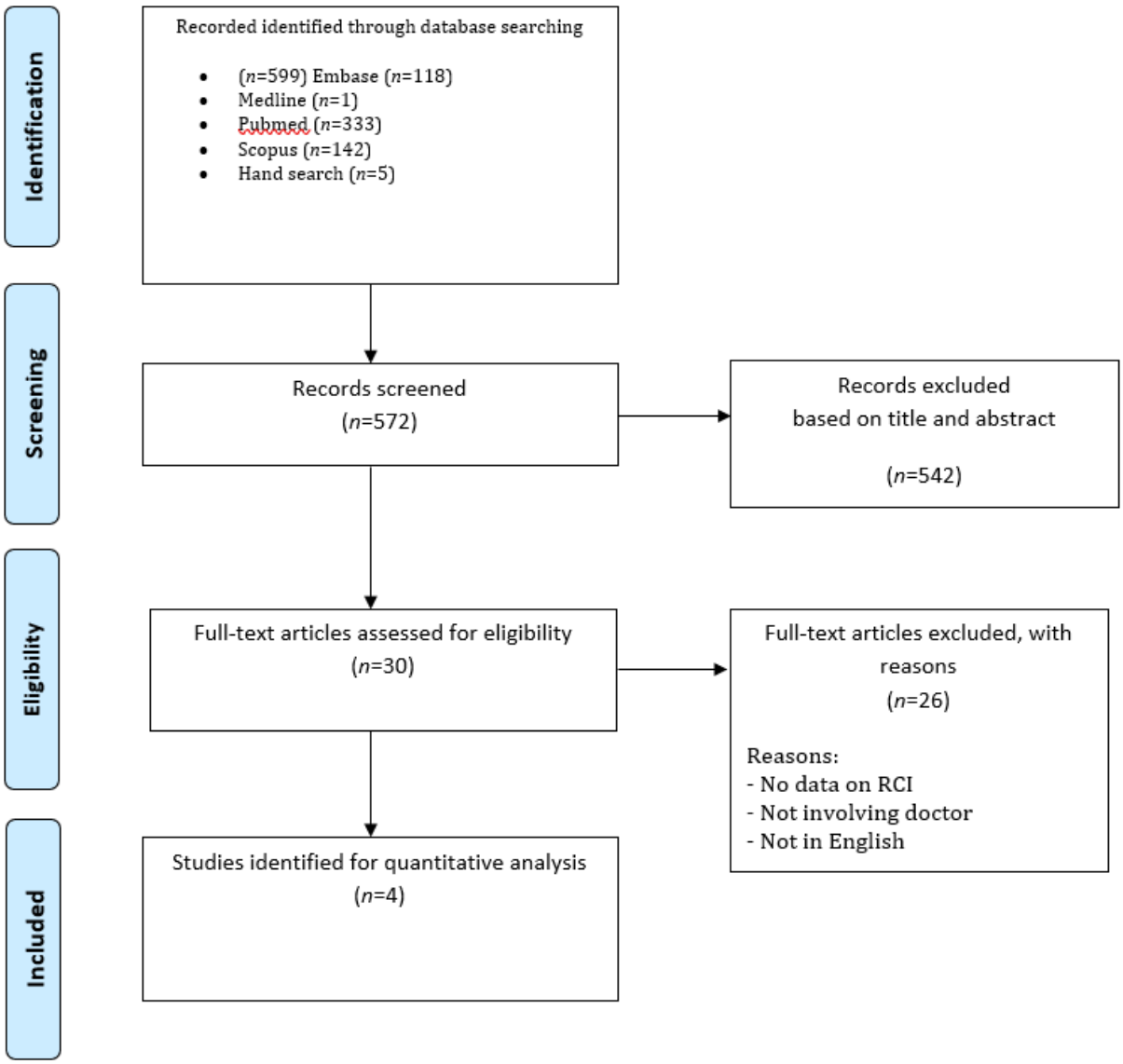

Figure 2: Forrest plot on the prevalence of road traffic accident

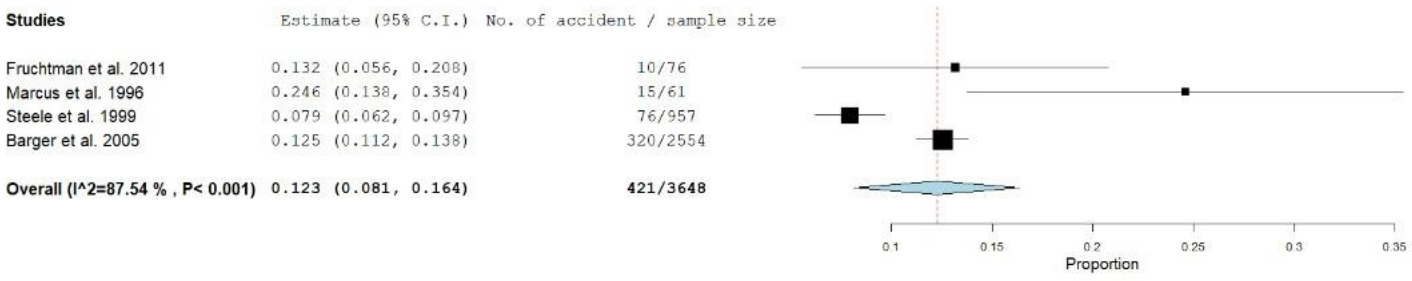

Table 1: Characteristics of included studies

Author	Year	Title study	Study design	Study population	Gender	Mean age	Sample size	No of accident	Pooled Prevalence	Risk Factors
Fruchtman et al.	2011	Fatigue in medical residents--lessons to be learned	Cross sectional	Medical resident from Soroka University Medical Center (SUMC), Israel.	40 males and 36 females	35.5 (±4.8) years	76	10	**13.9%**	Fatigue, number of years in residency, number of weekly working hours, hypertension, weight gain
Marcus et al.	1996	Effect of sleep deprivation on driving safety in housestaff (HS)	Cross sectional	Pediatric HS and faculty members (FAC), USA	17 males and 44 females (HS)	29	61	15	**24.6%**	Sleep deprivation
Steele et al.	1999	The occupational risk of motor vehicle collisions for emergency medicine residents	Cohort	Emergency Medicine Residents, USA	718 males and 239 females	30 (±3) years	957	76	**7.9%**	residents' subjective tolerance of shiftwork, ability to overcome drowsiness
Barger et al.	2005	Extended Work Shifts and the Risk of Motor Vehicle Crashes among Interns	Cohort	First postgraduate year residents (interns) different specialties, USA	1286 males and 1451 females	28 (±3.9) years	2554 (93% of the study cohort [2737] completed at least one monthly survey and were eligible for the analysis of crashes and near-miss incidents)	320 (131 of the 320 crashes occurred on the commute from work)	**12.5%**	Number of night shifts worked per month

Risk Factors

For clarity in terms of describing the risk factors, we divided them according to study design. For the cross-sectional studies, factors associated with RCI among medical doctors are number of years in residency, number of weekly working hours, weight gain, and hypertension. For the cohort studies, absence of breaks, inadequate rest facilities, residents' subjective tolerance of shiftwork, ability to overcome drowsiness, and number of night shifts worked per month, to be the contributing factors for the occurrence of RCI.

DISCUSSION

To our knowledge, this is the first systematic review on the prevalence of RCI among doctors. We report the pooled prevalence rate of 12.6%. Looking into other healthcare profession such as nurses, a study reported that the prevalence of RCI or near miss accidents is approximately 22%.[20] Therefore, there is not much difference between the prevalence of RCI occurrence among doctors and nurses as they usually share the same work-related stresses and environment, causing them to have similar risk factors to the occurrence of commuting accidents, bearing in mind that the data on the nurses also included near miss accidents. In contrast, the number of RCI among ambulance drivers is relatively greater than medical doctors. From a retrospective secondary data analysis conducted by the Ministry of Health (MOH), Malaysia, 129 ambulance accidents per year was reported.[21] Another retrospective analysis study conducted in the United States of America reported the occurrence of 339 RCI among ambulance drivers causing 405 fatalities and 838 injuries.[22] Compared to other hospital staffs such as ambulance drivers, medical doctors have different backgrounds and job specifications, so the risk of RCI also varies. For ambulance drivers, the occurrence of these accidents can be related to the fact that they not only drive vehicles, but also double-up as EMS (Emergency Medical Services) workers. Ambulance drivers are also authorized to exceed the speed limits and proceed past a red or stop signal as they are required to rush critical patients to the nearest health facility.[23] Therefore, RCI among medical doctors and other healthcare workers emerged as an important occupational safety issue which needs to be addressed quickly.

From review of the cross-sectional studies, the number of years in residency is closely related to RCI. Ideally, the more senior the doctor is, the more experienced he or she will be, hence, a more balanced work-life cycle will usually follow. However, a cohort study among 15,271 subjects in France reported that senior skillful workers (managers) had a higher risk of RCI compared to junior staffs.[24] This observation may be due to the higher stress or work pressure among those in higher medical posts and considered to be senior staffs. We also found that extended work hours may be a significant factor among medical doctors with increased tendency to fall asleep while driving and the potential for RCI and near miss. Doctors are known to work long hours, sometimes extending more than 24 hours, resulting in sleep deprivation and fatigue.[19] Fatigue and sleep deprivation have been studied extensively, especially among healthcare professionals, and have been reported to have a negative impact on their work and wellbeing.[17] Shorter sleep durations were associated with greater risks of struggling to stay awake driving home.[20] This often results in reduced clinical function, impaired neurocognitive impairment, and negative effect on mood. Reduced attention and reaction time has been shown to have measurable impact when driving a motor vehicle.[25] Sleep related disturbance, such as obstructive sleep apnea, micro sleep and poor sleep hygiene, have

also been said to affect driving performance. In addition, weight gain has been reported to have a significant effect on RCI based on the cross-sectional studies retrieved. This particular factor is an important feature to develop obstructive sleep apnea (OSA) which has a strong negative impact on RCI. A study by the American Academy of Sleep Medicine (AASM) among 1478 sleep apnea patients reported that obstructive sleep apnea patients were nearly 2.5 times more likely to have RCI compared to a control group of other drivers in the general population.[26] Hypertension, meanwhile, is a disease known for its systemic effects in impairing the cognitive function in patients with suboptimal to poor control of the disease. From the available reviews, we noted that hypertension has a meaningful contribution to RCI. A case control study conducted among 733 injured drivers in France reported that patients suffering from hypertension has a higher significant risk to be involved in RCI (adjusted odds ratio [adjOR] =3.82; 95%CI=[1.42–10.24]).[27]

As for the cohort studies that we reviewed, the number of night shifts worked per month also contributes to the occurrence of RCI. A study reported that shift duties working personnel had a 30% higher risk of traffic accidents while commuting to and from the workplace, compared to office hours only employees.[28] All of these factors are closely related to their role in handling and treating patients. Based on above reasons, working hour regulations are usually unintentionally violated due to major challenges in insufficient number of doctors, that makes the doctors on-call exposed to an intense workload and extended working hours. Moreover, inadequate rest facilities also have a role in RCI. This factor, however, has a close relationship to fatigue and sleep deprivation. Most hospitals fail to have rest facility for on call doctors. Since they have few or none of these facilities, they have no choice but to commute home straight after a long night or on call shift. Moreover, pit stops or Rest & Relax (R&R) centers are only available on major highways. Most doctors will therefore choose to live nearer to their workplaces. Nevertheless, micro sleep is hardly avoidable regardless of the distance between their homes and workplaces. For this reason, they are commuting on main roads where R&R centers are not available. A cross-sectional study among 949 male truck drivers in Italy reported that taking a **rest** break or a nap appear to be protective against RCI.[29] The ability to overcome drowsiness while driving can be considered a miraculous cure that not only doctors but all drivers should implement to promote a safer commutation. However, in a moderate to severely fatigue and sleep deprived person (even doctors), their cognitive functions as well as the decision-making ability are mainly impaired. Hence, they could not make decisions well especially during driving. A study conducted among 13 Australian armies reported that cognitive performance, decision making, self-regulation and self-monitoring declined significantly following a sleepless night.[30]

The main strength of this study was that it is one of the first systematic reviews that look at the prevalence of RCI among medical doctors worldwide. This study also employed a comprehensive search of four major databases in order to capture all the articles related to the study objectives. This study also has a high number of participants. The main limitation is the high heterogeneity noted among these studies due to differences in background and relatively small number of studies.

CONCLUSION

The prevalence of RCI among medical doctors are 7.9%-25.7%. This study shows that the pooled estimation of prevalence was 12.6%. The associated

factors are sleep deprivation and fatigue after long working hours. These factors should be addressed carefully as it has become a major occupational safety risk for doctors and other medical personnel. We recommend larger, nationwide studies looking into the prevalence and factors associated with RCI among doctors involving different specialties and further actions to be taken to reduce these significant and preventable work-related health problems. Table 2 highlights the summary of risk factors and recommendations

Acknowledgments

The authors would like to thank the Ministry of Education Malaysia for funding this study. Fundamental Research Grant Scheme. Grant no: FRGS/1/2018/SKK01/UPM/03/1.

Table 2: Summary of risk factors and recommendations

Risk factors	Recommendations
1. Increased number of years in residency 2. Presence of hypertension 3. Increased number of weekly working hours along with absence of breaks and increased number of night shifts 4. Weight gain 5. Inadequate rest facilities 6. Residents' subjective intolerance of shiftwork 7. Inability to overcome drowsiness	1. The main associated factors are sleep deprivation and fatigue after long working hours. 2. These factors should be addressed, and appropriate actions taken (e.g. shorter working hours and less night shifts) as it has become a major occupational safety risk for the health personnel. 3. We recommend larger, nationwide studies looking into the prevalence and factors associated with RCI among doctors involving different specialties.

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Appendix 1 Search numbers (20191107)

	Search strategy	Embase	Pubmed	Medline	Scopus
#1	Risk OR Risk factor OR Factor		4033638		
#2	doctor OR Physician		680319		
#3	road accident OR traffic accident		52786		
#4	prevalence OR Incidence		3060830		
#5	1 AND 2 AND 3 AND 4	118	333	1	142

#1 prevalence OR Incidence

#2 Risk OR Risk factor OR Factor

#3 road accident OR traffic accident

#4 doctor OR Physician

#5 1 OR 2

#6 5 AND 3 AND 4

Appendix 2: Assessment of risk of bias of included studies by STROBE Checklist (cross sectional studies)

	1a	1b	2	3	4	5	6a	6b	7	8	9	10	11	12a	12b	12c	12d	12e	13a	13b	13c	14a	14b	14c	15	16a	16b	16c	17	18	19	20	21	22	total
Fruchtman et al., 2011	0.5	0.5	1	1	1	1	0.5	0.5	1	1	0	1	1	0.2	0.2	0	0.2	0	0.3	0.3	0	0.3	0	0	1	0.3	0.3	0.3	0	1	1	1	1	0	17.4
Barger et al., 2005	0.5	0.5	1	1	1	1	0.5	0.5	1	1	0	1	1	0.2	0.2	0.2	0.2	0	0.3	0.3	0	0.3	0.3	0.3	1	0.3	0.3	0	1	1	1	1	1	0	18.9
Marcus et al, 1996	0.5	0.5	1	1	1	1	0.5	0.5	1	1	0	1	1	0.2	0.2	0.2	0	0	0.3	0.3	0.3	0.3	0	0	1	0.3	0	0	1	1	1	1	1	0	19.1
Steele et al, 1999	0.5	0.5	1	1	1	1	0.5	0.5	1	1	0	1	1	0.2	0.2	0	0.2	0	0.3	0.3	0	0.3	0	0	1	0.3	0.3	0.3	0	1	1	1	1	0	17.4