Received: July 17, 2022
Accepted: October 27, 2022

Acad Med J 2022;2(2):1-8
UDC: 614.1:656.13.052-051
DOI: 10.53582/AMJ2222001a
Review article

METHODOLOGICAL APPROACH TO ASSESSING THE IMPACT OF WORK-RELATED FACTORS AND OF HEALTH STATUS OF PROFESSIONAL DRIVERS ON SAFE DRIVING

Atanasovska Aneta

Institute of Occupational Health of R. N. Macedonia, WHO Collaborating center,
Faculty of Medicine, Ss. Cyril and Methodius University in Skopje,
Republic of North Macedonia
e-mail: aneta.atanasovska@medf.ukim.edu.mk

Abstract

Traffic accidents are a large public health issue due to the fact that they cause many deaths and injuries every year, both worldwide and in our country. Drivers and their ability to drive safely constitute a very important link in the traffic safety chain, besides road infrastructure, road conditions, and the condition of the vehicle.

Factors influencing safe driving are numerous. Rather than acting individually, they usually interact complementarily, hence the need for defining the most appropriate methodological approach to exploring them for the purposes of making a comprehensive analysis and efficient assessment of the impact of work-related factors and of professional drivers' health status on safe driving.

Select appropriate methods and instruments for assessing the impact of work-related factors and of professional drivers' health status on safe driving.

The methodology for an integrated approach to the analysis of the impact of work-related factors and of health status on safe driving is a two-phase dynamic process. The first phase includes the use of questionnaires and examinations, and the second phase consists of analyzing the findings about the impact of work-related factors, driver's health issues/fatigue, and sleep apnea risk on safe driving.

The methodology for an integrated approach should yield relevant data needed to propose concrete, preventive measures for ensuring improved traffic safety.

Keywords: professional drivers, traffic safety, integrated approach, Duty Fitness Model

Introduction

1. Traffic safety

Traffic safety is a big public health problem, bearing in mind that traffic accidents are the cause for many deaths and injuries every year across the globe [1]. The "Global Status Report on Road Safety 2018", published by the World Health Organization, reported about 1.35 million cases of death from traffic accidents, and 20 – 50 million victims of traffic-related traumatism[2]. Our country's strategic goal was to halve the number of victims of traffic accidents during the period 2011 – 2020 by way of achieving the goals included in the Second National Strategy on Improvement of the Safety of Road Traffic 2015-2020, from the current 75 to 49 deaths per 1 million population in 2020[3].

2. Professional drivers

Definition – "***professional driver"*** is defined as a driver of a motor vehicle from the categories B+E, C, C+E, D, D+E, as well as categories A, B, F, G and M, to whom driving is the main occupation"[4]. Compared to amateur drivers, professional drivers drive in order to make a living; in addition, they drive more kilometers annually, have longer working hours, and pass more difficult sections for driving. As a result of these factors and their exposure to professional work-related hazards, professional drivers are exposed to a high risk of traffic accidents[5]. Several factors, including the continuous pressure by the time factor, the sitting position of the body, the excessive stimulation by the external environment, the lack of social support at work, and the work in shifts (rotations)[6] are defined as factors associated with stress, which increase the occurrence of negative impacts on their health, safety, and driving performance[7]. Professional drivers are constantly exposed to environmental influences (e.g., noise, smog, changing light conditions)[8], and poor ergonomic conditions [9]. Rest breaks taken by professional drivers are insufficient/inappropriate to reduce the work-related fatigue [10]. It is exactly sleepiness and fatigue that constitute the key risk factors associated with risky behaviors by professional drivers but also risk factors for traffic accidents [11]. The association between the work in shifts, the occurrence of fatigue and the negative effects on road traffic safety is more prevalent among professional drivers working in public transport than in any other occupation[12].

Health problems of professional drivers should be analyzed from two aspects: health problems as a consequence of the exposure to professional hazards at their workplace, and health problems that have an impact on their ability to drive safely. In the available literature, the most common health problems as a result of the exposure to professional hazards at workplace are: hypertension[13]; musculoskeletal disorders[14]; gastrointestinal disorders[15]; metabolic disorders[16]; chronic fatigue[17]; and mental health problems[18]. Health conditions carrying a risk of unexpected and sudden disability to drive include: sudden cardio and cerebrovascular episodes[19]; neurological disorders[20]; narcolepsy[21]; hypoglemic episodes of diabetes I or II[22]; disorders of the eyes/vision and hearing senses. Health conditions that are considered as counter-indicative of safe driving are listed in the *Rulebook on the health requirements that must be fulfilled by the candidates for drivers*, published in the Official Gazette of R. Macedonia, No.139 from 2008[23].

Very often, driver's fatigue is presented as a reason for traffic accidents in the literature; fatigue leads to disrupted cognitive and psychomotor functions and prolonged time of reaction in drivers[24]. It is a hazard every driver is exposed to; unfortunately, drivers do not perceive fatigue as a hazard[25]. Reasons for fatigue can be factors associated with workplace conditions and with sleep[26]. Sleep-related factor that can lead to fatigue is sleep apnea. Sleep apnea is a serious sleep disorder where breathing repeatedly stops and starts. There are three types of sleep apnea: obstructive, central, and mixed[27]. Obstructive sleep apnea is a chronic condition associated with sleep, which can cause an increased risk of traffic accidents.

Rationale

In the complex system of road traffic safety, factors influencing safe driving are numerous. Rather than acting individually and in isolation from each other, they are intertwined and act on safe driving conjointly. Under the contemporary approach, the focus is on (i) dynamic influence of individual work environment factors (the psychophysical burden of the work and the organization thereof); (ii) health status of professional drivers; (iii) occurrence of fatigue; and (iv) risk of sleep apnea. Hence, there is a need to define the most appropriate methodological approach to explore these factors by a comprehensive analysis and efficient assessment of the impact of the work environment-related factors and of the professional drivers' health status on safe driving.

Goal

After reviewing the available literature in the area of road traffic safety, the most appropriate approach (methodology) for analyzing the impact of the work environment factors and of health status on safe driving should be determined. Efficient methods and instruments are to be selected for obtaining relevant data about the working conditions, the requirements and resources of the workplace, the health status of professional drivers, the occurrence of fatigue, the risk of sleep apnea, and the behavior of drivers while driving.

Materials and methods

The paper was based on a literature review. Peer-reviewed studies and systematic reviews of literature published in English after January 1, 2010 were searched on the Internet. Using the keywords "professional drivers, road traffic safety, integrated approach, Duty Fitness Model", the available databases PubMed and Web of Science were searched.

Discussion

Many studies carried out around the world over several decades have used various methodological approaches for exploring and determining numerous factors that can have an impact on safe driving.

For the occupation of professional driver, certain demographic characteristics and driving skills are of special importance, as indicated in the study by Poulter *et al*.[28]. Greiner, Ragland, Krause and Syme, as early as in 1997, proved that the age and the driving experience of bus drivers were negatively correlated with their involvement in traffic accidents[29]. Workplace requirements and working conditions (e.g., driving schedule, time pressure to reach the final destination, working with passengers, lack of regular breaks, and working in shifts) also have an impact on drivers' involvement in traffic accidents[30].

In their study from 2001, Hakkaken and Summala revealed that drivers who had a problem with their sugar blood level regulation (hyperglycemia) were involved in more accidents than their colleagues with good health status[31]. Dinges and Maislin (2006) published in their study that half of the respondents had a high body mass index, which was almost double the prevalence of overweight individuals among the general population, including men aged 45-64 (26.6% were overweight)[32].

Some of the most common issues related to truck driver behavior include traffic violations, mistakes, and driving under the influence of fatigue. Sullman, Gras, Cunill, Planes, and Font-Mayolas (2007) indicated that the most common traffic violation committed by truck drivers, which has led to accidents, was speeding. Sullman *et al.* found that most often aggressive driving violations by truck drivers were an expression of hostility (e.g., rude gesture towards the driver, yelling, and honking)[33].

Poulter *et al.* (2008) also found that the more the driver had control over his work, the higher was the probability that they would drive in conformity with the traffic laws [28]. Companies in which senior management is committed to safety, have much less traffic accidents[34]. Besides physical health, mental health is a key factor for well-functioning bus drivers[9]. Dissatisfaction with their work, low level of support by their supervisor, high psychological requirements, and recurrence of specific problems associated with their work can be predictors of greater involvement of drivers in traffic accidents.

According to the available literature regarding work environment factors as well as elements for assessing the health status of professional drivers, various research instruments and diagnostic methods have been applied.

Most commonly used instruments in epidemiological studies in this area are standardized or tailor-made questionnaires, which generate relevant data needed to define the various aspects of the subject of the study.

Demographic characteristics of professional drivers

One of the main questionnaires should be a questionnaire that will generate data about the demographic characteristics of the respondents (age, sex, marital status, and level of education), and about their work-related characteristics (total length of service, length of service as a professional driver, type of employment contract, number of working hours within one week).

Professional hazards associated with the organization of the work

The Norwegian study "Health and safety of professional bus drivers" [35] employed one of the most commonly used questionnaires in order to identify professional hazards associated with the organization of the work, such as working in shifts, number of working hours per week, and working during holidays and weekends.

Work-related stress

Stress at the workplace is a significant factor associated with an ever-increasing frequency of accidents and injuries at the workplace. The most commonly used questionnaire is the JDR (Job Demand Resource) model which identifies the stress factors by analyzing the requirements (demands) and the resources of the workplace [36].

Occurrence of fatigue

Existence of chronic fatigue among professional drivers is detected with the help of a standardized questionnaire (Checklist Individual Strength – CIS) – Questionnaire for Identifying Fatigue among Professional Drivers[37]. CIS is designed so as to measure several aspects of fatigue: subjective feeling of fatigue, reduced motivation, reduced activity, and reduced concentration.

Sleep apnea risk

The so-called Berlin Questionnaire is the most widely used tool for identifying sleeping disorder issues. It is standardized to identify patients with high risk of developing sleep apnea, including professional drivers. Moreover, its specific purpose is to identify professional drivers with a risk of developing sleep apnea. It consists of 10 questions divided in 3 categories: severity of snoring (category 1); daytime somnolence (category 2), and hypertension and BMI (category 3)[38].

Driver behavior in traffic

Most widely used tool for identifying inappropriate driver behavior in traffic is the DBQ – Driver Behaviour Questionnaire. This questionnaire is meant to be self-answered by the drivers regarding their behavior in traffic[39]. It primarily reflects the difference between two main types of inappropriate behavior while driving: "errors" and "violations". While "errors'' are characterized by unplanned behavior, "violations" of traffic rules constitute a deliberate aberration. The short version of the questionnaire includes 12 questions (3 for simple violations, 3 for aggressive violations, 3 for errors, and 3 for omissions[40].

Evaluation of the health status

Health card for evaluation of the ability to drive: in order to evaluate the health status of professional drivers, the most appropriate way would be to employ a procedure for evaluation of the ability to drive which is to be conducted in accordance with the *Rulebook on the Health Criteria to be fulfilled by Drivers* in our country[23]. The procedure includes check-ups/examinations done by the following specialists: occupational medicine specialist; ophthalmologist; ORL specialist; psychologist; psychiatrist; ECG; lung ventilation; arterial

hypertension (HTA); smoking status; and alcohol use. Laboratory tests are used to determine the driver's blood count: erythrocytes, leukocytes, thrombocytes, and hemoglobin. Biochemical analyses are used to determine glycemia, cholesterol, and triglycerides. Urine is examined for presence of proteins, blood, glucose, urobilinogen and bilirubin, as well as for presence of bacteria and leukocytes in the sediment.

This procedure provides data about the key elements of a professional driver's health status, which is then used to properly evaluate his/her ability to drive.

Integrated approach

The review of a number of traffic safety studies has shown that the factors with an impact on safe driving act in a complementary and mutual manner on safe driving. This dynamic process can best be analyzed through an integrated and comprehensive approach to the analysis of the factors that have an influence on safe driving.

The integrated approach methodology is presented in the Duty Fitness Model, in the 2013 report of the Norwegian Institute for Traffic[37]. The Duty Fitness Model makes it possible to analyze the dynamic integrated impact of several factors on drivers' behavior in traffic, such as: professional hazards associated with the work (psychophysical burden and organizational factors); health status of drivers; occurrence of fatigue; and risk of sleep apnea. The methodology for analyzing the impact of certain work-related factors and of the professional drivers' health status on safe driving constitutes a dynamic integrated approach which is done in two phases. In the first phase, questionnaires and clinical examinations are used to identify work-related factors (psychophysical burden and organization of the work), stress-generating factors, occurrence of fatigue, risk of sleep apnea, and professional drivers' behavior in traffic and health status. The second phase includes two subsequent stages: first, the impact of certain work-related factors (psychophysical burden and organization of the work) on professional drivers' health status, occurrence of fatigue and risk of sleep apnea is analyzed. Then, in the second stage, the association between drivers' behavior in traffic, on the one hand, and their health status, fatigue and sleep apnea risk, on the other, is analyzed. Moreover, direct impact of individual work-related factors on drivers' behavior in traffic is analyzed as well.

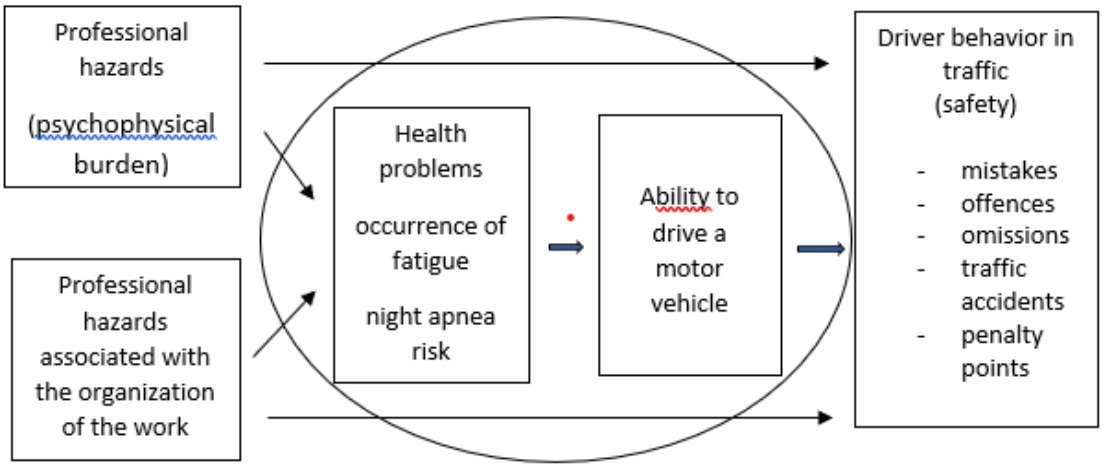

Fig. 1. Duty Fitness Model - model about the work-related factors' impact on drivers' health, occurrence of fatigue, night apnea risk, and safe driving. The circle represents the individual

This comprehensive, integrated and dynamic methodological approach offers an efficient assessment of the impact of the work-related factors and of the professional drivers' health status on safe driving.

Conclusion

The methodology for an integrated approach to analyze the impact of certain work-related factors and of professional drivers' health status on safe driving is suggested. This methodology is expected to yield relevant data about the work-related factors (psychophysical burden associated with the work and organization of work), professional drivers' health status, occurrence of fatigue and sleep apnea risk, as well as about the impact thereof on professional drivers' behavior in traffic. This data will be used for designing efficient preventive measures that will contribute to higher levels of traffic safety.

Conflict of interest statement. None declared.

References

1. World Health Organization (WHO). Global Status Report on Road Safety 2013: Supporting a Decade of Action; 2013. Available from: http://www.who.int/violence_ injury_prevention/road_safety_ status/2013/en.
2. World Health Organization (WHO). Global Status Report on Road Safety 2013: Supporting a Decade of Action; 2013. Available from: http://www.who.int/violence injury prevention/road safety status/2013/en.
3. Second National Strategy of the Republic of Macedonia on Road Traffic Safety Improvement for the period 2015-2020. Republic's Road Traffic Safety Council. Skopje, 2014.
4. Road Traffic Safety Law. Official Gazette of the Republic of Macedonia, No.169 of 30 September 2015.
5. Gopalakrishnan S. A Public Health Perspective of Road Traffic Accidents. *J. Fam. Med Prim Care* 2012; 1: 144-150. doi: 10.4103/2249-4863.104987.
6. Öz B, Özkan T, Lajunen T. Professional and non-professional drivers' stress reactions and risky driving. *Transp Res Part F Traffic Psychol Behav* 2010; 13: 32-40. doi: 10.1016/j.trf.2009.10.001.
7. Useche S, Gómez V, Cendales B. Stress-related Psychosocial Factors at Work, Fatigue, and Risky Driving Behavior in Bus Rapid Transport (BRT) Drivers. *Accid Anal Prev* 2017; 104: 106-114. doi: 10.1016/j.aap.2017.04.023.
8. Biggs H, Dingsdag D, Stenson N. Fatigue factors affecting metropolitan bus drivers: A qualitative investigation. *Work* 2009; 32(1): 5-10. doi: 10.3233/WOR-2009-0810.
9. Tse JLM, Flin R, Mearns K. Bus driver well-being review: 50 Years of research. *Transp Part F Traffic Psychol Behav* 2006; 9: 89-114. doi: 10.1016/j.trf.2005.10.002.
10. Costa G, ShiftWork and Health: Current Problems and Preventive Actions. *Saf HealthWork* 2010; 1(2): 112-123. doi: 10.5491/SHAW.2010.1.2.112.
11. Useche S, Cendales B, Gómez V. Work stress, fatigue and Risk Behaviors at the Wheel: Data to assess the association between psychosocial work factors and risky driving on Bus Rapid Transit drivers. *Data Brief* 2017; 15: 335-339. doi: 10.1016/j.dib.2017.09.032.
12. Philip P, Akerstedt T. Transport and industrial safety, how are they affected by sleepiness and sleep restriction? *Sleep Med Rev* 2006; 10(5): 347-356. doi: 10.1016/j.smrv.2006.04.002.

13. Shin SY, Lee CG, Song HS, Kim SH, Lee HS, Jung MS, *et al*. Cardiovascular disease risk of bus drivers in a city of Korea. *Annals of Occupational and Environmental Medicine* 2013; 25(1): 34. doi: 10.1186/2052-4374-25-34.
14. Bulduk EÖ, Bulduk S, Süren T, Oval F. Assessing exposure to risk factors for work-related musculoskeletal disorders using quick exposure check (QEC) in taxi drivers. *International Journal of Industrial Ergonomics* 2014; 44(6): 817-820. doi: 10.1016/j.ergon.2014.10.002.
15. Koda S, Yasuda N, Sugihara Y, Ohara H, Udo H, Otani T, *et al*. Analyses of work-relatedness of health problems among truck drivers by questionnaire survey. *Sangyo Eiseigaku Zasshi* 2000; 42(1): 6-16. doi: 10.1539/sangyoeisei.kj00002552185.
16. Howard ME, Jackson ML, Kennedy GA, Swann P, Barnes M, Pierce RJ. The interactive effects of extended wakefulness and low-dose alcohol on simulated driving and vigilance. *Sleep* 2007; 30(10): 1334-1340. doi: 10.1093/sleep/30.10.1334.
17. New standards and guidelines for drivers with obstructive sleep apnoea syndrome. Report of the Obstructive Sleep Apnoea Working Group. Brussels, 2013.
18. National Academies of Sciences, Engineering, and Medicine. 2016. Commercial motor vehicle driver fatigue, long-term health, and highway safety: research needs. Washington, D.C.: The National Academies Press.
19. Hentschel U, Bijleveld CC, Kiessling M, Hosemann A. Stress-related psychophysiological reactions of truck drivers in relation to anxiety, defense, and situational factors. *Accident Analysis & Prevention* 1993; 25(2): 115-121. doi: 10.1016/0001-4575(93)90050-7.
20. Shattell M, Apostolopoulos Y, Collins C, Sönmez S, Fehrenbacher C. Trucking organization and mental health disorders of truck drivers. *Issues in Mental Health Nursing* 2012; 33(7): 436-444. doi: 10.3109/01612840.2012.665156.
21. Winkleby MA, Ragland DR, Fisher JM, & Syme SL. Excess risk of sickness and disease in bus drivers: A review and synthesis of epidemiological studies. *International Journal of Epidemiology* (1988); 17(2): 255-262. doi: 10.1093/ije/17.2.255.
22. Hitosugi M, Gomei S, Okubo T, Tokudome S. Sudden illness while driving a vehicle - a retrospective analysis of commercial drivers in Japan. *Scand J Work Environ Health* 2012; 38(1): 84-87. doi: 10.5271/sjweh.3189.
23. Rulebook on the Health Requirements to be fulfilled by Candidates for Drivers. Official Gazette of the Republic of Macedonia No.139 of 4 October 2008.
24. Hancock, P.A., & Desmond, P.A. (Eds.). (2000). Stress, Workload, and Fatigue (1st ed.). CRC Press. https://doi.org/10.1201/b12791
25. Nordbakke S, Sagberg F. Sleepy at the wheel: Knowledge, symptoms and behaviour among car drivers. Transportation Research Part F. *Traffic Psychology and Behaviour* 2007; 10: 1-10.
26. May JF, Baldwin CL. Driver fatigue: The importance of identifying causal factors of fatigue when considering detection and countermeasure technologies. Transportation Research Part F. *Traffic Psychology and Behaviour* 2009; 12: 218-224. doi: 10.1016/j.trf.2008.11.005.
27. Sleep Apnea. Symptoms, causes, diagnosis and treatments. Mayo Clinic. Availavle from: https://www.mayoclinic.org/diseases-conditions/sleep-apnea/symptoms-causes/syc-20377631.
28. Poulter DR, Chapman P, Bibby PA, Clarke DD, Crundall D. An application of the theory of planned behaviour to truck driving behaviour and compliance with regulations 4. *Accident Analysis and Prevention* 2008; 40: 205-206.

29. Greiner BA, Ragland DR, Krause N, Syme SL, Fisher JM. Objective measurement of occupational stress factorsdAn example with San Francisco urban transit operators. *Journal of Occupational Health Psychology* 1997; 2(4): 325-342. doi: 10.1037//1076-8998.2.4.325.
30. Dorn L. Reducing the risk of bus crashes. Paper presented at the 68th Road Safety Congress: Safer Drivingd Reducing Risks, Crashes & Casualties, Blackpool, UK. 2003. https://trid.trb.org/view/698596.
31. Hakkanen H, Summala H. Fatal traffic accidents among trailer truck drivers and accident causes as viewed by other truck drivers. *Accident Analysis and Prevention* 2001; 33(2): 187-196. doi: 10.1016/s0001-4575(00)00030-0.
32. Dinges DF, Maislin GMS. Truck driver fatigue management. (Report No. FMCSA-RRR-06-008). Washington, DC: U.S. Department of Transportation, Federal Motor Carrier Safety Administration 2006.
33. Sullman MJM, Gras ME, Cunill M, Planes M, Font-Mayolas S. Driving anger in Spain. *Personality and Individual Differences* 2007; 42: 701-713.
34. Diaz RI, Cabrera DD. Safety climate and attitude as evaluation measures of organization safety. *Accident Analysis and Prevention* 1997; 29(5): 643-650. doi: 10.1016/s0001-4575(97)00015-8.
35. Health, safety and bus drivers TØI Report 1279/2013 Ross Owen Phillips and Torkel Bjørnskau Oslo 2013, 51 page https://www.toi.no/.
36. Wilmar B Schaufeli. Applying the Job Demands-Resources model: A 'how to' guide to measuring and tackling work engagement and burnout. *Organizational Dynamics* 2017; 46: 120-132. https://doi.org/10.1016/j.orgdyn.2017.04.008.
37. Beurskens AJ, Bültmann U, Kant I, Vercoulen JH, Bleijenberg G, Swaen GM. Fatigue among working people: validity of a questionnaire measure. *Occup Environ Med* 2000; 57(5): 353-357. doi:10.1136/oem.57.5.353).
38. Berlin questionnaire. Sleep Relate Questionnaires. American Thoracic Society Available from: https://www.thoracic.org/members/ assemblies/ assemblies/ srn/ questionaires/berlin-questionnaire.php.
39. Reason J, Manstead A, Stradling S, Baxter J, Campbell K. Errors and violations on the road: a real distinction? *Ergonomics* 1990; 33: 1315-1332. doi: 10.1080/00140139008925335
40. Rowe R, Roman GD, McKenna FP, Barker E, Poulter D. Measuring errors and violations on the road: A bifactor modeling approach to the Driver Behavior Questionnaire. *Accident Analysis & Prevention* 2015; 74: 118-125.