Original Article

The Effect of Dangerous Driving Behaviors on the Risk of Traffic Accidents Using Structural Equation Modeling

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Abstract

Background and Objectives: Professional drivers are mostly exposed to heavy workload, like night shifts, long working hours and irregular schedules, leading to high prevalence of psychiatric disorder, including fatigue, memory loss, and insomnia leading to road traffic accidents and injury. The present paper evaluates the relationship between unsafe behaviors and accident risk in heavy vehicle drivers. **Methods:** This cross-sectional study was carried out among 303 professional drivers in Kashan. Unsafe behavior was measured using the Driving Behavior Questionnaire. In addition, a questionnaire was developed to assess the number of accidents and sociodemographic factors. Structural equation modeling (SEM) approaches were employed in the evaluated research hypothesis. **Results:** The results revealed that the average age of participants was 43.15, consisting of passenger vehicle drivers (20.1%) and commercial vehicle drivers (79.9%). The majority were married (94%). Participants drove for an average 11.3 years (standard deviation [SD] = 9.2) with the average speed 85.9 km/h (SD = 13.2). The DB questionnaire had validity and reliability (the factor loading, alpha Cronbach, composite reliability, and average variance extracted were more than 0.5, 0.7, 0.7, and 0.5, respectively). The SEM's results showed proper fit indices for the tested model (x2/df = 2.37; confirmatory fit index = 0.83; root mean square error of approximation = 0.06). **Conclusions:** The main factors of the driver to get involved in a traffic accident and dangerous driving behavior are followed: (a) driver's education level, (b) driver's experience, (c) hours of driving, (d) driver's drug use habit, and (f) risky and slip. It was noted that the level of road safety awareness is low. It can be decided that additional exertions should be made for arranging and imposing road safety and active traffic law legislation to encourage traffic safety responsiveness of the public.

Keywords: Dangerous driving behaviors, professional driver, structural equation modeling, traffic accident

Introduction

Road traffic injury and the related mass casualties are persistent public health challenges in most regions of the world, threatening people's health and substantial human and economic losses and huge costs to the states.[1,2] The world shown on the road traffic accident estimated that 1.2 million individuals die in road traffic accidents every year, and many as 50 million are injured.[3] Current and projected trends in motorization have shown that the problem of Road Traffic Accident (RTAs) will worsen, causing a global public health crisis. Accordingly, by 2020, it has been revealed that traffic accident is expected to be the third

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major killer after HIV/AIDS and TB.[4] Road traffic accidents and related injuries are likely to be acknowledged as significant health problems in developing countries because of insight as a "developmental disease."[3] Due to road accidents, developed countries have the most significant number of victims, and road accidents are measured as one of the primary causes of death. The considerable frequency of road accidents and the injury degree are so high that it is indicated the "war on the roads."[5] Statistics worldwide indicate that 10% of injuries are the leading cause of death,[6] and 3,000 individuals are killed daily because of traffic accidents.[7] According to the World Road Safety Report (2015), the death rate due to traffic accidents in Iran is 1.32 per 100,000 people.[8,9] In total, 2.5% of the world's traffic accidents occur in Iran, which means that the rate of accidents in Iran is 20 times higher than elsewhere.[10] According to the Iranian traffic police, a road accident occurs every 3 min.

Furthermore, every 19 min, one person is killed in these accidents.[11] Identifying the causes and factors affecting the occurrence or severity of an accident is always an important issue for countries. From a scientific and technical point of view, the three factors of vehicle, road, and human are the active factors in the road accident occurrence according to the available information and records. Among these factors, the human factor (share of 93%–98%) is the primary and most compelling factor. Therefore, the cognition of human beings and physical and psychological characteristics affecting their accidental behavior will provide the necessary ground for presenting and formulating effective scientific and practical plans and programs to reduce injuries caused by accidents. Therefore, it is essential to identify drivers' behavior from their perspective and analyze human factors.[12] According to Reason *et al*.,[13] there are two main categories of risky driving behaviors: violations and errors. Errors are actions represent fall short of reaching the preferred outcomes because of the driver's scantiness and accountabilities (e.g., improper handling of the vehicle and misinterpretation of road conditions). On the other hand, violations are abusive behaviors that are always intentional (e.g. exceeding the speed limit, intentional disregard of road sings). Winter and Dodou's meta-analyses (2010) were performed on 70 studies to investigate the relationship between errors and driving violations with a history of accidents. The overall result was that dangerous driving behaviors were positively related to crash risk and could predict crash risk.[14] Kaplan and Prato's 2012 study results on the factors influencing the severity of US bus accidents show that the severity of accidents increases among young people under 25 due to less experience and older people over 65 due to reduced driving skills. Driving while drowsy and tired has a significant effect on the severity of accidents, and dangerous driving behaviors positively correlate with the severity of accidents. Speeding is related to an augmented risk of death as well as an increase in the severity of accidents.[15] Identifying the causes of accidents and traffic accidents due to their frequency is considered one of the essential tasks of the scientific community. Because without identifying the causes of accidents, it will be impossible or at least challenging to provide fundamental solutions to solve this problem, which causes irreparable financial and human damage to society every day.[16] Given the importance of the subject, the present model's primary determination is to identify the dangerous driving behaviors on the risk of traffic accidents.

Methods

Study design

This research is a cross-sectional research design performed in Kashan, Iran, from February 2018 to September 2019.

Ethics

The driver's involvement is voluntary, and they were informed about the project objectives. Then, the written consent form was delivered and signed, and indeed between anonymous questionnaire was used. Ethical authorization for the research was obtained from the Ethics Committee, University of Kashan Medical Sciences (IR.KAUMS.NUHEPM.REC.1397.047).

Participants

The study participants performed many heavy vehicle drivers with a mix of the bus (20%), truck, and trailer (80%) drivers.

Sampling

According to MacCallum *et al*., the minimum sample size for exploratory studies should be between 100 and 200 people.[17] Bentler and Chou (1987) also suggested a scale of at least ten people for each expression.[18] Furthermore, numerous commendations are made within the literature, which suggests that the sample size should be at least 10–15 times the observed variable number. The sample size in this study is ten times the experimental variable number (320 samples/32 experimental variables). The sampling method was simple random. The inclusion criteria for the participants were lacking physical and mental disabilities, ability to read and write, and keenness to contribute to the research. Exclusion criteria for the participants included providing incomplete responses to the question. Data from 303 heavy vehicles drivers were completed in Kashan occupational medicine center.

Measures

1. Exogenous variable (dependent variable): The assessment evaluated precisely how many accidents the lorry drivers had been tangled in throughout the last 3 years while driving a lorry themselves
2. Intermediate variable (intervening variable): Driving behavior; dangerous driving is a 15-item self-divulge measure of risky driving manners plus encompassed four subcategories: risky violation (5 items), slip and lapse (4 items), highway violations (3 items), and mistake (3 items). Each item was rated on a 4-point rating scale, ranging from 1 (never) to 5 (almost always)[19]
3. Endogenous variable (independent variable): this section included demographic and job variables included drivers marital status, age, educational status, medical backgrounds and diseases, such as hypertension,

pulmonary and cardiovascular diseases, diabetes, vision weakness, and other diseases, alcohol consumption, and smoking, type of vehicle (bus, truck, and trailer), hours of occupational driving in a day, days of occupational driving in a week, speed (km/h), years of occupational driving experience.

Data analysis reliability, validity, and correlation analysis

An alpha Cronbach (α) and composite reliability (CR) were utilized to calculate the consistency of those items utilized within the instrument. CR new factor in structural equation modeling (SEM) is an improved criterion than Cronbach's alpha. In calculating Cronbach's alpha coefficient for each construct, all indices are entered with equal importance in the calculations. However, indices with a higher load factor are more critical in CR. CR is an alternative to Cronbach's alpha coefficient in SEM.

The average variance extracted (AVE) and factor loadings (FLs) were adopted to establish the validity analysis. The loadings of all items were tested, and those whose values were more than 0.5 were accepted. The AVE indicates the extent to which the indices of a construct contribute to the explanation of common variance. Convergent validity is established when the AVE is above 0.5.[20,21]

$$CR = \frac{\left(\sum\lambda\right)^2}{\left(\sum\lambda\right)^2 + \sum\delta} \quad AVE = \frac{\sum\lambda^2}{n}$$

Bartlett and Kaiser–Meyer–Olkin (KMO) tests were carried out before factor examination to evaluate the proportional data for the exploratory factor analysis. A high KMO value (0.5–1.0) is proper for factor assessment. Certainly, the Bartlett test value should be significant.[22]

Structural equation modeling test

SEM is titled SEM. It is utilized to resolve multivariate issues in studies and analyze complex multivariate study data (Dan Y H 2008). SEM is a family of statistical techniques authorizing researchers to test such models. Researchers can test hypothesized correlations amid constructs as a factor analysis hybrid and path examination. In a model, variables may include both measured latent variables (LVs) and manifest variables (MVs). LVs are hypothetical constructs, which cannot that cannot be directly measured. We followed a two-stage SEM using the AMOS 19 program. First, fitting the measurement model: we conducted a confirmatory factor analysis to endorse the questionnaire validity. *t*-value more than 2.58 and a FL above 0.40 mean that each item calculates its LV with 99.5% confidence. The subsequent step was to test the theorized framework postulated in Figure 1. After testing numerous models, we selected the model comprising the maximum significant figure related to all possible combinations of indirect and direct relations between the latent and observed variables while controlling for the fit requirements.[23]

The prominent connotation routes can be verified by *t*-value. A *t*-value above 1.96 or under −1.96 designates a substantial

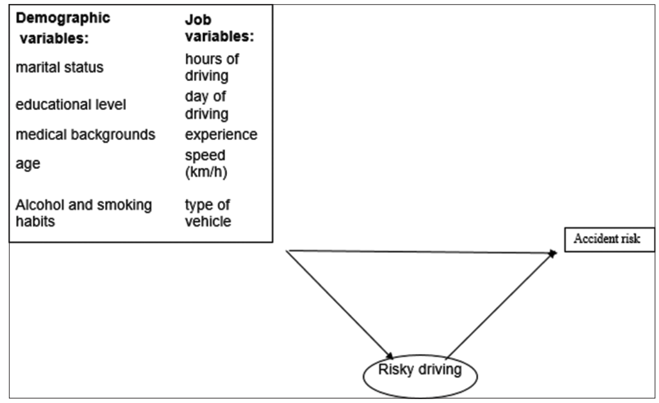

Figure 1: Conceptual model of study

route. Model fit was evaluated with the Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), Chi-square statistic, and confirmatory fit index (CFI). Chi-square statistics are deeply prejudiced by sample size. Hence, CFI, RMSEA, and TLI have improved fit evaluations in a large sample. TLI and CFI values >0.90 and RMSEA values up to 0.08 are typically used to designate a good fit.[24]

Results

Descriptive and correlation statistics

A cautious analysis was done for the total of 320 questionnaires composed, and the questionnaires with missing data were removed, reducing the number of questionnaires to 303. The 303 respondents are among the educational background, and the dispersals of their age, experience, etc., were described. Descriptive statistics revealed the average age of participants was 43.15 (standard deviation [SD] = 10.29) and ranged from 21 to 75, consisting of passenger vehicle drivers (20.1%) and commercial and good vehicle drivers (79.9%). The majority were married (94%). Participants drove for an average 11.3 years (SD = 9.2) with the average speed 85.9 km/h (SD = 13.2). Professional drivers' average daily driving rate was 11.73 h (SD = 3.92) in a day and 5.15 days (SD = 1.58) of driving in a week. Most participants revealed that they do not use drugs (97%), alcohol (93.4%), and cigarettes (63.4%). Correlations were computed to explore the interrelationships among variables [Table 1]. There was a significant and positive correlation between risky driving behavior variables (i.e., slip, highway violations, mistakes, and risky violations) ($P < 0.01$).

Evaluation of the measurement model

The Cronbach's alpha values of the experimental variables and combination consistency of the LVs are given in Table 1. The acceptable alpha Cronbach value is when >0.7.[25] The outcomes indicate that the Cronbach's (α) value of the questionnaire is 0.772, suggesting that the items used in the variables are reliable. The AVE criterion represents the mean variance shared between each factor with its items. In an adequate model, AVE should be >0.5, which means that factors should clarify at least 50% of the total variance of their respective indicators. In the present study, if CR values are more significant than 0.7 and CR values are > AVE (CR > AVE), it indicates the reliability of LVs. According to the results, for all the variables of the present model, the AVE and CR values are ≥0.5 and 0.7, and CR values are > AVE.

The SEM outcomes showed passable fit indexes for the measurement model (x^2/df = 2.14; CFI = 0.89; Normed fit index (NFI) = 0.8; TLI = 0.86 RMSEA = 0.06). All FLs of each LVs were statistically substantial ($P < 0.001$) and were above 0.32, that is, the minimum value that the literature commonly proposes to assent for a FL.

Evaluation of the structural model

Figure 2 indicates the ways among the LVs. Concerning the ways amid the LVs [Figure 2], the SEM outcome investigation exhibited that this model elucidated a total of 31% variance in accident involvement.

Estimation outcomes revealed that the hypothesized model generated an applicable fit to the data ($x^2 \times df^{-1} = 2.37$, $P < 0.001$, RMSEA = 0.06, CFI = 0.83, TLI = 0.8). In heavy vehicle drivers, risky and slip driving behaviors had a positive, remarkable relation with accident risk ($\beta = 0.46$ and $\beta = 0.47$, respectively). Educational level was negatively associated with all subscales of dangerous driving (risky = –0.59, slip = –0.53, highway = –0.21, mistake= –0.29) and negatively associated with accident involvement ($\beta = -0.56$). Furthermore, there were significant relations between narcotic use, hour of driving and job experience, and dangerous driving behaviors among background variables [Figure 2].

Discussion

A present work contributing to the literature is that our conclusions elucidated and underlined the function of driving behaviors and concrete background variables in accident risk by SEM analysis while replicating earlier indications concerning risky driving behavior and driving outcomes by simple statistical analysis.[26-28] Our research presents a high percentage of elucidated variance (31%) in accident risk related to the experience of driving, educational level, hours of driving,

Table 1: Correlation matrix, construct reliability 0.33, 0.09, 0.44, 0.54, 0.26

	1	2	3	4	5	Mean±SD	Cronbach's α
Risky violations	1					7.68±2.82	0.677
Slip	0.221**	1				5.93±1.99	0.664
Highway violations	0.327**	0.373**	1			4.34±1.63	0.625
Mistake	0.209**	0.459**	0.257**	1		4.79±1.7	0.6
Dangerous driving behaviors	0.734**	0.709**	0.661**	0.642**	1	22.77±5.65	0.772

SD: Standard deviation. **P< 0.01

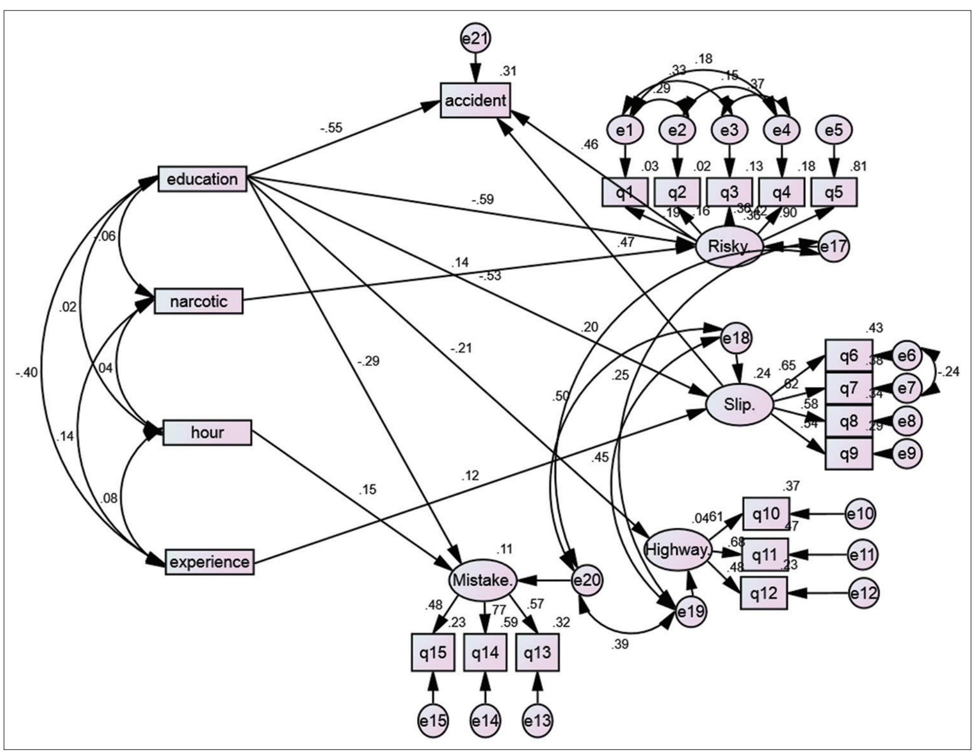

Figure 2: Final structural model of study

drug use, and risky driving behaviors. This value was higher than other studies (lower than 15%).[29-32]

Our results correlate with the previous studies[28,30,31,33] that revealed that driving experience directly influences accident risk. Many experienced drivers are likely to be involved in more traffic accidents. As it seems, drivers acquired a slight advantage from their expertise in accident prevention. Although our research found that driving affects expertise on risky driving behaviors, more experienced drivers could perceive some risky driving behaviors, such as speeding, to be less dangerous, confirming the latter proposition that amplified driving experience could lead to safe behavior and overconfidence. Consequently, it will motivate future studies to explore different factors, like confidence level, that prevent risky driving behavior among professional drivers. Furthermore, this finding drawn in that accident stoppage programs should be unceasingly conveyed to even experienced drivers to keep an appropriate level of safe driving awareness.

The results show a negative and remarkable relationship between educational level, risky driving behavior, and accident risk. This could be because drivers with higher education are more aware of the dangers of driving and drive safer. They also respect the rules that these factors reduce the risk of accidents and high-risk driving behaviors. This finding clearly shows the vital effect of safe driving training in identifying driving hazards and factors affecting accidents. Additional research on the Driving Behavior Questionnaire with older heavy vehicle drivers indicated that slips were related to crash involvement. Perhaps, this discovery can be elucidated through the growth-related drop in older drivers' physical and mental abilities. In the case of driving slips, this drop might damagingly impact response times concerning modifying these risky driving behaviors or carrying out counteractive maneuvers to evade an accident. Similar to previous studies that show this relationship.[34-36] Furthermore, because the drivers in the current survey are professional and drive for a living, they suffer from fatigue due to long-term driving. Driving task-associated fatigue is related to bad trends within the drivers' performance indicators. Hence, it could be said that feeling fatigued. At the same time, driving is connected to an augmented risk of acting in a possibly risky while operating a vehicle. According to a few research, it even explains the enormous number of traffic accidents in the occupational population.[37-39] There is no relation between highway violation and accident involvement.

Consequently, additional factors are estimated to impact the connection amid risky behaviors and law opposition on the highway, for example, social attractiveness. Professional drivers are diligently cognizant that violations on the road are not desirable. Thus, they could be inclined by this when counting their responses on the questionnaire. Further research is needed to examine the correlation between the possibility of risky driving and disagreement about putting into practice specific traffic regulations.

A cross-sectional design, which limited the prospect of beginning any causality within the relationships analyzed in the model, was one of the limitations of this study. However, driving behavior has been stable and predicts accident risk.[40] Second, self-reported use measures to evaluate driving behavior might have shown report or reminiscence biases. Conversely, a meta-analysis carried out by de Winter and Dodou[10] revealed that the questionnaire used in the current research was a valid prognosticator of car accident participation. A third limitation is that the present study is based on Iranian professional drivers, so the sample is not the worldwide population representative. The fourth limitation is that all scales in this study were calculated via a paper-and-pencil test. The objects in the hierarchy encompassed altruistic and illegal behaviors (i.e., helping drivers try to pass, not disturbing other drivers, etc.). These items could be affected by social desirability. Even though there were limitations, present outcomes support the model's applicability in predicting dangerous driving behavior and accident risk.

Conclusions

This study used an SEM technique to different variables that affect accident involvement. The SEM models were advanced and statistically substantiated to be a satisfactory fit. Using the primacy of the SEM technique, this research substantiated the study theories, the degree of upshot measured through way coefficients, and evaluated direct and indirect effects by analyzing causal relationships between manifest and latent variables. The main factors of the driver to get involved in a traffic accident and dangerous driving behaviors are followed: (a) driver's education level, (b) driver's experience, (c) hours of driving, (d) driver's drug use habit, and (f) risky and slip. It was noted that the level of road safety awareness is low. Based on the challenge related to education, it can be decided that additional exertions should be commended for arranging and implementing operational traffic regulations and road welfare legislation with encouraging public awareness of traffic safety.

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Conflicts of interest

There are no conflicts of interest.

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