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The influence of driving safety attitudes on risky driving behavior: a driving simulator study

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Abstract

Context and relevance. Road traffic accidents and violations of traffic regulations continue to be a frequent occurrence on highways, particularly among motor vehicle operators who demonstrate a tendency to disregard fundamental driving safety practices. **Objective.** The aim of this study is twofold: first, to explore the impact of the aforementioned factors on the subject's performance; second, to assess how driving safety attitudes influence driving risks through simulations. **The hypothesis** of this study is that a higher level of safety in driving behaviour will be associated with a lower frequency of risky driving behaviour in the simulation environment. **Methods and materials**. The study's participants comprised drivers who were in possession of a valid driving licence. In this study, researchers employed the City Car Driving 5 software and utilised a driving simulator, a driving risk scale, and a driving safety attitude scale. The subjects were divided into two groups. One group was subjected to a traffic density level and a pedestrian density level of 75%, which was designed to act as a form of disturbance. Following the utilisation of the driving simulator, subjects were required to complete a driving risk questionnaire and a driving safety attitude scale. **The results** obtained from this study are as follows. The findings of the study demonstrate a substantial relationship between driving safety attitudes and driving risks, with a value of 0,000 and a negative correlation value of -0,804. The study also indicates a 70,6% influence of driving safety attitudes on driving risks. **Conclusions.** The findings indicate that there remains a significant risk associated with driving, and there is no observed difference in risk between men and women, as both groups demonstrate equivalent levels of risk.

Keywords: risky driving, safety driving attitudes, drivers

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Влияние отношения к безопасному вождению на рискованное поведение водителя: исследование с использованием автосимулятора

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Резюме

Контекст и актуальность. Дорожно-транспортные происшествия и нарушения правил дорожного движения по-прежнему являются частым явлением на скоростных дорогах, особенно среди водителей транспортных средств, которые демонстрируют тенденцию пренебрегать основными правилами безопасного вождения. **Цель.** Настоящее исследование преследует две основные задачи: используя симуляционные методы, во-первых, проанализировать, как указанные факторы влияют на результаты испытуемых; во-вторых, определить, каким образом отношение к безопасному вождению влияет на уровень риска за рулём. **Гипотеза** исследования заключается в том, что в ситуации симуляции более высокий уровень безопасного вождения будет связан с меньшей частотой рискованного поведения за рулем. **Методы и материалы** В исследовании приняли участие водители, у которых были действительные водительские права. В исследовании использовалось программное обеспечение City Car Driving 5, а также симулятор вождения, шкала рисков вождения и шкала отношения к безопасному вождения. Испытуемые были разделены на две группы. Для одной группы был установлен уровень плотности дорожного движения и пешеходов в 75%, этот уровень был разработан таким образом, чтобы создавать помехи для водителя. После использования симулятора вождения испытуемые должны были заполнить анкету о рискованном поведении во время вождения и шкалу отношения к безопасному вождению. **Результаты** исследования показывают, что существует значимая связь между отношением к безопасному вождению и уровнем рисков при управлении автомобилем. Статистическая значимость связи высокая (значение 0,000). Также обнаружено, что чем лучше человек относится к безопасному вождению, тем ниже его риск попасть в опасную ситуацию за рулем — эта связь выражена отрицательной корреляцией (-0,804). Кроме того, исследование показывает, что отношение к безопасному вождению влияет на уровень рисков примерно на 70,6%. То есть, позитивное отношение к безопасности значительно снижает вероятность возникновения опасных ситуаций за рулем. **Выводы.** Полученные данные показывают, что риск при управлении автомобилем остается высоким. Также выяснилось, что мужчины и женщины имеют примерно одинаковый уровень риска — разницы между ними в этом отношении нет.

Ключевые слова: рискованное вождение, отношение к безопасному вождению, водители

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Introduction

Many individuals who drive on the streets today are involved in accidents, whether they are driving two-wheeled or four-wheeled vehicles. This behaviour is still the subject of research in various major countries around the world. According to the International Transport Forum (Wegman, 2020), various causes of accidents, such as driving while using a mobile phone, are still a problem in several countries. In addition, speeding and drink-driving are the two main factors in fatal accidents in many countries: speeding contributes to 15% of accidents, while drink-driving contributes to 10%.

The Global Status Report on Road Safety (Passmore et al., 2019) states that more than 1.25 million people die from traffic accidents worldwide every year, and 50 million people are seriously injured. 90% of these occur in developing countries, despite these countries having only 54% of the world's registered vehicles. In light of these facts, it is crucial that all road users in Indonesia demonstrate a commitment to road traffic safety. It is hoped that drivers will recognise the importance of safety when driving on the highway and that the government will increase road safety campaigns to raise awareness of road safety (Nanditho & Yola, 2022).

A WHO report from 2022 found that more than 90% of road traffic deaths occur in low- and middle-income countries. The highest road traffic fatality rates are found in Africa, while the lowest rates are found in Europe. People from low socio-economic backgrounds are more likely to be involved in road accidents. From a young age, men are more likely to be involved in road accidents than women. Around three-quarters (73%) of all road deaths are among young men under 25, who are almost three times more likely to die in road accidents than young women. This approach considers people's vulnerability to serious injury in road accidents and recognises that systems must be designed to accommodate human error (Carey et al., 2014).

In Indonesia, for example, the rate of driving deaths is often higher among young drivers aged between 20 and 30. In this age group, which is considered the most productive demographic, the incidence of accidents is much greater in middle-income countries such as Indonesia. Therefore, it is important to study the factors that influence traffic accidents in such countries (Soehodho, 2007). Most accidents are caused by young drivers who commit violations such as ignoring applicable signs (Ismail & Halim, 2016; Suwanto & Alfanti, 2020), running traffic lights (Jiang & Rau, 2018), driving above the speed limit and not having a driving licence (Tucker et al., 2015), and performing other tasks such as holding a smartphone (Jiang & Rau, 2018; Kirkcaldy & Furnham, 2000; Newbold & Scott, 2017; Soehodho, 2007) or changing radio channels (Kirkcaldy & Furnham, 2000).

These various behaviours can cause accidents, which are one of the risks associated with driving. Driving behaviours that can cause accidents include crashing into other vehicles, which can provoke emotional responses in drivers (Newbold & Scott, 2017; Deffenbacher et al., 2003, 2004; Sullman,

2015; Vassallo et al., 2007), accidentally hitting a pedestrian (Dula & Geller, 2003; Iversen & Rundmo, 2004; Lafont et al., 2018; Newbold & Scott, 2017; Popuşoi & Holman, 2016), or hitting a cyclist (Lafont et al., 2018; Matthews et al., 1998; Monteiro et al., 2018). This behaviour is part of risky driving behaviour. Carey (Carey et al., 2014) said that risky driving behaviour involves taking risks while driving and engaging in various behaviours, such as driving above-average vehicles and driving while doing other things. It also involves having safety attitudes to reduce the risks that occur while driving. However, driving safety is still often ignored by drivers, for example by not wearing a helmet or seatbelt, violating traffic regulations, and so on. Furthermore, these violations affect people of all ages, including those between 15 and 64 years old (Lafont et al., 2018). This is why the government is taking various measures to make driving safer for teenagers and young drivers. Not infrequently, government programmes regarding safe riding target students who often drive (Carey et al., 2014).

Several other studies have examined the relationship between driving safety attitudes and risk-taking behaviour while driving. For example, Ulleberg and Rundmo (2003) found that driving safety attitudes influence risk-taking behaviour to a degree of 47%. Additionally, individual differences such as risk perception, attitudes towards traffic safety and aspects of the driver's personality have been associated with an increased likelihood of unsafe driving, including aggressive driving (Chen, 2009). In a previous study, Chrisnatalia et al. (Chrisnatalia et al., 2021) administered a questionnaire to 151 drivers in Jakarta in order to ascertain the extent to which they engaged in risky driving behaviours. The results indicated that many drivers lacked a comprehensive understanding of safe driving behaviours and attitudes, which is a key factor in the high rate of traffic accidents in Indonesia. Subsequently, the researchers conducted further research using a driving simulator to ascertain whether driving risks have the capacity to influence driving safety attitudes. In this case, the focus was on car drivers.

It is therefore the objective of researchers to ascertain how the driver's safety attitude is affected when confronted with a driving simulator, the method employed in this study, so that the results obtained are comparable to those obtained when driving a real vehicle. The utilisation of driving simulators in research endeavours enables the observation of participants' responses to various stimuli, including the presence of other drivers crossing the road, obstructions, traffic congestion on highways, careless pedestrian crossing, and other road users or drivers attempting to collide with each other. This approach provides a comprehensive and controlled environment for studying driver behaviour and responses to different scenarios.

The driving behaviour exhibited by the participants in the simulator study aligns with the perspective articulated by Fisher et al. (2011), who asserted that the primary function of driving simulators is to facilitate researchers in observing actual driving behaviour, thereby minimising the impact of extraneous variables. Schweiger (Schweiger, et al., 2019) proposed that the benefit of joint simulation is flexibility, achieved by combining features from different tools.

The utilisation of a driving simulator constitutes a methodology through which the impact and behaviour of the subject can be observed. This enables researchers to study the driver's behaviour in the simulator, thereby acquiring data that has the potential to result in severe accidents or unsafe driving behaviour (Fisher et al., 2011). Therefore, the following hypothesis is proposed: that a higher

level of safety in driving behaviour will be associated with a lower frequency of risky driving behaviour in the simulation environment?

Materials and methods

In this study, the researcher employed the utilisation of a driving simulator as a methodological approach to observe the impact and behaviour of the subject. As posited by Fisher et al. (2011), this facilitates the analysis of driver behaviour in a simulated environment, thereby enabling the acquisition of data that has the potential to result in severe accidents or unsafe driving behaviour.

The driving behaviour of the participants was assessed using City Car Driving 5 simulation software in conjunction with a three-screen driving simulator that was equipped with a Logitech G29 steering wheel and pedal set (see Figure 1).

Fig 1. Driving simulator. Image source: Chrisnatalia Research (Chrisnatalia, et al., 2021a).

Thirty research participants were obtained by the researchers, and by employing the experimental

method, the subjects were divided into two groups: namely, the experimental group and the control group. The participants comprised 14 female drivers and 16 male drivers, with an age range of 17-45 years and a minimum driving licence period of one year.

The subjects of the study were divided into two stages by the researchers. The initial phase of the experiment was conducted in the morning with the experimental group, and in the afternoon with the control group. The participants were divided into two research groups: the experimental group (Group 1) and the control group (Group 2).

The road type is designated as urban, with a highway density set at 75%, indicating a high traffic volume. The aggression exhibited by other drivers is also considered to be high, including the presence of drivers who interfere, those who drive carelessly, and pedestrians who cross the road in a careless manner (Yang, Deng, Wang, Li & Wang, 2006; Zeng, Chen, Nakamura & Iryo-Asano, 2014). The participants were divided into two groups. The initial group was administered treatment involving a road density of 75% and a pedestrian density of 75%. This was undertaken to ascertain the safety of drivers when operating vehicles in congested and traffic-dense environments, with a high number of pedestrians suddenly crossing the road. The underlying rationale for this selection is that it is anticipated that researchers will be able to observe the level of driver aggressiveness in these

conditions. The estimated duration of the journey by car is 10 minutes. At a predetermined point or end point, the driver will arrive.

The form of disturbance is shown in Figure 2.

Fig 2. Other drivers cutting ways. Image source: Chrisnatalia Research (Chrisnatalia, et al., 2021a).

The second group was subjected to the following conditions: a type of urban road, with highway density set at 50%. This corresponded to a normal traffic volume, a moderate level of aggressiveness from other drivers, law-abiding pedestrians and pedestrians crossing carelessly with normal intensity (Yang et al., 2006; Wijayanto et al., 2020).

Following the completion of the driving task using the simulator, participants were requested to complete a questionnaire on the driving risk scale according to Ulleberg and Rundmo (Ulleberg, Rundmo, 2003), comprising a total of 14 items, and on the driving safety attitude scale (Ulleberg, Rundmo, 2003; Iversen, Rundmo, 2004), comprising a total of 15 items. The measurement is based on a Likert scale, with choices ranging from 1 to 5. The data analysis technique employed in this study is linear regression analysis. This analysis is utilised to ascertain the extent of influence in the present study. The researchers employ the Statistical Package for the Social Sciences (SPSS) tool.

Results

The second group was subjected to a density level of 50%, and the number of pedestrians was set at 50%. This scenario is analogous to typical road conditions, characterised by a moderate road density. Researchers obtained results from the driving simulator in the form of the number of accidents experienced by the subjects and the number of violations that occurred.

Following the completion of the driving task using the simulator, participants were invited to complete a questionnaire on the driving risk scale (Ulleberg, Rundmo, Newbold, Scott, 2017), which comprised a total of 14 items. Additionally, they were asked to complete a questionnaire on the driving safety attitude scale (Iversen, Rundmo, 2004; Ulleberg, Rundmo, 2003), which comprised a total of 15 items. The measurement is based on a Likert scale, with choices ranging from 1 to 5. The data analysis technique employed in this study is linear regression analysis. This analysis is utilised to ascertain the extent of influence in the present study. The researchers employ the Statistical Package for Social Science (SPSS) tool.

Table 1**.**
Item discrimination power and reliability

Variable	Item after being tested	Item Discrimination Power Value	Reliability Value
Risk of driving (Y)	14 items	0,387- 0,777	0,904
Attitude towards driving safety (X)	15 items	0,631- 0,866	0,949

Table source: SPSS

Prior to conducting the relationship and linearity tests, the researcher implemented normality and linearity tests, the data for which is presented in Table 2.

Table 2**.**
Assumption and linearity test

	df	F	Sig	p	Result
Deviation from Linearity	43	0,929	0,594	p > 0,05	Linier
Risk of driving (Y)	65		0,200*	p > 0,05	Normal
Attitude towards driving safety (X)	65		0,200*	p > 0,05	Normal

Table source: SPSS

As demonstrated in Table 2, the assumption and linear tests have been successfully completed, thereby paving the way for the subsequent progression to the hypothesis test, the relationship test, and the regression test. The present study set out to investigate the relationship between driving safety attitudes and driving risks. The results of the study demonstrated a negative relationship between driving safety attitudes and driving risks, with a significance value of 0,000. The study also revealed a Pearson Correlation of -0,840, as illustrated in Table 3.

Table 3.
Correlation

		Attitude towards driving safety	Risk of driving
Attitude towards driving safety	Pearson Correlation	1	-,840**
	Sig. (1-tailed)		,000
	N	30	30
Risk of driving	Pearson Correlation	-,840**	1
	Sig. (1-tailed)	,000	
	N	30	30

**. Correlation is significant at the 0,01 level (1-tailed).

Table source: SPSS

Following the evaluation of the relationship, the researcher conducted a regression test to ascertain the extent to which the driving safety attitude value influenced driving risk. This yielded a significance value of 0,000 and an R-Squared value of 0,706, as illustrated in Table 4.

Table 4.
Correlation test and driving simulator regression test

Variable	**R-Squared**	**Sig**	**P**	Standardized coefficients Beta	**F**	**Result**
The driving safety attitude value had on driving risk	0,706	0,000	p < 0,05	-,881	219,008	Supported

Table source: SPSS

The results of the study indicate a relationship between driving safety attitudes and driving risks, with a significance value of 0,000. The study also demonstrates a negative relationship with a Pearson correlation of -0,840 (see Table 3). This indicates a negative correlation between attitudes towards driving safety and risky driving behaviour. The findings of this study indicate that individuals who adopt a positive attitude while driving are more likely to engage in low-risk driving behaviours. These individuals demonstrate a propensity to drive with focus and calmness, thereby reducing the risk of adverse driving incidents. The findings, derived from the utilisation of the simulator, indicate that individuals who drive with focus exhibit a reduced incidence of violations and fewer errors.

Table 5**.**
Driving risk categorization

Variable	**N**	**Empirical average**	**Result**
Control	15	45,60	Average
Experimen	15	46,80	Average
Women	8	49,25	Average
Men	22	45,09	Average

Table source: SPSS

Discussion

The safe driving attitude exhibited by the subject has an R-Squared value of 0,706. The findings indicate that attitudes towards driving safety have a significant impact on risky driving behaviour, with an influence value of 70,6%. The residual 29,4% is influenced by other factors. It is conceivable that individuals who drive may possess a commendable safety attitude, which enables them to curtail risky driving behaviour, such as adhering to applicable signage.

Despite the majority of participants exhibiting moderate to high safety attitudes, the recurrent violations observed in the simulator suggest a discrepancy between their stated attitudes and their

actual behaviour. However, the findings of the simulator study revealed that the vast majority of drivers made errors. One such error was driving above the stipulated speed limit. In Indonesia, it is common for drivers to exceed the average speed limit, which is in excess of 80 kilometres per hour. This tendency is particularly prevalent on roads that appear to be free of traffic, prompting drivers to operate their vehicles at that particular speed.

The findings of this study are consistent with the assertion of Chraif et al. (Chraif et al., 2016) that aggressive driving is associated with adverse driving outcomes, including accidents, suspension of tickets and licences. Aggressive driving is recognised as a risk factor for accidents. Conversely, drivers frequently disregard traffic regulations and are predisposed to involvement in road traffic accidents. It is a common occurrence for drivers to neglect their immediate environment or to become completely distracted while operating a vehicle. The results of the simulator indicated the presence of three distinct categories: events, accidents and violations. Events are defined as the results obtained to observe the driver's response to various behaviours that occur on the highway. An accident is defined as an occurrence that transpires while a vehicle is in motion, such as the impact of a vehicle on another vehicle or pedestrian. The third is a violation, namely the type of violation committed by the driver in the simulator. The results of the simulator are presented in tabular form in Table 4, which shows the number of events, accidents and violations that occurred.

As demonstrated in Table 4, it is evident that the subjects in Group 1 (the experimental group) exhibited a higher frequency of violations. These violations encompassed a range of infractions, including speeding, failure to utilise turn signals, reluctance to yield to other vehicles, and disregard for traffic signals.

In the female cohort, one subject demonstrated a relatively elevated violation value in comparison to the other participants. It is conceivable that the subjects in this study frequently engaged in infractions while operating a vehicle, such as speeding and neglecting to utilise turn signals during manoeuvres. This finding was derived from the simulator. In contrast, the male cohort exhibited 39 violations, with the most prevalent type of infraction being speeding and the failure to utilise turn signals during turning manoeuvres. This observation aligns with the findings reported by Cordellieri et al. (Cordellieri et al., The 2016 study by Cordellieri et al. (Cordellieri et al., 2016; Cordellieri et al., 2019) found that the perception of risk experienced by both men and women tends to be the same when driving. This study was conducted in several European countries.

The findings demonstrate that the outcomes are not distinct due to the fact that both cohorts are situated within the moderate category for driving risk. It is conceivable that the subjects in this study both possess a high risk when utilising a driving simulator. The explanation can be found in Table 4.

As asserted by Romano et al. (2008), there was a notable increase in the number of female drivers involved in accidents, as evidenced by traffic accident data. This phenomenon can be attributed to a shift in the sociocultural role of women, which necessitates a convergence in behaviour with that of men. Furthermore, Grbović et al. (2011) asserted that traffic situations have the capacity to induce stress in drivers, precipitating erratic conduct that may culminate in accidents. This phenomenon is influenced by emotional and behavioural factors that manifest during driving.

The findings of the difference test administered to both the experimental and control groups were considered. The mean risk of score in the experimental group was determined to be 46,80, while in

the control group, it was recorded as 45,60. The findings demonstrate minimal discrepancy, as both cohorts are classified within the moderate driving risk bracket. Consequently, it is plausible that the subjects of this study exhibit elevated risk levels when engaging with the driving simulator.

The findings of the relationship test conducted by the researcher indicated the presence of a very significant relationship and a negative relationship. This suggests that an increase in attitudes towards driving safety is associated with a decrease in the risk of driving. It is conceivable that the subjects in this study exhibited a positive attitude towards driving, thereby reducing the risk of accidents.

Nevertheless, this finding is incongruent with the preceding research undertaken by Chen (Chen, 2009). The latter researcher posited that there exists a positive correlation between unsafe driving attitudes and risky driving behaviour. This suggests that drivers who exhibit a greater propensity for risk-taking are more likely to engage in risky driving behaviour.

Furthermore, Ulleberg and Rundmo (Iversen, Rundmo, 2004) have asserted that driving safety attitudes exert a direct influence on driving risk. This assertion is substantiated by the regression test conducted in this study. The regression test yielded an R^2 value of 0,706, indicating that driving safety attitudes exert a significant influence on driving risk, with a 70,6% impact. Consequently, an enhancement in driving safety attitudes is associated with a reduction in driving risk.

A plethora of factors have the capacity to influence driving risk; for instance, personality traits and attitudes pertaining to aggressive driving. This assertion is corroborated by research undertaken by Ulleberg and Rundmo (Iversen, Rundmo, 2004), which posits that individual personality factors exert an independent influence on risk-taking behaviour.

The present study is subject to certain limitations, the most significant of which pertains to the absence of variation in the research subjects included in the study. This is due to the fact that at the time of data collection, the global spread of the novel Coronavirus (Covid-19) had already begun, which resulted in restrictions on the number of people carrying out activities outside the home.

Conclusions

The study concluded that there is a negative relationship between driving safety attitudes and driving risks. This means that an increase in driving safety attitudes is associated with a decrease in risk when driving. The present study demonstrates a significant correlation between driving safety attitudes and driving risks, with a correlation coefficient of 0,706. The findings of the driving simulator study indicated that there was no statistically significant difference between male and female subjects in terms of the number of violations committed during the experiment.

It is recommended that future studies augment the sample size and incorporate real-time attention measures, such as eye tracking, with a view to enhancing ecological validity. The enhancement of driver awareness regarding traffic safety remains a public health priority, particularly in developing countries such as Indonesia.

Limitations. The present study is constrained by its sample size, which is limited to 30 subjects. In the event of further research being conducted, it would be possible to increase the number of subjects and utilise an eye tracker tool to observe their eye movements while they are driving a car. This instrument is utilised for the purpose of ascertaining the primary focal point of the subject during operation of a vehicle.

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