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THE IMPACT OF DEMOGRAPHIC FACTORS ON THE TRAFFIC ACCIDENT RATE IN CZECH REPUBLIC

Summary. Demographic factors, such as age and gender, significantly influence the causes of traffic accidents, which is essential for providing effective road prevention and safety. The work aims to assess the dependency of the demographic factor of age on the causes of traffic accidents and the dependency of gender on the causes of traffic accidents in the Czech Republic from 2011 to 2023, which may be crucial for creating measures. Pearson's and Spearman's correlation methods, based on the results from the Shapiro-Wilk test, were used for the analysis. Pearson's correlation method showed a strong positive correlation between inattention and accident rate in women (0.862) and a substantial positive correlation in men (0.638). Excessive speed and failure to yield were less significant in men than women. Furthermore, the impact of the age groups on the selected causes of accidents was examined. In young drivers (15–24 years), inattention was the leading cause of accidents with a very strong correlation (0.912), excessive speed had a moderate impact (0.505), and failure to yield had a significant impact (0.698). In middle-aged drivers (25–64 years), inattention was still important (0.599). However, excessive speed had a negligible impact (-0.049). In old drivers (65+ years), inattention (0.945) and excessive speed (0.989) were very strong factors, while failure to yield had a very strong impact (0.802) as well. The centralization of data is a limitation of the work.

1. INTRODUCTION

Traffic accidents represent anomalies in transport systems triggered by a combination of factors, including human behavior, vehicle conditions, roadway quality, and the environment. Among these, human behavior is the predominant cause of traffic accidents, contributing to over 70% [1]. Drivers' behavior can influence their driving style, and consequently, it can impact the cause of traffic accidents. Drivers with maladaptive tendencies, such as those exhibiting antisocial, risky, and aggressive behaviors, often experience a distorted sense of control and feel capable in high-pressure situations when, in reality, they are not. In contrast, drivers with an adaptive driving style are less likely to be involved in accidents due to their more cautious driving style [2]. Active and passive feedback from family and friends can positively influence drivers, helping to reduce undesirable behaviors, such as aggressive driving, intentional loss of attention, and deliberate violation of traffic rules [3]

Accident rates can be influenced by a wide range of factors, such as socioeconomic, demographic, and technological factors [4]. Demographic factors can considerably influence the accident rate. Drivers' age and experience have a significant impact on the probability of an accident [5], as age influences important aspects needed for participating in traffic, such as reaction time, sight, and mobility. However, young drivers may lack experience in crises, and they can become slightly confused or

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misjudge the vehicle's behavior and cause an accident. In various countries, the economic situation of accident participants may impact their chance of survival [6], as communities with low incomes lack access to decent healthcare. However, [7] confirmed that the price of a vehicle may not affect its safety.

Traffic accidents negatively affect the economy in both the short and long term. This impact is visible in the microenvironment (individual and family) and, thus, can influence the macroenvironment (GDP, inflation, degree of unemployment). In China in 2017, economic losses caused by traffic accidents amounted to USD 72.6 million, which corresponds to 0.60% of the Chinese GDP. The biggest proportion of the loss was the productivity loss of 72%, followed by the costs of trip delays corresponding to 12%, and then healthcare costs, property damage costs, and insurance costs [8]. Further expenditures weighing over the economic situation are long-term investments that the state puts into infrastructure providing greater traffic security and prevention, which is to prevent the dangerous behavior of drivers on the roadway.

Consequently, the accident rate is not an isolated issue; it has a broad negative impact on society. Traffic accidents affect individuals, families, and communities, who often must cope with deaths or serious injuries that can have lifelong consequences. These accidents also create economic burdens, including direct medical and recovery costs, lost workforce productivity, property damage, and substantial investments in infrastructure and safety measures.

The aim of the study is to analyze the influence of age and gender as demographic factors on the causes of traffic accidents in the Czech Republic between 2011 and 2023.

Two research questions were determined to fulfill the aim of the work. The relation between gender and the cause of traffic accidents (lack of attention, high speed, failure to yield) is analyzed by RQ1. The analysis was carried out employing correlation analysis. We identified the power of the cause of traffic accidents for the specific gender by answering this question.

RQ1: Was there a significant relationship between the cause of traffic accidents and gender in the Czech Republic from 2011 to 2023?

We analyze the relationship between different age groups of drivers - young (15–24 years), middle-aged (25–64 years), and older drivers (65+ years) and specific causes of traffic accidents. These causes include lack of attention, excessive speed, and failure to yield the right of way. The analysis was carried out employing correlation analysis. We identified the power of the cause of traffic accidents for the specific age group of drivers by answering the following research question:

RQ2: Was there a significant relation between the cause of traffic accidents and drivers' age groups in the Czech Republic from 2011 to 2023?

2. LITERATURE REVIEW

According to [5], who dealt with the cause of traffic accidents, age has an influence on the probability of such accidents. Middle-aged drivers are more frequently involved in traffic accidents than other age groups. Driving experience influences the probability of causing a traffic accident. In the case of more experienced drivers, the degree of accident risk decreases. The methods employed for this research included a Geographic Information System (GIS), a questionnaire, and logistic regression. [9], whose research analyzed the demographic and social factors influencing the mortality of females in productive age in traffic accidents using descriptive statistics, confirmed the link between experience and the number of accidents. It was found that female drivers with little experience had the highest incidence of traffic accidents. This was confirmed by [10], who also examined the relationships between demographic factors and the emergence of motorcycle traffic accidents. The results show that more experienced drivers are less susceptible to traffic accidents. Fatigue and time pressure from the employers of lorry drivers may be another factor in the increased accident rate. [11] identified fatigue as a factor increasing the probability of accident risk across all age groups in their research. According to [12], whose research dealt with improving older drivers' behavior, older drivers have a more oscillating ability to manage their vehicles. However, their tendency to drive dangerously decreased after the training. According to [13], who dealt with emotional intelligence and its impact on drivers'

behavior, high emotional intelligence has a negative impact on dangerous behavior during driving. This study utilized correlation and regression analysis to identify relationships between variables.

The degree of light commercial use of plots, the number of housing units, and the number of students at secondary schools positively influence accident rates. According to [14], who researched the influence of demographic factors on the frequency of accidents involving young individuals. [15], focusing on the risk assessment of traffic accidents involving bus drivers in Iran and using a logistic regression model, found that bus drivers over 55 years of age have a higher participation in traffic accidents than bus drivers who are less than 35 years of age. According to [16], who examined the deterring factors of using mobile phones by young drivers, legal deterrent factors are not consistently effective. Using a mobile phone may have a negative influence on a driver's concentration. Likewise, wandering thoughts were examined by [17], who dealt with the hypothesis of increased wandering thoughts of young male drivers in bad moods. The hypothesis was confirmed by a preliminary pre-post (T1, T2), randomized, controlled, single-blind experiment.

According to [18], who investigated the predictors of driving cessation using multifactor logistic regression analysis, demographic variables such as age, sex, and marital status are significantly associated with the decision to stop driving. These demographic factors are just as influential as physical, financial, and mental conditions. This was complemented by [19], who pointed to the demographic factor of age as a statistically significant factor contributing to the accident rate. The resource at the end of the work stated that age and other factors can serve as indicators to assess driving capability. The methods used to create this study were chi-square and cross-distribution analysis. According to [20], who explored the differences in assessing the safe and risky behavior of drivers provided by drivers and pedestrians, older drivers regard themselves as safe drivers. In contrast, young drivers claim a higher rate of dangerous behavior in their self-assessments. According to [21], who examined the impact of the mode of driving on the mental comfort of persons over 50 years of age by using regression analysis, driving a car has a positive impact on the mental comfort of these persons.

According to [22], who analyzed demographic factors and their influence on traffic accidents, demographic factors can significantly impact the accident rate. According to [23], who researched traffic accidents in 2010, the proportion of injured men is significantly higher than the proportion of injured women. The data analysis method was employed in their research. The work of [24] examining the psychological effects on persons who experienced a traffic accident found that the psychological effects of traffic accidents are worse among women than among men. This research used a cross-sectional survey of sleep quality assessment and association analysis. [25], who examined the demographic factors and the behavior of motorcyclists intoxicated by alcohol with the help of comparative analysis and anonymous questionnaires, arrived at an interesting conclusion that women have a higher representation of drunk driving than men. Study [26], which examined psychological symptoms and driver behavior using a logistic regression model, found that women demonstrated better prevention of symptoms linked to a higher risk of traffic accidents. This preventive effect was more pronounced in women than in men. According to [27], women tend to use automobiles to fulfill domestic chores. This research employed comparative analysis. According to [28] and their cross-sectional self-assessment study, young female drivers rated their safety abilities higher than their driving proficiency. Among young male drivers, the outcome was reversed. It was also determined that both genders experienced an improvement in driving abilities, whereas their safety skills declined. It was found that male drivers increased their driving skills as their age increased, but the increase in skills was not as dramatic for female drivers. This study used correlation analysis, MANOVA, and ANOVA methods.

According to [29], who researched the changes in the mortality rate of children from 1–14 years of age by correlation analysis in traffic accidents in 33 European countries. The study points to the existence of a negative correlation between mortality rate and the economic level of the country. This was complemented by [30], who referred to the positive increase of deaths in traffic accidents together with the natural growth of urbanization and population with the use of panel analysis and fixed effects model. [31], who analyzed a load of hospitalized child patients by using epidemiological characteristics, found that the most frequently hospitalized group of traffic accident victims are children aged one to three years old (predominantly males).

In this study, correlation analysis was employed to quantify the interrelation between two variables. This approach was crucial in elucidating the connection between demographic factors and accident frequency. Examples of the application of correlation analysis can be found in studies such as [29], which focused on child fatality rates in road accidents, and [28], which examined the self-assessment of young drivers.

3. DATA

Investigation of RQ1 was based on data from a public database [32], which provides statistical information on traffic accidents in the Czech Republic, including demographic factors related to traffic accidents. Specifically, data for this research question were obtained by selecting the gender (male, female) and driver group. In this way, data on the total traffic accident rate of drivers of one gender were obtained.

Subsequently, the cause of the accident was selected (driver not fully engaged in driving, speeding, failure to yield the right of way), thus obtaining data on single-sex accidents caused by one of these causes. The cause of a driver not being fully engaged in driving can be considered any activity that prevents a driver from fully concentrating on driving. Speeding is a violation of the reasonable speed rule. This rule requires the driver to adjust their speed to various factors, including their own abilities, the characteristics of the vehicle and its load, and the expected structural and traffic conditions of the road. It also considers the road's category and class, weather conditions, and other foreseeable circumstances. Failure to yield the right of way is a violation of the right of way rule. Yielding the right of way is the obligation to stop or continue driving when the driver to whom the right of way applies should not suddenly change his speed.

These factors were selected because of their variability and the potential to show different levels of correlation across demographic groups. This selection reflects how these factors relate to specific aspects of human behavior and decision-making while driving, enabling a deeper understanding of how various groups of drivers behave in different situations. The analysis was conducted using annual data from January 1, 2011, to December 31, 2023.

The same public database [32] was used to investigate RQ2 as was used for RQ1, but instead of gender, the age groups of drivers were considered. The age groups were as follows: young drivers (15–24 years), middle-aged drivers (25–64 years), and senior drivers (65+ years). Subsequently, the same causes of accidents as in RQ1 (driver not fully engaged in driving, speeding, failure to yield the right of way) were used.

4. METHODS

To investigate RQ1, a comparative analysis was carried out focusing on the differences between the total number of accidents caused by each gender and the number of accidents caused by drivers of that gender. Furthermore, Spearman and Pearson correlation analyses were performed based on the results of the Shapiro-Wilk test, where for normally distributed data, Pearson's correlation analysis was applied, whereas Spearman's correlation analysis was utilized for non-normally distributed data. These tools helped to quantify the relationship between single-sex accidents and the three selected causes.

The same approach used for RQ1 was applied to RQ2. However, the comparative and correlation analyses examined the relationships between the number of accidents in each age group and the causes of accidents caused by these age groups. The age groups were divided into three categories: young drivers (15–24 years), middle-aged drivers (25–64 years), and old drivers (65+ years). Correlation analysis helped us analyze the relationship between each age group and the selected causes of traffic accidents. The data were analyzed using RStudio analysis software.

The type of correlation analysis was determined by the confirmation or refutation of normality of the data, which was determined by the Shapiro-Wilk normality test and visually rechecked by histograms. The Shapiro-Wilk normality test confirms the normal distribution of the data when p-values are greater

than 0.05. This test compares the order of the values with the corresponding quantiles of the normal distribution. This formula is used in the Shapiro-Wilk normality test, according to [33]:

$$W = \frac{(\sum_{i=1}^{n} a_i X_{(1)})^2}{\sum_{i=1}^{n}(X_i - \bar{X})^2} \quad . \tag{1}$$

Histogram visualizations were created to visually inspect the normal distribution, showing the outlying points and the distribution of the data. This allowed for visual rechecking of normal or non-normal data distributions.

In cases of normal data distribution, Pearson's correlation analysis was applied to assess the magnitude and direction of the linear association between two variables [34]:

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad . \tag{2}$$

If a non-normal distribution was detected, Spearman's correlation analysis was used to convert the data into a sequence, and then Pearson's formula was used for these ordinal values according to [29]:

$$\rho = 1 - \frac{6\sum d_i^2}{n(n2-1)} \quad . \tag{3}$$

In the last step, a visualization of the correlation coefficients was created using the Corr plot command to make it easier to see and understand the relationships between them. At the same time, the strengths of the relationships were illustrated using heat maps. Red shades mean negative correlation, white means no relationship, and blue means positive correlation. The individual strengths are easily recognizable by the saturation of the mentioned shades.

The strengths of the correlation coefficients were classified according to the following values.

Table 1

The strength of correlation coefficients according to [34]

Relation strength	Coefficient
Trivial or none	0.01–0.09
Weak to medium	0.10–0.29
Medium to substantial	0.30–0.49
Substantial to strong	0.50–0.69
Strong to very strong	0.70–0.89
Very strong to perfect	0.90–0.99

Source: Created by the author based on [34]

5. RESULTS

The visualizations and the entire process of deriving correlation coefficients were generated in RStudio concerning the defined research inquiries.

5.1. Results for RQ1

The starting point of the correlation analysis is the Shapiro-Wilkinson test of normality.

```
> print(normality_test)
       accidents_W      Inattention_W  excessive_speed_W Failure_to_yield_W
         0.3045357          0.3702770          0.8287497          0.1069085
       accidents_M      Inattention_M  excessive_speed_M Failure_to_yield_M
         0.8040705          0.3676431          0.6861054          0.4303734
```

Fig. 1. Results of the normality test and the correlation method for RQ1. Source: Own processing based on the data from [32]

The results show that all data sets confirmed their normal distribution. Therefore, Pearson's correlation test for the normal distribution of data was chosen. This was confirmed by visually inspecting the histograms, which showed no deviations from a normal distribution.

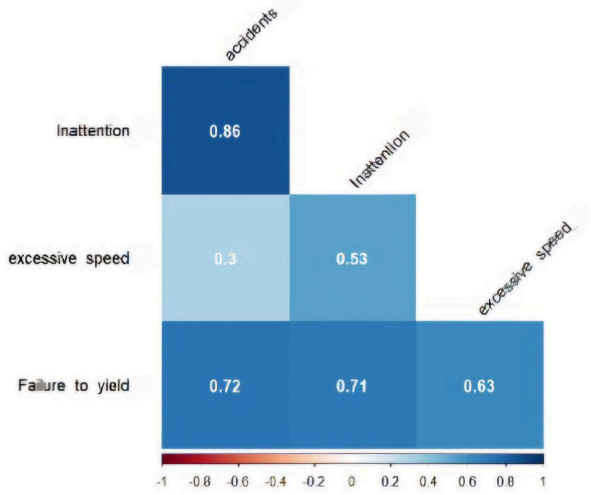

Fig. 2. Visualisation of correlation coefficients for women. Source: Own processing based on the data from [32]

The analysis indicates the relationship between the overall female accident rate and excessive speed as the cause, with the smallest relationship analyzed showing a moderate positive correlation (0.3). On the other hand, inattention is the strongest factor related to the overall female accident rate, with a strong positive correlation (0.86).

Subsequently, a visualization of the male correlation coefficients was created to compare the factors of road traffic accidents between the sexes.

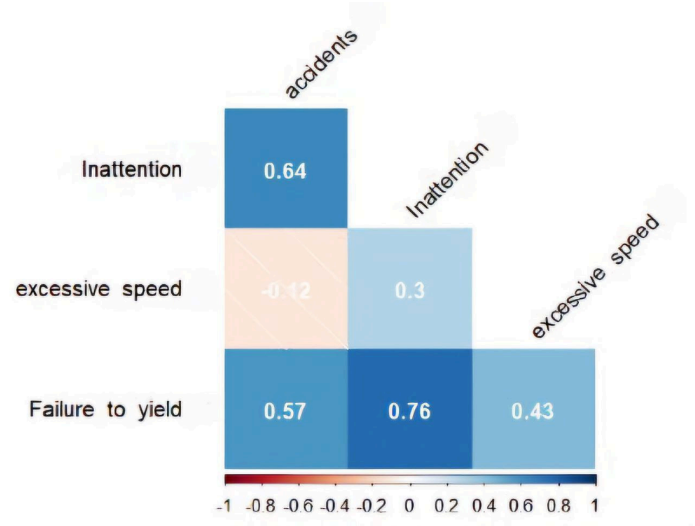

Fig. 3. Visualization of correlation coefficients for males. Source: Own processing based on the data from [32]

In the case of males, a very slight negative correlation coefficient between the total accident rate and excessive speed (-0.12) can be observed. This suggests that the total accident rate for males is negatively related to accidents caused by speeding. Inattention (0.64) has the largest effect on the total accident rate for males. For the correlation coefficients of females, we can observe a slight decrease in the influence for all values.

5.2. Results for RQ2

Since the same code with only minor changes, was used for RQ1 and RQ2, the same visual image from the case of RQ1 was used in the case of RQ2.

The Shapiro-Wilk normality test, which was employed to confirm or refute the normal distribution of data, was done as in the case of RQ1.

```
> print(normality_test)
      accidents_15_24      Inattention_15_24  excessive_speed_15_24 Failure_to_yield_15_24
            0.85305874            0.04758039            0.77216369            0.07675111
      accidents_25_64      Inattention_25_64  excessive_speed_25_64 Failure_to_yield_25_64
            0.78405585            0.57103089            0.62811217            0.38558473
         accidents_65         Inattention_65     excessive_speed_65    Failure_to_yield_65
            0.08868099            0.48937258            0.38682864            0.16941185
```

Fig. 4. The result of the normality test for the RQ2, Source: Own processing based on the data from [32]

Based on the p-value, we determined a non-normal distribution of the data, although 11 of the 12 data sets demonstrated normality of the data (p-values were greater than the 0.05 significance level). In the case of inattention in the young drivers' data set, the non-normal distribution of the data was demonstrated (p-value = 0.048). Due to this, Spearman's correlation analysis for a non-normal distribution of the data was used.

The results of the Shapiro-Wilk test were then visually rechecked using histograms to find further discrepancies in the speeding datasets for all age groups. Because of this finding and the results of the Shapiro-Wilk test, Spearman's correlation analysis was used to investigate RQ2.

Furthermore, correlation coefficients were calculated, and visualizations were created for each age group of drivers.

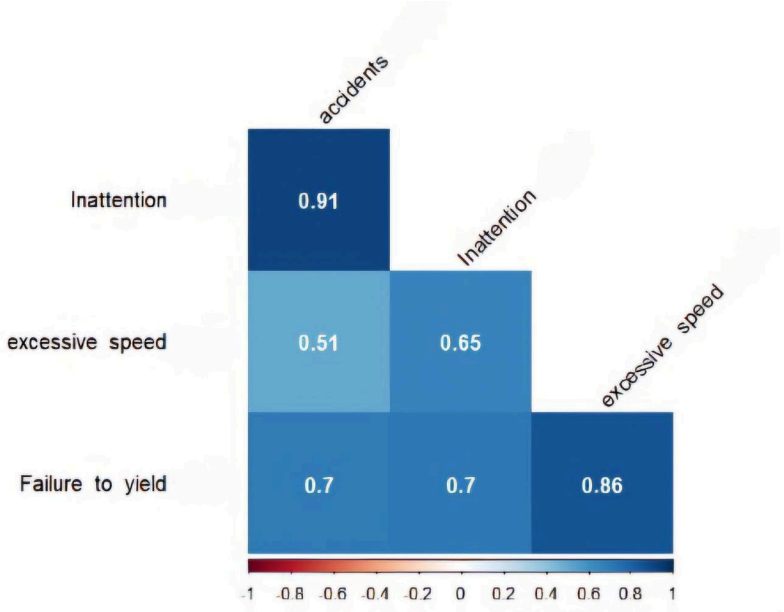

Fig. 5. The visualization of correlation coefficients for young drivers. Source: Own processing based on the data from [32]

In the visualization for the age group of young drivers, we can observe a positive correlation between the total number of accidents and the three selected causes of accidents. Inattention showed the strongest correlation (0.91), making it the cause with the greatest influence on the accident rate of young drivers.

The next visualization of the correlation coefficients shows the correlation coefficients for middle-aged drivers (aged 25–64).

In the visualization of the correlation coefficients for the middle-aged driver group, the correlations are significantly weaker than for the young driver group. When the strongest correlation is in the case of attention (0.6), making it the strongest cause affecting the accident rate of the middle-aged driver group. A correlation coefficient close to zero (-0.05) was found between the total number of accidents and excessive carelessness in middle-aged drivers. This suggests a lack of relationship between these phenomena.

The third visualization shows the correlation coefficients of old drivers aged 65+.

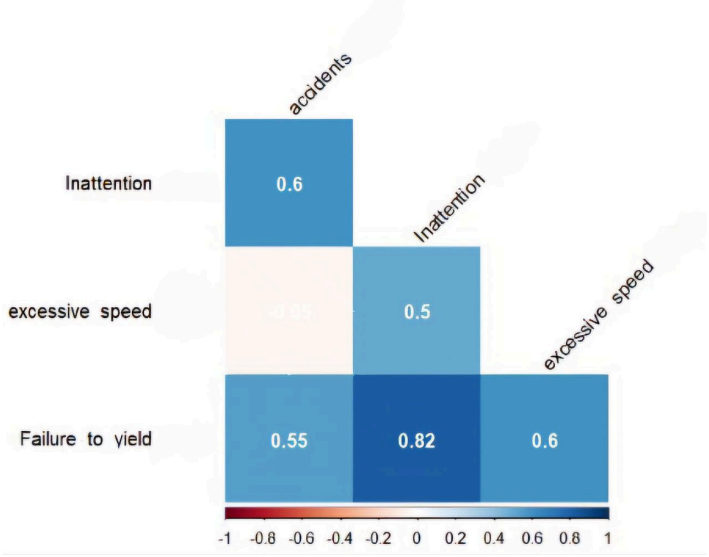

Fig. 6. The visualization of correlation coefficients for middle-aged drivers. Source: Own processing based on the data from [32]

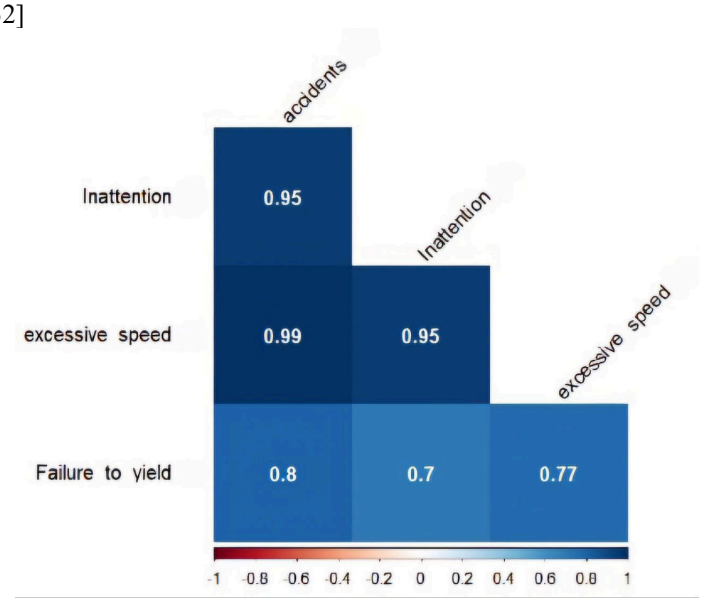

Fig. 7. The visualization of correlation coefficients for the groups of old drivers. Source: Own based on the data from [32]

The strongest correlations of all driver age groups can be observed in this visualization for old drivers. The strongest correlation (0.99) is between accident rate and excessive speed. This visualization highlights that all causes of accidents are strong factors influencing the overall accident rate of old drivers.

6. DISCUSSION

RQ1: Was there a significant relationship between the cause of traffic accidents and gender in the Czech Republic from 2011 to 2023?

An analysis of the correlation between the total number of road accidents by gender and the number of accidents caused by specific factors in the Czech Republic (2011–2023) reveals a clear pattern. Inattention emerged as the most common cause of traffic accidents across all demographic groups. However, the analysis also showed a stronger correlation between the overall accident rate and inattention-related accidents for women (0.86) compared to men (0.638). This suggests that inattention is a more critical factor in road accidents in women, which is consistent with [13], which found that higher emotional intelligence, which is more prevalent in women, negatively affects concentration while driving. At the same time, men show a weaker but still significant correlation between overall accident rates and inattention, suggesting that although both sexes experience accidents caused by inattention, its impact is more pronounced in women.

A medium-strong positive correlation (0.302) was found between total female accident rates and accidents caused by speeding, indicating that speeding is not the most significant factor in female accidents. For males, the correlation between the total accident rate and speeding accidents showed a small negative value (-0.121), which suggests a slight decrease in speed-related accidents with an increase in the total number of accidents for males. This indicates that speeding may play a less significant role in female crash rates, which is contrary to previous research such as [23], which reported that the proportion of males injured in traffic crashes is higher than that of females. This discrepancy may be related to differences in driving style, as men may exhibit riskier behavior behind the wheel, leading to fewer but more serious accidents.

The correlation between the total number of accidents for women and accidents caused by failure to yield the right of way showed a strong positive correlation (0.720), suggesting the importance of this factor for women. For males, the correlation between the total number of accidents and accidents caused by failure to yield the right of way was also significant (0.574), confirming the importance of this cause for males. This suggests that while both sexes are exposed to an increase in accidents caused by failure to yield the right of way as the total number of accidents increases, this trend is weaker for males. This is consistent with the finding reported by [28] that women tend to rate their safety skills higher than their driving skills, which can lead to cautious but sometimes incorrect driving. Further, [34] reported that women are less likely to take defensive driving courses, which could contribute to their higher correlation with accidents caused by failure to yield the right of way.

For men, all three factors—inattention, failure to give way, and speeding—are also significant, but their impact is less pronounced than for women. The correlation coefficients of these factors are lower for men, suggesting that each factor is less important in the overall number of accidents. This means that even though men face similar risks, their driving behavior and error patterns differ. For example, inattention may be a less common cause for men, but it remains significant. The significance of failure to yield the right of way and speeding is more balanced for men compared to women.

This finding is contrary to research by [23], which shows that the proportion of men who are injured in road accidents is higher than for women, which suggests that men cause fewer accidents, but the consequences tend to be more severe.

RQ2: Was there a significant relationship between the cause of traffic accidents and drivers' age groups in the Czech Republic from 2011 to 2023?

For drivers aged 15–24, inattention appears to be a very significant cause of road accidents. The correlation between the overall accident rate of this age group and accidents caused by inattention is very strong (0.912). This suggests that inattention is a major factor resulting in accidents involving young drivers. Excessive speed is also an important cause and has a significant positive correlation (0.698), suggesting that this area needs to be targeted to improve the safety of young drivers. These findings are also supported by [14], who pointed out that inattention or failure to yield the right of way is a strong factor in young driver crashes. These results may be higher than in the middle-aged driver group due to the lack of driving experience among young drivers. This lack of experience can lead to an

increased number of road accidents, as shown in the work of [36], who identified male drivers aged 21–30 as the most likely to be involved in a road accident.

For drivers aged 25–64, inattention is also a significant factor with a moderate positive correlation (0.599), but this is considerably lower than for young drivers, although inattention is the strongest factor for the middle-aged group. Interestingly, excessive speed shows no significant effect on the overall accident rate of middle-aged drivers (ages 25–64), as indicated by a trivial correlation (-0.049). This finding is consistent with studies [5, 10], which identify driver experience as a factor that reduces the likelihood of traffic accidents. On the other hand, failure to yield the right of way remains an important factor, with a positive correlation (0.549). According to the results, it is possible to define the group of middle-aged drivers as the least susceptible to these three causes of traffic accidents. Drivers in this group are very experienced and suffer from few health problems that would affect their riskiness on the roads.

For drivers over 65 years of age, inattention is the most significant cause of accidents, with a very strong positive correlation (0.945). For this age group, there is also a very strong correlation between the overall accident rate for this group and accidents caused by speeding (0.989), suggesting that speeding is a significant risk factor for older drivers. Failure to yield the right of way is also an important factor with a strong positive correlation (0.802), confirming that it is important to emphasize compliance with the rules of the road for older drivers. The higher correlations for the groups of older drivers are also confirmed by [14], [9], and [5], which mention aspects such as inattention, failure to yield, and failure to adapt speed to traffic conditions. From these results, it can be concluded that the old driver group is very susceptible to all three of the above causes of traffic accidents. This may be due to slower reflexes or health problems that naturally occur in the elderly.

It can be concluded that inattention is a major cause of accidents across all age groups and that it has the strongest impact on the youngest and oldest drivers. Speeding is also a significant cause of accidents, particularly for older drivers, while it has a minimal effect on the middle-aged group. Failure to give way is a significant cause of accidents in all age groups, and it has the greatest impact on young and older drivers.

7. CONCLUSIONS

The aim of the study was to analyze the influence of age and gender as demographic factors on the causes of traffic accidents in the Czech Republic between 2011 and 2023.

The correlation analysis shows that for the demographic factor gender, the total number of traffic accidents caused by men has a lower relationship with the three selected causes of traffic accidents. For female traffic accidents, the same order of strength of influence was observed. Inattention was the strongest positive relationship for both genders, failure to yield the right of way showed a strong positive relationship for males and a substantial one for females, while speeding had a moderate-to-strong relationship for females and a weak negative relationship for males.

The results were more mixed for the demographic factor of age. For crashes involving older drivers, a strong or very strong positive correlation was found with all examined causes. This indicates that older drivers are the most susceptible to the three types of accidents studied. In contrast, middle-aged drivers exhibited lower correlation levels with accident causes than both younger and older drivers, suggesting a relatively lower risk in this group. A significant positive correlation with inattention was observed, but it was the weakest among the three age groups. For speeding, a trivial correlation was found, indicating no meaningful relationship between the number of accidents caused by middle-aged drivers and this particular factor.

A significant correlation was also noted between failure to yield the right of way and accidents involving middle-aged drivers, although it was less pronounced than the correlation with inattention. For young drivers, a very strong positive correlation with inattention was observed, making it the most influential factor in their accident rates. A very strong correlation was also found in the case of failure to yield, and a significant positive correlation was identified for speeding. Although these correlations

were lower than those for older drivers, they remained relatively high. This may be due to young drivers' limited experience, which they have not yet had time to develop.

8. LIMITATIONS

Despite the sophisticated analysis, it is important to be aware of several limitations that may affect the interpretation of the results.

First, the study relied on official data on traffic accidents obtained from police records in the Czech Republic between 2011 and 2023. While these records provide valuable insights, they may not capture all accidents, especially minor accidents that were not reported to the state authorities. This could introduce some bias into the dataset that would affect the accuracy of the observed correlations.

Second, the study used correlation analysis to examine the relationships between demographic factors, driver age, and crash causes. However, correlation does not imply causation. Although significant relationships were found between the variables, it remains unclear whether demographic factors directly cause differences in crash rates or whether other factors, such as driver behavior, road conditions, or environmental influences, contribute. Future studies could use more robust statistical methods, such as regression modeling or structural equation modeling, to further explore causal relationships.

Third, the analysis was geographically limited to the Czech Republic, making it difficult to generalize the findings to other regions or countries. Traffic laws, infrastructure, driver training programs, and cultural attitudes to driving vary from country to country, which may have different effects on accident rates. While some results are consistent with international research, this needs to be taken into account when applying these findings to a wider context.

A further limitation arises from the distribution of drivers into broad age groups (15–24, 25–64, and 65+). While these categories provide a general overview of trends, they do not account for more subtle age differences that may reveal more subtle patterns. For example, the risk factors for drivers aged 18 may differ significantly from those for drivers aged 20, just as the behavior of drivers aged 65 may not match that of drivers aged 80. Future research could refine these classifications to improve the accuracy of demographic analyses.

In addition, the study did not account for psychological or socioeconomic variables that may influence crash risk. Factors such as stress, fatigue, income level, education, and driving frequency could play a role in driver behavior and the likelihood of a crash. While demographic factors provide a useful framework for understanding crash trends, incorporating psychological and socioeconomic considerations could increase the predictive power.

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