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Analysis of Perceptions of Cycling Safety on Roads with Mixed Traffic Depending on Age, Gender, and Riding Experience

Mevlan Bixhaku [1], Gëzim Hoxha [2*], Ramadan Duraku [2]

[1] Akademia Tempulli, Prishtine 10 000, Kosovo.

[2] Department of Traffic and Transport, University of Pristina "Hasan Prishtina", 10000 Prishtina, Kosovo.

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Abstract

Promoting cycling as a sustainable mode of transport necessitates understanding how individuals perceive the risks associated with bicycling based on age, gender, and riding experience. This study addresses a critical gap in the field of traffic by examining cyclists' perceptions of risk and safety on mixed-traffic roads. Despite increased interest in promoting cycling as a sustainable means of transportation, research on this topic is rare. Therefore, this study aims to contribute to existing literature on cyclist perceptions and cycling safety on roads with mixed traffic by examining the significant differences that may exist among age groups, genders, and individuals with varying riding experiences. The research focuses on roads lacking distinct bicycle paths and characterized by heterogeneous traffic streams. The study surveyed 120 cyclists on 13 roads in Pristina, the capital of Kosovo. Safety perception, measured using a Likert scale (1–5), was the dependent variable. Non-parametric methods, specifically the Mann-Whitney and Kruskal-Wallis tests, were employed to analyze the data and test the hypotheses. The results revealed statistically significant differences between genders (Mann-Whitney test: $U = 720$; $Z = -5.887$, $p = 0.000 < 0.05$; $r = -0.537$), between groups with and without riding experience (Mann-Whitney test: $U = 1240.5$; $Z = -2.59$; $p = 0.01$; $r = -0.236$), and among age groups (Kruskal Wallis test: $df = 4$; $p = 0.022 < 0.05$). With Bonferroni correction, post hoc analysis using the Mann-Whitney test demonstrated significant differences (adjusted $p < 0.0125$) between at least two age groups. The median perception of general safety was at Likert scale 3 (average safety), while the perception of comfort was at level 2 (uncomfortable). These findings provide valuable insights for policymakers involved in urban planning, offering targeted strategies to enhance cycling safety based on age, gender, and riding experience. The findings highlight the complicated interaction of these elements and their impact on riders' safety perceptions. By understanding these dynamics, policymakers and urban planners may build targeted interventions and infrastructure upgrades to promote safer and more inclusive riding environments. This work adds to the field by shining light on the elements that influence cyclists' risk perception, eventually guiding methods for improving cycling safety and boosting the use of bicycles as a sustainable transportation choice.

Keywords: Cyclists' Safety; Bicycle; Age; Gender; Experience; Mann-Whitney Test; Kruskal-Wallis Test.

1. Introduction

The use of bicycles is increasingly considered a clean and sustainable mode of transport with multiple benefits, such as those in health, ecology, and economy; however, using bicycles daily still needs improvement. Compared to European countries and those in the region, the use of bicycles as a form of transport in Pristina has yet to be addressed appropriately. The low level of bicycle use is also associated with the poor urban planning that Pristina has been facing

* Corresponding author: gezim.hoxha@uni-pr.edu

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over the last two decades. During this period, road infrastructure planning and construction have been mainly focused on accommodating motor vehicles without considering the need for and demands of active movement.

Based on recent data*, only around 1% of daily transport is conducted by bicycle in the city of Pristina. Based on online surveys, in which 1579 respondents participated, 1.25% of respondents stated that they use the bicycle as the main transport mode in Pristina. On household surveys regarding bicycle traffic safety, about 39.1% of respondents consider that bicycle riding on the streets of Pristina is dangerous. Moreover, about 53.6% of respondents stated that they would use the bicycle as a transport mode if the cyclist-oriented infrastructure and cyclist safety improved. Besides infrastructure, the way people perceive the risks of riding a bicycle also depends on demographic factors and their prior experience with cycling. One study found that people's attitudes towards cycling become more positive and their perception of external obstacles changes as they gain more experience with riding a bicycle. This suggests that by encouraging more people to use bicycles for transportation, even those who are currently hesitant about it may develop more positive attitudes towards cycling [1].

In a similar study, Ducheyne et al. [2] also found that there were differences in how experienced and non-experienced riders perceived risks. They emphasized the importance of understanding these variations in attitudes and perceptions in different populations and contexts so that interventions can be designed to encourage cycling [3]. The literature in the transport field suggests that gender influences how people perceive and choose their transportation methods. Women specifically consider safety and accessibility when deciding how to travel [4]. Understanding the factors that discourage women from cycling is crucial to promoting gender parity in cycling. Additionally, studies by Stinson et al. reveal that travel time plays a significant role in transportation choices [5]. Environmental factors such as a lack of infrastructure for cyclists and pedestrians, as well as heavy traffic, can deter people from engaging in active forms of transportation, regardless of age [6, 7].

In terms of safety, cyclists have a significantly higher level of comfort and security when riding on dedicated cycling tracks, as opposed to roads with a mix of different types of vehicles. This was demonstrated in a study conducted in Copenhagen, where nearly half of the participants felt "very safe" when using cycling paths, compared to a lower percentage on cycle tracks and an even lower percentage on roads with mixed traffic. This emphasizes the importance of providing cyclist-friendly infrastructure and prioritizing cyclist safety, such as implementing dedicated cycling paths or tracks, in order to encourage more people to choose bicycles as their mode of transportation [8]. Krizek et al. (2017) conducted a study on the impact of interruptions in cycle tracks on road safety. They found that intersections that end on the left side of the road, longer crossing distances, parking at the end of cycle tracks, and wider right curb lanes all contribute to increased safety for cyclists [9]. Rivera Olsson & Elldér [10] have investigated in their research how the design of the micro-environment of bicycle streets can improve cyclists' perceived safety in mixed traffic. According to their recommendations, bicycle-friendly streets should be planned with a microenvironment that clearly denotes the place of the bicycle on the road. This is essential for increasing people's perceptions of cyclists' safety, which is essential for the bicycle street's success in promoting cycling. Importantly, a micro-environment that is properly planned to increase cyclists' subjective sense of safety may also help close gaps across different bicycle demographics, making urban transportation more equitable [10].

Pyrialakou et al. [11] explore the perceptions of the general public in terms of their potential roles as conventional vehicle drivers, bicyclists, and pedestrians. Based on their research, the least safe activities were considered to be walking, driving, and cycling close to an autonomous vehicle. The elements linked to the perceived safety of various travel options showed both similarities and variances [11]. According to numerous studies, female riders are viewed as being more risky than male cyclists [12, 13]. Like so many other aspects of culture, bike infrastructure and safety views are gendered [10]. Women generally felt less secure than men in a number of microenvironments. According to earlier studies [12, 13], this is accurate. The fact that this does not apply to all microenvironments is a significant discovery. We observe no gender disparities in several micro-environments with less traffic and in all environments with obvious road markings for bicycles. This demonstrates how initiatives to enhance the bicycle infrastructure's microenvironment can help create a more gender-equal transportation system [10, 12–14].

Graystone et al. [15] come to the conclusion that safety perceptions are probably a result of societal norms, expectations, and traditions associated with a cyclist's gender expression by drawing on feminist theories of performativity and embodiment [15]. Cubells et al. [16] provided a framework to recognize the movement behavior of cyclists and electric scooters and the involvement of identity axes using objective location data. Their findings highlight the need to approach individual characteristics in an intersectional way when designing policies that aim to regulate micromobility and create inclusive urban environments [16].

1.1. Objective and Hypotheses

This paperwork is part of a more comprehensive study focusing on the perception of cyclists' risk and safety, which includes more influencing factors. Consequently, there will be a tendency to treat the search problem wider and deeper.

* Institute for Science and Technology "INSI", June 2020.

Due to the nature of the publication, for this paperwork, the treatment will be partial with a primary objective—testing the differences in the perception of danger and sense of safety, respectively, while riding the bicycle between people of differing genders, ages, and experience levels. Consequently, we will test three hypotheses:

Hypothesis 1. There are statistically significant differences in the perception of risk and the sense of safety, respectively, when riding a bicycle between men and women.

Hypothesis 2. Age statistically significantly impacts the perception of risk and safety when riding a bicycle.

Hypothesis 3. Experience has a statistically significant impact on the perception of risk and the sense of safety, when riding a bicycle.

The findings from this study will be of interest for promoting the movement of cyclists on the road as an ecological and sustainable form of transport. This paperwork can also help urban planners consider the need for creating cyclist-oriented infrastructure and improving safety conditions so as to accommodate cyclists in the urban road network.

2. Methods and Procedure

2.1. Statistical Methods

In order to obtain accurate and reliable results, we will use quantitative methods and collect data through observations and surveys. To test our hypotheses about variable interest, we need to understand the level of safety and risk involved. We will measure this using a Likert scale with five categories. Since the data we collect will be ordinal in nature and not normally distributed, we will use non-parametric methods to analyze the results [14, 17–19], which do not require the assumption of a normal distribution of the variable—also called distribution-free methods [14]. Depending on the nature of the data, as we will see in the data section, independent variables are either binary (gender and experience) or continuous (age); adequate statistical methods will also be used. In the case of having the ordinate dependent variable and the independent nominal variables with two categories (binary), the Mann-Whitney test is applied to test the difference in perception between the two groups, the non-parametric equivalent of the independent t-test. Likewise, in the case of age, the variable can be used as a constant variable and can be grouped.

Given that in the case of using this variable as a continuous one, we can only apply Sperman's correlation, which shows us the conection's strength state. The data grouping enables us to test the difference between the age groups and analyse their perceptions. The most appropriate test for this case is Kruskal-Wallis, which enables the testing of differences between several independent groups. This is the non-parametric equivalent of a one-way independent ANOVA.

If the Kruskal-Wallis test shows a statistically significant result, it indicates that there is a difference between at least two of the groups being compared. To determine which specific groups are different, we need to conduct follow-up tests. One common option is to use Mann-Whitney tests, which compare pairs of groups. However, we need to be cautious when conducting multiple tests, as this can increase the likelihood of making false discoveries [17]. To ensure that the probability of making a Type-I error is below 5% ($p < 0.05$), it is recommended to make adjustments to the p-values. One common method is to use the Bonferroni correction, which involves dividing the critical value for significance (usually 0.05) by the number of tests conducted. This adjustment helps maintain the desired level of significance for each individual test [17].

We will use the SPSS software to analyze the results, and we will interpret the findings using the explanations given by Field (2013) [18]. In both tests, it is important to interpret three statistical indicators. Initially, we have to deal with interpretations of the mean rank score for each group—males and females. Since the Mann-Whitney test relies on scores being ranked from lowest to highest, the group with the lowest mean rank is the group with the greatest number of lower scores in it, while the group with the highest mean rank has the greater number of high scores within it. The Kruskal-Wallis test has the same interpretation.

The p-value is a statistical measure that indicates whether the observed difference between groups is statistically significant. In this analysis, a significance level of 5% is used, meaning that a p-value less than 0.05 suggests a significant difference. The p-value is calculated based on various coefficients, such as U, W, Z, or H, depending on the specific test being conducted. These coefficients are used to determine the probability of obtaining a test statistic as extreme as the one observed, assuming that there is no true difference between the groups. The p-value is compared to the predetermined significance level to evaluate the statistical importance of the observed difference. The degrees of freedom, which indicate the number of independent variables in the analysis, are calculated based on the number of groups being compared [18]. The third indicator is the effect size statistic (r), which indicates whether the observed difference between the groups is significantly small, moderate, or large. According to Cohen's criterion [10], the effect size when the absolute value of r is below 0.3 is small; values between 0.3 and 0.5 are considered moderate; and values above 0.5 represent a large effect. The effect size is computed by dividing the z-score (z) by the square root of the total observations (N) [11]:

$$r = \frac{Z}{\sqrt{N}} \tag{1}$$

Field (2013) [18] suggests (r) should be applied in the Mann-Whitney test, since in the Kruskal–Wallis test, the generalisation effect is more pronounced, and therefore it has been rarely used as an indicator.

2.2. Data Collection and Methodological Approach

Data for this study were collected in the capital of Kosovo, Pristina, between April 15, 2021, and May 18, 2021. The city of Pristina has about 200,000 inhabitants, while the district in total reaches up to around 500,000 inhabitants [20]. The 202 cyclists were surveyed throughout the survey, and only 120 respondents were on the selected roads for this study. In order to include both genders in the research, approximately 52% male and 48% female respondents have been selected. Also, respondents from 17 to 70 years old were selected to include all agents in the research. Due to age and real-life assessment, respondents under age 17 have yet to be considered.

The data collection process followed a structured questionnaire that was tested and revised before implementation. The study considered the limitations of relying solely on mixed-traffic roads and suggested the inclusion of more varied road types in future research for improved external validity. The study followed a well-designed quantitative research approach, collecting data through structured surveys on selected roads. The data were analyzed using appropriate statistical methods, considering the non-parametric nature of the variables. The study employed a quantitative research design to investigate cyclists' perceptions of risk and safety on mixed-traffic roads. The research design aimed to gather empirical data using a Likert-scale assessment to measure variations in risk perception.

The methodological steps for data collection and hypothesis testing are shown in the following algorithm (Figure 1):

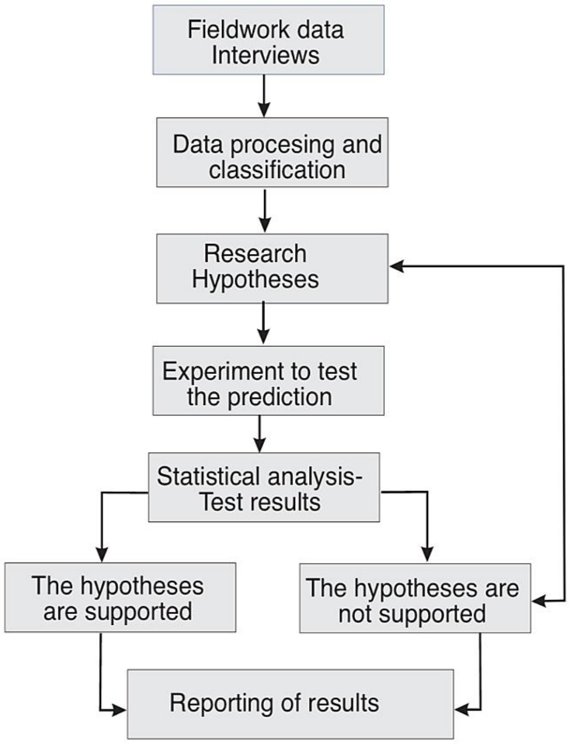

Figure 1. Methodological approach

2.2.1. Roads and Traffic Characteristics

As noted above, the data are from broader research involving 26 streets in Pristina with various characteristics. In order to test the hypothesis, 13 roads of mixed traffic in the Pristina city network with approximately the same characteristics and traffic were selected for this paper. This selection is made so that the factors that influence cyclists' risk perception are approximately the same. The roads on which the research was conducted have a width of 7.0m (3.5m for each strip). On these roads, traffic flows in two directions without physical separation, and due to the lack of cycling paths, cyclists use the road together with vehicles. Vehicle traffic was from 400 to 600 cars per hour.

In order to evaluate, as realistically as possible, the perception of cyclists' safety on the road, the observation was carried out through direct surveys on the road ("face to face" survey). Checkpoints were placed at the end of each road. Respondents indicated risk perception o in 13 road segments with mixed traffic during rush hour (Figure 2).

Figure 2. The road segments in which the research was done

The data analysis employed appropriate statistical methods to determine the results. Given the nature of the data, which involved ordinal variables and non-parametric assumptions, non-parametric tests were applied. The Mann-Whitney test was used to compare differences in risk perception between groups, such as gender and experience. The Kruskal-Wallis test was employed to analyze differences in risk perception among age groups. Post hoc tests, specifically Mann-Whitney tests with Bonferroni correction, were conducted to identify significant differences between specific age group comparisons. Statistical Package for the Social Sciences (SPSS) software was utilized for data processing and analysis. Descriptive statistics, such as mean ranks and percentages, were calculated to summarize the data. The p-value, significance level, and effect size statistic (r) were interpreted to determine the findings' statistical significance and practical significance. For the purpose of this study, the impact of road and traffic infrastructure parameters has been analyzed (Table 1).

Table 1. Road and traffic infrastructure parameters

Traffic characteristics	Vehicles volume (veh/h) Vehicle speed Heavy Vehicle volume
Road characteristics	Roadway width The presence of on–street parking Pavement width available for bicycling

Final factors deemed significant to the safety of cyclists on roads with mixed traffic include vehicle volume (veh/h), vehicle speed, heavy vehicle volume, roadway width, the presence of on-street parking, and pavement width available for bicycling.

2.2.2. Demographic Questionnaires

The questionnaires were compiled to obtain the respondents' assessments of the key factors affecting their traffic safety. Within the questionnaires, apart from the data on age and gender, questions were asked in such a way as to assess the participants' driving experience [21]. In the first part of the questionnaire, demographic data on age and gender were obtained. Gender data were collected individually, ungrouped, so that later during the results' processing they could be used as needed, either as such or grouped. Then, data on the riding experience was obtained. Ultimately, all were randomly selected using a Likert scale of 1–5. Initially, the questionnaire was tested in 15 cases, and after its revision, data collection started.

2.2.3. The Assessment of Respondents' Experience

Previous research has shown that cyclists can regard themselves as experienced riders even though they may not be at that level [22, 23]. For this reason, to assess the drivers' experience, some questions were inserted in the questionnaires to assess their approximate riding experience. As part of the questionnaire, some questions were added about the number of days spent cycling within a month (How many times do you ride a bicycle within a month?) and within a week (How many times do you ride a bicycle within a week?) and the kilometers covered in a week on the bicycle (How many kilometers do you ride in a week?). In the end, respondents were asked about their experiences on the streets of Pristina (Do you consider that you have enough experience for riding a bicycle in Pristina?). For respondents who claimed to have riding experience, their responses are analyzed based on how often they ride a bicycle within a week and how many kilometers they cover. Respondents who claimed to ride bicycles more than twice a week and cover more than 20 km per week are considered to have riding experience. According to this method, based on previous research [22], out of the three methods used for this purpose, it is the most widespread for assessing bicycle riding experience; 74 respondents out of 120 were considered to be experienced in riding, while 46 did not have sufficient experience.

3. Results and Interpretation

In this session, we initially present the results related to safety perception during bicycle riding. Then descriptive statistics will be presented regarding perceptions based on age, gender, and experience. In the end, the results of the Mann-Whitney and Kruskal-Wallis tests will also be presented.

3.1. Descriptive Statistics

Table 2 shows that the third rate labeled as the average is the median rate, while the mode is in the second degree, respectively uncomfortable. Whereas, depending on their age, gender, and experience, a change in risk perception is evidenced. According to the assessment from the Likert scale (1–5), 54.84% of the respondents aged 17–20 said they felt comfortable riding bicycles on the road. On the other hand, 40.82% of the respondents aged 21–30 years have not felt comfortable, while respondents aged 31–40 have equally rated 27.78% comfortable and moderately comfortable perceptions while riding a bicycle on the road. As age increases, the risk perception also increases, so 38.46% of the respondents aged 41–50 are more likely to feel uncomfortable. Moreover, 62% of respondents aged 51–60 rated riding as moderately comfortable.

Table 2. Population demographic characteristics (N=120)

Characteristics		Very uncomfortable -1		Uncomfortable -2		Moderate Comfortable -3		Comfortable - 4		Very comfortable -5		Total		Median	Mode
		Fi	%	Fi	%	Fi	%	Fi	%	Fi	%	Fi	%		
Overall perception of safety		14	11.7	38	31.7	31	25.8	35	29.2	2	1.7	120	100	3	2
Age	Up to 20 years	3	9.68	6	19.35	3	9.68	17	54.84	2	6.45	31	26.1	4	4
	Age 21-30 years	4	8.16	20	40.82	15	30.61	10	20.41	0	0.00	49	41.2	3	2
	Age 31-40 years	4	22.22	4	22.22	5	27.78	5	27.78	0	0.00	18	15.1	3	3;4
	Age 41-50 years	3	23.08	5	38.46	3	23.08	2	15.38	0	0.00	13	10.9	2	2
	Age 51-60 years	0	0.00	3	37.50	5	62.50	0	0.00	0	0.00	8	6.7	3	3
Gender	Female	14	24.1	26	44.8	11	19.0	7	12.1	0	0.00	58	48.3	2	2
	Male	0	0.00	12	19.4	20	32.3	28	45.2	2	3.2	62	51.7	3	4
Experience	Yes	8	10.8	16	21.6	22	29.7	27	36.5	1	1.4	74	61.7	3	4
	No	6	13.0	22	47.8	9	19.6	8	17.4	1	2.2	46	38.3	2	2

The greatest change in risk perception is observed by gender. Men rated riding as comfortable more often, with about 42.5%. Meanwhile, only 12.1% of women said they felt comfortable riding a bicycle. On the other hand, 44.8% of women said they felt uncomfortable while riding a bicycle, while only 19.4% of men felt uncomfortable riding a bicycle.

Changes in risk perception are also noted based on the experience of bicycle riding. Respondents with more experience in riding have rated it as comfortable, 36.5% of them, while only 17.4% of inexperienced cyclists have appreciated riding the bike as comfortable. On the other hand, 47.8% of non-driving cyclists said they felt uncomfortable while riding a bicycle, while 21.6% of experienced cyclists did not feel comfortable riding a bicycle.

3.2. Results of the Mann-Whitney Test

Data processing for tests on the differences between the groups regarding gender and experience is done through SPSS. The Mann-Whitney test is performed independently in both cases, and the results are presented in Tables 3 and 4. Also, by using the data from SPSS output, the effect size is manually calculated.

Table 3. Ranks

Overall Perception		N	Mean Rank	Sum of Ranks
Cyclist gender	Male	62	77.89	4829.00
	Female	58	41.91	2431.00
Bicycle riding experience	Yes	74	66.74	4938.50
	No	46	50.47	2321.50

Table 4. Mann Whitney Test for gender and experience

Risk perception	Mann-Whitney Statistics (N = 120)			
	U	Z	R	Sig. (2-tailed)
Gender	720.00	-5.887	-0.537	0.000
Experience	1240.50	-2.590	-0.236	0.010

As seen in Table 3, the rank average is much higher for men (77.89) than for women (41.91), which shows that men had a higher perception of safety and felt safer riding bicycles than women. Likewise, this difference in rank average is statistically significant as the Mann-Whitney test has these indicators U=720; Z=-5.887, p = 0.000 <0.05; r=-0.537 (Table 4). Also, the p-value shows that safety level P < 0.01 (or credibility level 99%)—the difference in safety perception between the two genders—is statistically significant, which offers a high assurance of the difference between the two groups, women and men. While using the coefficient of the effect size (r=0.53 7>0.5), we can observe that the difference in perception between the two genders is quite big.

Regarding the experience of the cyclists (respondents) and its effect on perceptions of riding safety, in Table 3, there are differences in average ranks, with experienced bikers having an average rank (66.74) higher than those without experience (50.47). This average margin appears to be statistically significant according to the Mann-Whitney test, which has these indicators U = 1240,5; Z = -2,59; p = 0.01; r = -0.236. The test indicators show that statistical significance is very high and is located at the safety margin of 0.01. So, we can conclude with a confidence level of 99% that there is a significant difference between the two groups in the perception of safety when riding a bicycle. Unlike the gender test, according to the effect size indicator (r = -0.236 < 0.3), this difference is not great.

3.3. Results of the Kruskal–Wallis Test

As presented in the Statistical Methods section, since the variable of the age of cyclists is grouped into classes, to test whether there is a difference between age groups, the Kruskal-Wallis test is applied, which is also based on the difference between the average of the ranks. As shown in Table 5, the average rank that differs from others belongs to the group up to 20 years old (76.55), which includes young people aged 18–20 years. Other age groups have an average equal score besides the age group 41–50, which has a range average of 10 smaller than the other three age groups.

Table 5. Mean Ranks of age-groups (N120)

Overall Perception	Cyclist age	N	Mean Rank
Cyclist gender	Age 17-20 years	31	76.55
	Age 21-30 years	49	55.61
	Age 31-40 years	19	55.92
	Age 41-50 years	13	45.77
	Age 51-60 years	8	55.06
	Total	120	

The differences in range averages are statistically significant according to the Kruskal-Wallis test, which is presented in Table 6, where we see that with four degrees of freedom (df = k-1), the value is p = 0.022 <0.05. This shows that, at a confidence level of 95%, we are sure there is a significant change between group ages regarding safety perceptions when riding a bicycle.

Table 6. Kruskal Wallis test for the difference of group ages

Test Statistics [a, b]	
	Overall Perception
Chi-Square	11.413
df	4
Asymp. Sig.	0.022

[a] Kruskal Wallis Test; [b] Grouping Variable: Cyclist age

However, this test tells us only that a difference exists; it does not tell us exactly where the differences lie, so we have to move forward by doing post hoc or ‘follow-up pairs’ tests.

3.3.1. Post Hoc of Kruskal-Wallis Test – Comparisons between Groups

To identify significant differences between groups, we will use boxplots to visually compare the groups. This method allows us to easily see which groups have the greatest differences. Comparing each group to every other group using statistical tests may lead to exaggerated p-values, increasing the chances of a Type II error. By using boxplots, we can avoid this issue and still identify significant differences between groups [17]. Looking carefully at Figure 3 and also looking at the average ranks among groups (Table 4), we will get the first age group, 'Age 17–20 years', and we'll compare it with other age groups, where we will have four comparisons in total. According to the Bonferroni correction, the adjusted p-value will have the significance limit $p < 0.05 / 4 = 0.0125$.

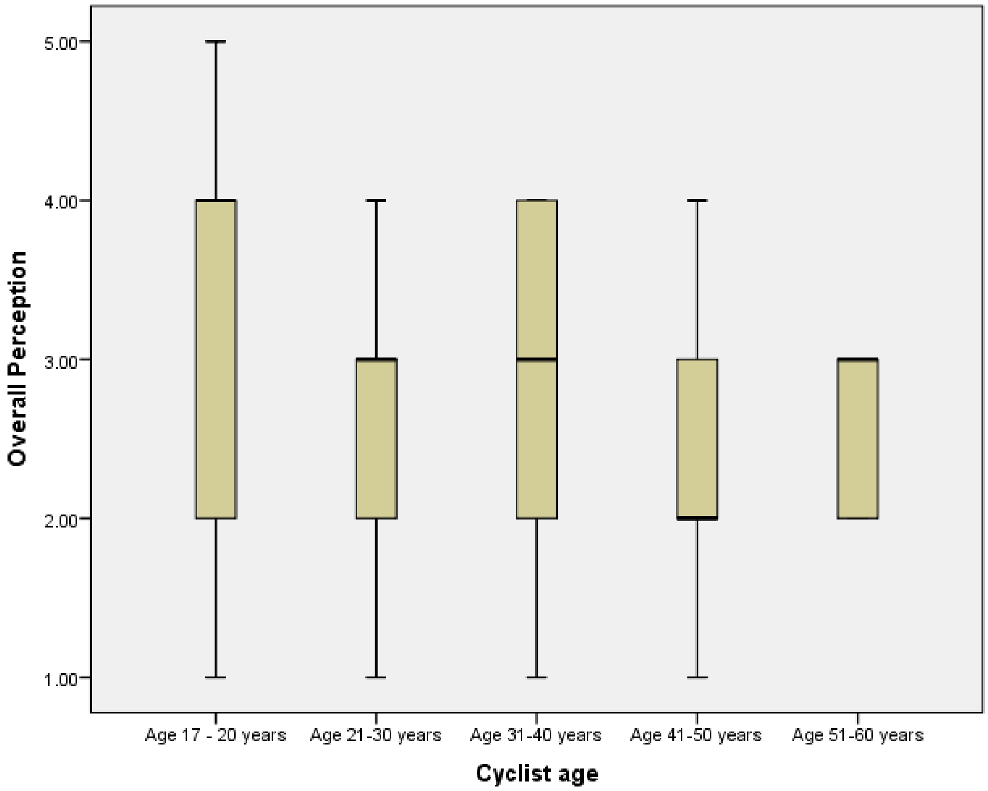

Figure 3. Boxplot of age-groups

Mann-Whitney tests conducted between the age groups of '17–20 years' have produced the results presented in Table 7. Here we see that in all comparisons, p-values are less than 0.05. However, if we refer to the Bonferroni correction basis, then the statistically significant differences are between the 17–20 and 21-30 years age groups, where $p = 0.005 < 0.0125$, and between the 17–20 and 41–50 age groups, where $p = 0.01 < 0.0125$.

Table 7. Mann Whitney tests of comparisons between age-groups

Comparisons	Mann-Whitney Statistics (N = 120)		
	U	Z	Sig (2-tailed)
I: Age 17–20 years: Age 21–30 years	488.500	-2.797	0.005
II: Age 17–20 years: Age 31–40 years	185.000	-2.062	0.039
III: Age 17–20 years: Age 41–50 years	107.00	-2.564	0.010
IV: Age 17–20 years: Age 51–60 years	70.500	-1.965	0.049

The experience of cyclists is a vital parameter that can impact their perceptions of risk and safety. The study found that experienced cyclists exhibited a higher level of confidence and perceived riding on mixed-traffic roads as more comfortable, whereas inexperienced cyclists expressed greater insecurity and discomfort. Gender is another sensitive parameter that can influence cyclists' perceptions of risk and safety. The study revealed significant differences between men and women in their perceptions of road risk. Women tended to perceive higher levels of risk and felt less secure while cycling on mixed-traffic roads compared to men. As can be seen in Figure 4, about 24% of women without riding experience felt very uncomfortable, and 56% felt uncomfortable, compared to about 38% of men without riding experience who felt uncomfortable.

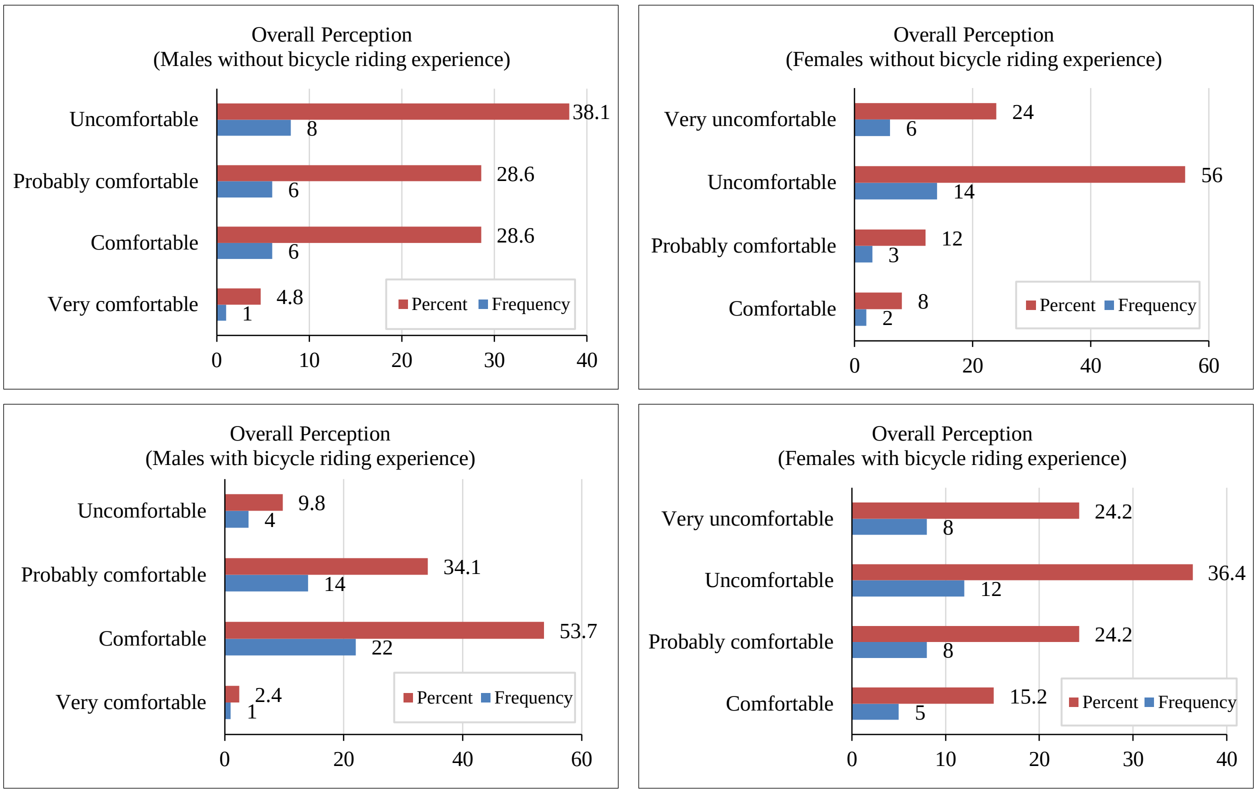

Figure 4. Overall perception of cyclists

3.4. Testing Hypotheses

From the results of the statistical analysis of the non-parametric tests used in this paperwork, such as Mann-Whitney and Kruskal-Wallis, the following hypothesis testing results emerged:

Hypothesis 1 – *'There are statistically significant differences in risk perception, respectively in the sense of safety when riding a bicycle, between men and women'.* According to the Mann-Whitney test, p = 0,000. Therefore at the safety level $p < 0.01$ (or confidence level 99%), the difference in the safety perception between the two genders is statistically significant and alternative hypotheses are accepted.

Hypothesis 2 – Statistically, age risk perception regarding when riding bicycle. When judging by the Kruskal-Wallis test, $p = 0.022$, so at safety level < 0.05 (or confidence level 95%), the difference in safety perception between the age groups is statistically important, and alternative hypotheses are accepted.

Hypothesis 3 – *'Statistically, experience has an important impact on risk perception, respectively on the sense of safety when riding a bicycle'* – according to the Mann-Whitney test, $p = 0.01$, therefore at safety level $p \leq 0.01$ (or confidence level 99%), the difference in safety perception between two groups, with and without experience, is statistically important, and alternative hypotheses are accepted.

4. Conclusion

The study examined cyclists' perceptions of risk and safety on mixed-traffic roads in Pristina, emphasizing the effects of age, gender, and experience. The findings underscore the significance of taking age, gender, and experience disparities into account when promoting cyclist security and building inclusive cycling settings. The paper provides valuable insights into the factors influencing cyclists' risk perception and safety on mixed-traffic roads. The findings emphasize the importance of tailored treatments and infrastructural upgrades that consider age, gender, and experience inequalities. By recognizing and resolving these differences, policymakers and urban planners may build a safer and more inclusive cycling environment, increasing the use of bicycles as a sustainable method of transportation.

This study contributes to the field's increasing knowledge and emphasizes the necessity of actionable and practically engaged scholarship in effecting real change in urban mobility and transportation practices. The study revealed that men and women perceive danger differently, with women experiencing higher levels of risk and feeling less comfortable while riding. These findings highlight the importance of targeted treatments and infrastructure upgrades that address the unique concerns of female bikers. Policymakers and urban planners may work to create safer and more gender-inclusive cycling environments by recognizing and resolving gender inequalities in risk perception. Furthermore, the study shows that age affects risk perception, with younger cyclists having a lower risk perception and better comfort levels when riding on mixed-traffic roads. On the other hand, older cyclists tend to be more careful and have a higher risk perception. These age-related differences underscore the necessity of age-appropriate road safety measures and educational programs promoting safer cycling experiences. In addition, the study emphasizes the importance of experience in influencing risk perception. Experienced cyclists are more confident and view cycling on mixed-traffic roads as more pleasant, whereas inexperienced cyclists are more insecure and uncomfortable. This emphasizes the need to allow individuals to gain cycling experience, skills, and confidence through training programs and supporting infrastructure.

Various limitations of this study should be considered for future researchers. To begin, the findings of this study are based on data obtained from cyclists in the city of Pristina, with a sample size of 120 respondents. As a result, caution should be used when extrapolating the results to other geographical regions. Second, Pristina's risk perception study mainly focused on mixed-traffic roads with comparable characteristics. While this method enabled a controlled assessment of risk perception in specific situations, it may restrict the findings' generalizability to other road types or traffic conditions. Finally, this study classified age groups and cycling experiences using established criteria. Different age groups or categories of cycling experience may provide different outcomes. Future studies might examine different classifications to 'better understand how age and experience impact risk perception and safety outcomes.

5. Declarations

5.1. Author Contributions

Conceptualization, M.B. and G.H.; methodology, M.B.; software, G.H.; validation, M.B., G.H., and R.D.; formal analysis, M.B.; investigation, M.B.; resources, M.B. and R.D.; data curation, M.B. and G.H.; writing—original draft preparation, M.B.; writing—review and editing, G.H.; visualization, M.B.; supervision, M.B. and G.H.; project administration, M.B., G.H., and R.D.; funding acquisition, M.B., G.H., and R.D. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

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5.4. Conflicts of Interest

The authors declare no conflict of interest.

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