PUBLIC HEALTH

THE RELATIONSHIP BETWEEN CYCLIST BEHAVIOR, SAFETY MEASURES, AND TRAFFIC ACCIDENTS: A CROSS-SECTIONAL STUDY IN SKOPJE

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Key words: bicycle, traffic accidents, phone, protective equipment, education level

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Abstract

Globally, vulnerable road users - cyclists, pedestrians and motorcyclists – account for more than half of all road traffic injuries. The aim of this paper was to identify the relationship between sociodemographic characteristics, education level, mobile phone and headphone usage, and wearing protective equipment during cycling and involvement in traffic accidents. Materials and methods: A cross-sectional study was conducted via online questionnaire in Skopje, Republic of North Macedonia in 2022. The questionnaire consisted of 35 questions; grouped in four different topics. Data were analyzed with SPSS 16.0. Results: More than half of the participants (59%) did not wear protective equipment during cycling, and 17.7% wore protective equipment always. Mobile phones during cycling were used by 32.5% of participants, regularly or sometimes, and using headphones during cycling was reported by 41%. Usage of protective equipment is highly correlated with a reduced risk of involvement in a traffic accident. Cycling with the use of mobile phones is strongly associated with an increased risk of accidents. The largest percentage of participants who had experienced a traffic accident, did not wear protective equipment. On the other hand, 70% of participants who had not been involved in a traffic accident did not use a mobile phone while cycling. Conclusion: The findings of this study should be implemented in future policies for better public health and traffic safety, emphasizing the use of protective equipment and reducing mobile phone-related distraction. Addressing these aspects can help policymakers improve cyclist safety, reduce traffic accidents, and improve overall road safety.

ЈАВНО ЗДРАВЈЕ

ПОВРЗАНОСТА ПОМЕЃУ НАВИКИТЕ НА ВЕЛОСИПЕДИСТИТЕ, ЗАШТИТНИТЕ МЕРКИ И СООБРАЌАЈНИТЕ НЕЗГОДИ: СТУДИЈА НА ПРЕСЕК ВО СКОПЈЕ

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Клучни зборови: велосипед, сообраќајни незгоди, телефон, заштитна опрема, ниво на образование

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Печатарски права: ©2025 АЏансун Буковец, Кристина Шунтова, Анета Костова, Гордана Ристовска, Даница Стевковска, Михаил Кочубовски. Оваа статија е со отворен пристап дистрибуирана под условите на нелокализирана лиценца, која овозможува неограничена употреба, дистрибуција и репродукција на било кој медиум, доколку се цитираа ториганалниот(ите) автор(и) и изворот.

Конкурентски интереси: Авторот изјавува дека нема конкурентски интереси.

Извадок

На глобално ниво, вулнерабилните учесници во сообраќајот - велосипедисти, пешаци и мотоциклисти - сочинуваат повеќе од половина од повредите на учесниците во сообраќајните патни несреќи. Целта на овој труд беше да се идентификува односот помеѓу социодемографските карактеристики, нивото на образование, користењето мобилни телефони и слушалки, како и носењето заштитна опрема за време на возење велосипед и учеството во сообраќајни незгоди. Материјали и методи: Беше спроведена студијата на пресек преку онлајн прашалник во 2022 година во Скопје, Република Северна Македонија. Прашалникот се состоеше од 35 прашања, групирани во четири различни теми. Податоците беа анализирани со SPSS 16.0. Резултати: Повеќе од половина од учесниците (59%) не носеле заштитна опрема за време на возење велосипед, додека 17,7% секогаш носеле заштитна опрема. 32,5% користеле мобилни телефони за време на возење велосипед, редовно или понекогаш, додека 41% користеле слушалки при возење велосипед. Користењето заштитна опрема е силно поврзано со намалена инволвираност во сообраќајни незгоди, додека користењето мобилни телефони во тек на возењето велосипед е силно поврзано со зголемен ризик од незгоди. Најголем процент од учесниците кои имале сообраќајна незгода не носеле заштитна опрема, додека, пак, 70% од учесниците кои немале сообраќајна незгода, не користеле телефон. Заклучок: Резултатите од ова истражување треба да се имплементираат во идни политики за подобро јавно здравје и сообраќајна безбедност, со акцент на користењето заштитна опрема и одвлекување на вниманието со користење мобилни телефони додека се вози велосипед. Обраќањето внимание на овие аспекти може да им помогне на носителите на политики да ја подобрат безбедноста при возење велосипед, да го намалат бројот на сообраќајни незгоди и да придонесат кон општо подобрување на безбедноста на патиштата.

Introduction

Globally, vulnerable road users - cyclists, pedestrians and motorcyclists – account for more than half of all road traffic injuries[1]. The World Health Organization, in its agenda on sustainable development 2030, has set a goal to reduce the number of traffic-related accidents by 50%[2]. Reduction in road traffic fatalities and injuries did not align with the Sustainable Development Goals (SDG) target in United Nations Economic Commission for Europe (UNECE) region[3]. Of the total amount of road traffic fatalities, there were approximately 1.19 million in 2021. Road traffic injury continues to be the leading cause of fatality amongst children and young adults (5-29 years) and the 12th for all ages in 2019[4]. Cycling is highly promoted for having considerable advantages to public health, personal welfare, and the environment[5]. Yet, compared to motor vehicles, cyclists are specifically vulnerable for not having any protective covering. One of the major barriers to boosting cycling, especially for novice or anxious cyclists, is road safety[6]. On the other side, transportation is also causing an increase in road accidents, early deaths, and physical and psychological injuries. This trend increases health care costs and puts additional pressure on public finances. Because of this, scientists, together with police and accident reconstruction experts, are researching possible causes of cyclist-related crashes[7]. A contributing factor to this increasing traffic injury and death rate among pedestrians and bicyclists may be increasing distractions due to mobile phone use. The world population was estimated at 7.9 billion in 2022. From 6.9 billion mobile phone subscriptions in 2014, the number increased to 8.9 billion subscriptions in 2023. More recently, smartphone subscription numbers have overwhelmingly exceeded the numbers of people on earth[8].

Over half of the cyclists (56%) aged 12 to 80 used their phones occasionally while cycling[9]. As mobility in traffic is increasingly associated with use of mobile phones, MP3 players, and similar portable devices, serious road safety issues are raised. These devices are capable of diverting the drivers in several ways (physically, visually cognitively, auditorily). Furthermore, emotionally driven driving behavior induced by the use of such devices can negatively influence driving performance affecting emotional states and mood[10]. Consequently, a distracted cyclist using a phone is at a higher risk of collision, and the resulting accidents can have severe consequences[11]. Bicycle helmets cannot prevent accidents, but they can reduce head injuries[12]. Measures can be directed at the individual cyclist or the cycling environment, and can be focused on pre-event prevention or post-event mitigation[13]. Driving speed is a key to the problem of road traffic injuries in North Macedonia[14].Lower speed limits are appropriate to ensure safety and can better handle high levels of cycling traffic[15]. The largest subgroup of patients who suffered a traumatic brain injury (TBI) were drivers, while smaller subgroups were bicyclists (11%), and this proportion in North Macedonia is 10%[16]. In North Macedo-

nia, children and young people under 24 years old account for 43.6% of all traffic injuries and 26.5% of traffic fatalities, and traffic accidents cause 30-50% of fatal injuries in those aged 5 to 2414.[14] Analysis of bicycle accidents provides for an in-depth investigation of the causes and contributing circumstances of collisions, taking into consideration the drivers, cyclists, vehicles, roadways, and environmental conditions. The conclusions from these investigations assist in providing recommendations for improvements in transportation infrastructure and vehicle safety features[17]. The aim of this paper was to identify the relationship between sociodemographic characteristics, education level, mobile phone and headphone usage, and wearing protective equipment during cycling and involvement in traffic accidents.

Materials and methods

A cross-sectional study was performed from April to November 2022 in Skopje, Republic of North Macedonia. We prepared and distributed an online questionnaire to various social media platforms, in order to reach specific target groups (cycling enthusiasts, people that do sports via riding a bike). At the outset of the questionnaire, participants were informed about the study's objectives and made aware that by completing the questionnaire, they were consenting to take part in the survey. The study was conducted entirely anonymously. Participants were thoroughly briefed on the purpose of the study and provided their voluntary consent to participate. The questionnaire consisted of 35 questions, grouped into four different topics: sociodemographic characteristics, cycling habits, safety and behaviors while cycling, and infrastructure. Data were analyzed with SPSS 16.0. Chi-square test was used to determine the association between two nominal variables. Statistical significance was defined as $p<0.05$.

Results

Demographic characteristics

The questionnaire was completed by 1169 participants with age range from 20 to 64 years; the mean age was 37.8 years. In terms of gender, 52.7% of participants were male, 46.8% were female, and 0.5% did not report their gender. Regarding education level, the majority of participants claimed to have completed a high school as the highest level of education (78.1%), followed by those with secondary school (21.4%), and elementary school (0.5%). According to the place of residence, the largest number of participants were from the municipalities Aerodrom (25.2%), Karposh (25%) and Centar (18%). Other municipalities included Kisela Voda (11%), Gazi Baba (8.2%), and Gjorche Petrov (8%). Fewer participants were from Butel (2%), Chair (1.7%), Shuto Oriz-

Table 1: Characteristics and behavior of study population

	Male (N)	Male (%)	Female (N)	Female (%)	Prefer not to tell the gender (N)	Prefer not to tell the gender (%)	Total (N)	Total (%)
Elementary school	4	0.3	/	/	2	0.17	6	0.50
Secondary school	175	15	74	6.33	1	0.08	250	21.5
High school	437	37.4	473	40.4	3	0.2	913	78
Involvement in traffic accident								
Yes	126	10.7	79	6.8	2	0.17	207	17.7
No	491	42	467	40	4	0.34	962	82.2
Wearing protective equipment during bicycling								
Yes, all the time	134	11.5	64	5.5	2	0.17	200	17.2
Only when I ride out of the bicycle path	165	14.1	89	7.6	/	/	254	21.7
Only when I ride in the city	14	1.2	14	1.2	/		28	2.4
No, I don't	304	26	379	32.4	4	0.34	687	58.7
Phone usage while cycling								
Yes	33	2.8	19	1.6	2	0.17	54	4.6
Sometimes	220	18.8	106	9.06	/	/	326	27.9
No	364	31.1	421	36.1	4	0.34	785	67.5
Headphones usage while cycling								
Yes	103	8.8	101	8.6	3	0.2	207	17.7
Sometimes	166	14.2	104	8.9	/	/	270	23.1
No	348	29.8	341	29.2	3	0.2	692	59.2

ari (0.4%), and Saraj (0.5%).

A total of 207 participants or 17.7% claimed having experienced traffic accidents. Among them, 125 were male, 80 were female and two did not want to specify the gender. Most of the participants involved in traffic accidents were males (60.9 %).

Protective equipment use

The majority of participants (58.7%) reported not wearing protective equipment while cycling, 17.2% of them always wore protective equipment, and 21.7% of them wore protective equipment only when riding bicycles outside of the bicycle path. Fewer participants (2.4%) reported using protective equipment only when cycling within the city.

Regarding wearing protective equipment while cycling, e.g., helmets, , 134 (11.4%) male participants

reported always using protective equipment, whereas 483 (41.3%) reported not using it or using it occasionally. Among female participants, 64 (5.5%) reported always using protective equipment, whereas 482 (41.2%) reported never using it or using it sometimes.

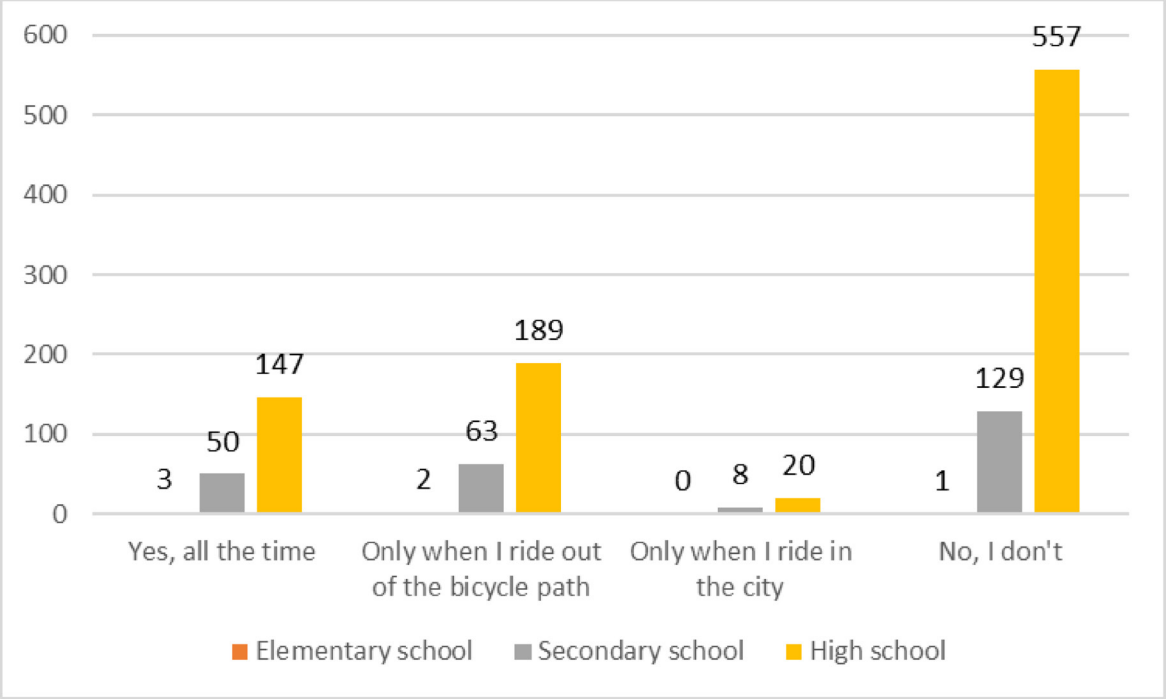


Figure 1: Wearing protective equipment while cycling and education level

61% of cyclists with high school reported never using protective equipment, while 51.6% of cyclists with a secondary school did not use protective equipment. 20% of cyclists with secondary school reported using protective equipment allways, whereas only 16.1% of cyclists with high school education reported always using protective equipment. The Chi-square test was conducted to examine the association between education level and the use of protective equipment. The analysis revealed a significant relationship between these two variables, with a Chi-square value of 13.514, df = 6, and a p-value = 0.036. This indicates a notable association between the level of education and the likelihood of wearing protective equipment. With the increase in education, the wearing of protective equipment has decreased. Out of the total number of participants, the highest percentage of participants with high school (47.6%) responded 'No, I Don't', while 11% of respondents with secondary school responded 'No, I don't' (Figure 1). Specifically, Cramer's V statistic was 0.076, and the p-value was 0.036, reinforcing the significance of this relationship.

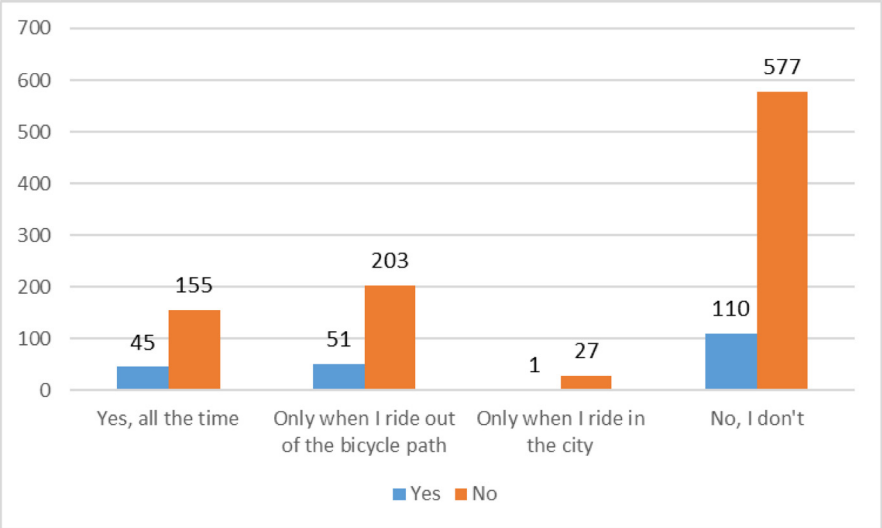


Figure 2: Wearing protective equipment while cycling and having traffic accident

The Chi-square test was conducted to examine the relationship between wearing protective equipment and involvement in a traffic accident. The analysis revealed a significant association between these variables: $\chi^2(3) = 9.328$, df=3, p = 0.025. Cramer's V value of 0.089, with a p-value of 0.025, further supported the association between wearing protective equipment and having a traffic accident. Of the total number of participants who had a traffic accident, the largest percentage did not wear protective equipment (53.1%) (Figure 2).

Phone usage while cycling

The results showed that 34% of participants reported using their phones while cycling, while 67.5% indicated that they did not use their phones during cycling. Among male participants, 253 (21.6%) reported using their phones while cycling (either all the time or sometimes), while 364 males (31.1%) reported not using their phones at all. Among female participants, 125 (10.7%) and 421 (36.1%) did/did not use mobile phone when cycling, respectively.

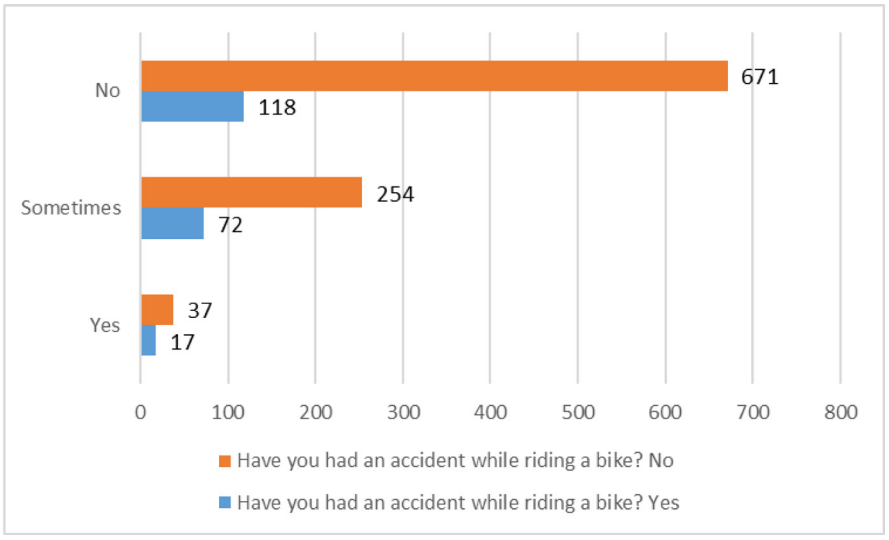


Figure 3: Phone use during cycling and traffic accidents

The Chi-square test was conducted to assess the relationship between phone use while cycling and involvement in traffic accidents. The analysis showed a highly significant association between these variables, with $\chi^2(2) = 15.420$, df=2, $p < 0.001$. This indicates a notable difference in the likelihood of having a traffic accident based on phone use while riding a bike. Cramer's V of 0.115 and a p-value of less than 0.001 confirmed a mild association between phone use and traffic accidents. Of the total number of participants who did not have a traffic accident, 69.8% did not use a phone (Figure 3).

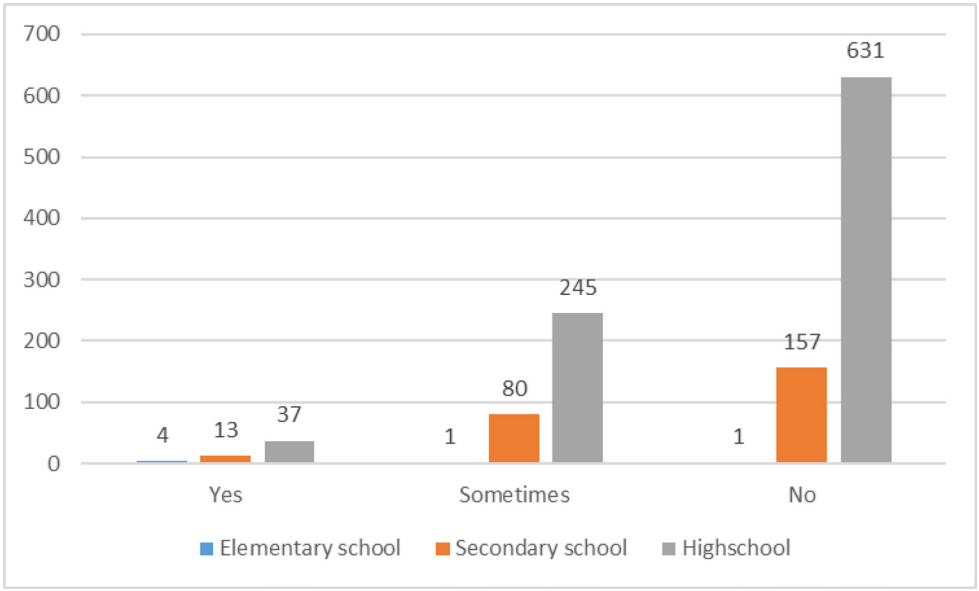


Figure 4: Phone use during cycling and education level

The Chi-square test was used to assess the relationship between education level and the use of a mobile phone while cycling. The analysis revealed a highly significant association between these variables, with a Chi-square: 56.440, df = 4, and $p < 0.001$. This indicates a significant difference in phone usage based on education level, with Cramer's V statistic at 0.155 and a p-value less than 0.001. The results show that the highest proportion of participants with primary education tend to use a phone while cycling. In contrast, individuals with higher education are less likely to carry a phone while riding a bicycle. 32.5% of participants use their mobile phone always or sometimes while riding a bike (Figure 4).

Headphones while cycling

The survey revealed that 40.8% of participants used headphones while cycling, while a majority (59.2%) among those who did not use headphones had not experienced a traffic accident (Figure 5). A total of 269 (23%) male participants reported always or sometimes wearing headphones during cycling, and 348 (29.8%) did not use headphones during cycling. A total of 205 (17.5%) female participants used headphones , and 341 (29.2%) did not use headphones.

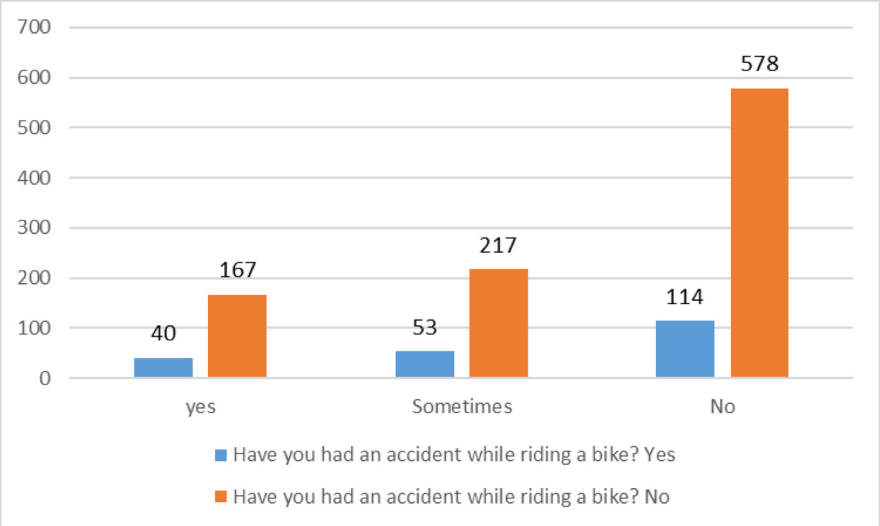


Figure 5: Wearing headphones while cycling and traffic accidents

The Chi-square test was conducted to evaluate the relationship between wearing headphones while riding a bike and experiencing a traffic accident. The results showed non-significant association $\chi^2(2) = 1.778$; df=2, p = 0.411, indicating no significant difference in accident rates based on headphone use.

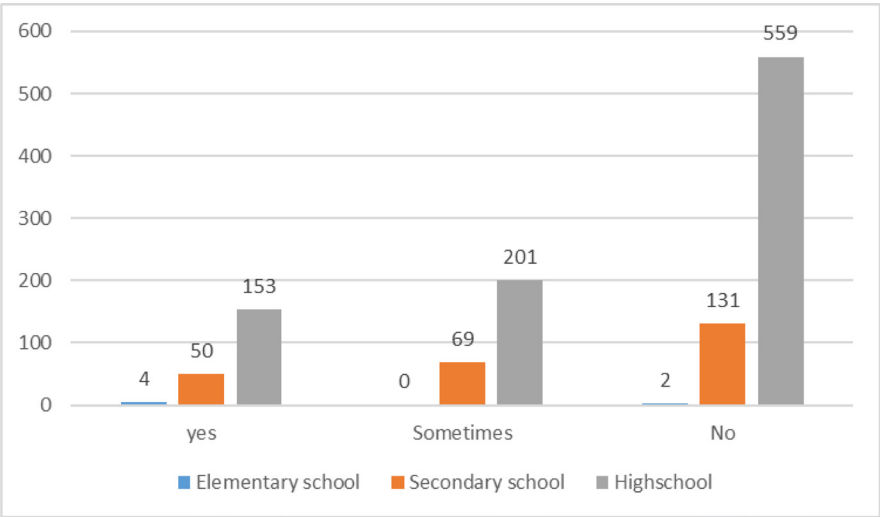


Figure 6: Wearing headphones while cycling and education level

The Chi-square test was conducted to investigate the relationship between education level and the use of headphones while cycling. The analysis revealed a significant association between these variables, with a Chi-square: 20.651, df = 6, p = 0.002. This indicates a notable difference in the use of headphones based on education level, with Cramer's V statistic of 0.094 and a p-value of 0.002. The findings showed that participants with only primary school education were more likely to wear headphones while riding a bicycle, whereas those with a high school degree generally did not use headphones while cycling. 30.3% of participants with high school education used their headphones always or sometimes while riding a bike (Figure 6).

Construction works on bike paths

We found no significant association between construction works on bike paths, which were not appropriately marked and protected and traffic accidents. However, 89.1% of participants reported that bike paths were not appropriately marked and protected (Figure 7). The Chi-square Test was performed to assess the relationship between properly marked and protected construction works (excavations) on bike paths and the occurrence of traffic accidents. The analysis revealed a $\chi^2(1) = 0.738$, with a p-value of 0.390, indicating no significant difference in accident rates related to the presence of well-marked and protected construction sites.

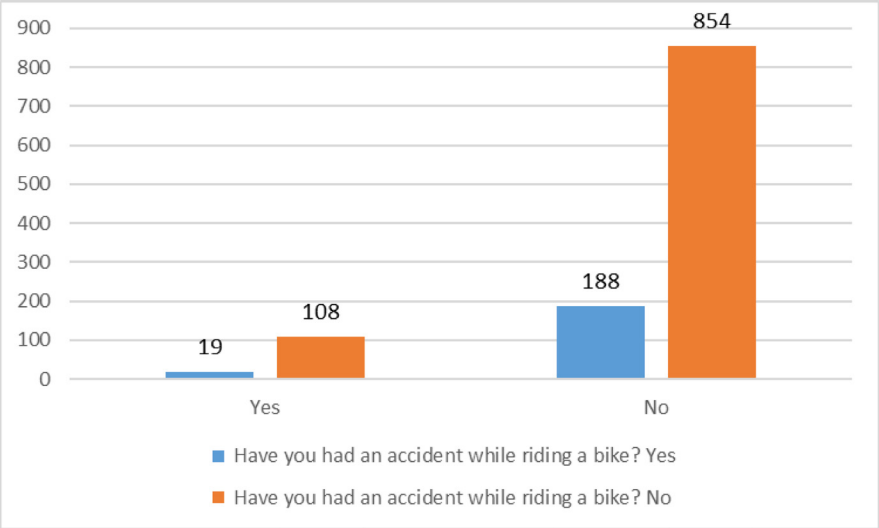


Figure 7: Construction works (excavations) on the bike path and traffic accidents

There was no significant association between properly marked and protected construction works (excavations) on bike paths and the likelihood of traffic accidents. Participants who did not experience a traffic accident generally reported that construction works on bike paths were not adequately marked and protected. Conversely, those who had experienced a traffic accident were more likely to report that these construction sites were not properly marked and protected.

Speed limitation

With regard to the question 'Do you agree with speed limiting on boulevards to be 50 km/h and streets 30 km/h?', 83% said 'Yes' and 17% 'No'.

Table 2: Relationship between education level and support for speed limits on boulevards

	Yes	No	
Elementary school	4	2	Pearson Chi-square = 6.591
Secondary school	197	53	df =3
High school	767	146	p = 0.086

The Chi-square test was conducted to examine the relationship between education level and support for speed limits on boulevards. The results indicated that this relationship was not statistically significant, p = 0.086 (Table 10). This indicated no significant difference in participants' opinions on speed limiting on boulevards based on their level of education.

Discussion

The study investigated the influence of various factors on involvement in a traffic accident and provided many valuable insights into the way different factors contribute towards road safety. More than half of the participants (59%) did not wear protective equipment during cycling, and 17.7% wore protective equipment always. Mobiles during cycling, regularly or sometimes, were used by 32.5% of participants, while 41% used headphones during cycling. The study found that wearing protective equipment significantly reduced the risk of accidents, highlighting its importance for safety. In contrast, mobile phone used while cycling was strongly associated with higher accident rates, indicating the dangers of distractions. However, wearing headphones had little impact on accident involvement.

Construction site conditions on bike paths did not significantly affect accident rates, suggesting that such sites are not major contributors to accidents. The study also found that education level influenced safety practices; individuals with higher education were more likely to use protective equipment, while those with lower education were more prone to using mobile phones while cycling, indicating a potential gap in safety awareness. There is widespread support for stricter speed limits, with many advocating for 50 km/h on boulevards and 30 km/h on streets.

EU cyclists are a unique group in that fatality numbers have remained virtually the same for more than ten years, ranging between 1,800 and 2,100. While the overall number of road fatalities decreased by 34% during this time, the share of cyclist fatalities increased, increasing from 7% in 2011 to 10% in 2020. The highest share of cyclist fatalities - i.e. the number of cyclist fatalities within the total amount of road fatalities - was recorded in the Netherlands, Denmark, Belgium, and Germany, in order from high to less high. The number of cyclist fatalities per million inhabitants is lower in the south and in the north - i.e. Sweden and Finland - of the EU and higher in the EU Member States in between. These observations are at least partly related to the number of bicycle trips and bicycle kilometers traveled in the respective countries, though safe infrastructure also plays a key role as do other factors such as user behavior - one from both cyclists and other road users - and lack of enforcement. In most collisions, cyclists were involved with cars, other cyclists, and pedestrians[18]. According to Evgenikos *et al.*, the actual cycling fatality figures are likely to be higher because police statistics are particularly poor at recording cyclist accidents compared to hospital records and other studies[19].

In the period from 2010 to 2023, 1,176 people died, and 53,817 were injured in traffic accidents in the Republic of North Macedonia. Of these, 6.7% were cyclists. The Skopje Department of Internal Affairs reported that 538

(45.7%) people died, and 35,168 (65.3%) were injured in the city of Skopje[20]. It is intriguing to note that in North Macedonia, bicycles are used for commuting by only 2.3% of the population aged 15-79 years, and by 4% in Skopje[21]. This is much lower compared to the numbers reported in the Netherlands (45%) and Spain (6%)[22].

Distribution of injured and dead citizens in the whole country for the period 2017-2021 year was killed cyclists, motorcyclists and passengers: 119; seriously injured cyclists, motorcyclists and passengers: 1135; slightly injured cyclists, motorcyclists and passengers: 4291. In this period, 69% of men were involved in traffic accidents and 31% of women[22]. From 2010 to 2021, the Skopje Department of Internal Affairs reported 2,073 traffic accidents involving cyclists. Of these incidents, 20 resulted in fatalities, 240 in severe injuries, 1,363 in minor injuries, and 450 involved only property damage. Interestingly, vehicles involved were over 80% private motor vehicles. Finally, in 2020-2021, the municipalities with the highest incidence rate of cycling-related accidents were Centar (98), Karposh (52), Aerodrom (44), and Gazi Baba (37) cases, respectively[21],[23].

UNECE reported that the number of persons injured, of persons killed, and of road traffic accidents in North Macedonia slightly moved in the same direction -8.8%, -32.6%, and -2.8% for the period 2011-2021, respectively[3]. In 2015, Road Traffic Injuries (RTIs) in Macedonia resulted in 4,960 disability-adjusted life years (DALYs), with young males (aged 15-29) being the most affected group. Speeding was the main factor and despite the existence of road safety national strategy, traffic law enforcement was still negligibly poor[24]. By 2017, the RTIs burden had slightly reduced to 4,894 DALYs and still significantly affected young males. Although the Decade of Action for Road Safety was successful compared to a 4-month period "baseline", there was continued necessity for strengthened law enforcement and cross-systematic collaboration[25]. According to Eurocost disability weights, the average disability weight for a temporary cyclist injury is 0.0326. For lifelong injuries, the average DALYs is 8.3. A Norwegian study reported that most injuries were temporary, with very few classified as lifelong. The median disability weight of these injuries was lower than the mean, indicating that while some injuries were more severe, the majority were less serious[26].

Safe infrastructure and understanding some needs of the population will be of importance to encourage safe cycling. In Germany, for instance, the cycling boom is benefiting highly educated people disproportionately, and an approach aimed at addressing this gulf is vital if cycling is to make its full contribution towards sustainability and reduced social inequalities[27]. Infrastructure can reduce the incidence of accidents and stimulate safety feeling among cyclists, as psychological safety is one of the factors supporting and sustaining cycling as a mode of transport[28]. Many authors share the view that human misbehavior accounts for about 85% of the total number of traffic accidents, while poor condition of roads, vehicles defects and other factors account for the remaining 15%[29]. Most studies reported factors of road users' behavior (59.3%) and infrastructure characteristics (57.6%) as relevant causes

of BMV collisions. Notably, 20.3% of these studies mentioned the presence of environmental factors that could be significant causes[30]. Providing adequate space on cycling lanes is a prerequisite for cyclists' subjective safety. Well-designed bike lanes enhance the feeling of safety, while physical demarcation further increases cyclists' perception of safety by a significant margin[31].

A detailed analysis of single bicycle accidents in Denmark showed that the leading causes included skidding on water or ice (60%), inadequate roadway design (24.9%), including things such as kerbstones and road maintenance, and cyclist-related factors such as alcohol use (1.4%), excessive speed (4.6%), and distraction (4.6%)[32]. Similarly, a Finnish study[33] on commuter bicycle crashes found that over 60% were linked to infrastructure issues, such as slippery road surfaces. Shared paths are commonly used in many countries for cycling when dedicated bike paths are not feasible. However, safety concerns are rising, as most accidents on these paths involve falls due to loss of control or collisions with objects and a significant number involve collisions with pedestrians, other cyclists, or motor vehicles at intersections[34]. Barriers related to safety were more commonly reported (31.9% of total bicyclists), compared to barriers related to infrastructure (22.1% of total bicyclists)[35].

Although our research team cannot determine whether the low usage of personal protective equipment among participants (58.7% do not use it) is due to habitual behavior, insufficient awareness, or the observation by Aldred and Woodcock[36] that protective clothing use declines when cycling is perceived as safer, it is evident that the use of bicycle helmets significantly reduces injuries: head injuries by 48%, serious head injuries by 60%, traumatic brain injuries by 53%, facial injuries by 23%, and the overall rate of fatalities or severe injuries by 34%[37]. In the US and Canada, helmet use among adults typically ranges from 30% to 50% in the absence of legal mandates, and slightly over 70% where helmet laws are enforced. Helmets were used on 69% of trips, with usage rates of 76% in Vancouver, where law mandates helmet use, and 59% in Toronto, where it is not. Helmet use was positively correlated with bike light use, longer trip distances, hybrid bike type, and abstinence from alcohol in the six hours prior to the trip, female gender, older age, higher income, and higher education levels. In two of Canada's largest cities, helmets were the most widely used safety equipment[38].

Personal behaviors and habits also play a significant role in enhancing traffic safety. The possible harms of mobile phone distraction are often dismissed. Focusing on nonmotor distracting activities during cycling shifts part of the cyclist's attention and it makes it more difficult to concentrate on the main task of cycling[39]. De Waard *et al.*,[40] in 2010 concluded that telephoning while cycling is associated with decreased speed, impaired peripheral vision, and heightened risk and mental effort ratings. Among various mobile phone activities, text messaging has the most detrimental effect on cycling performance. The reduced accident rate that has been observed in the group of people who are calling by phone may be explained by their slower speed and higher mental workload, which

can help avoid some of the dangerous issues. In a study conducted in Mexico City in 2022, 31.4% of participants used a mobile phone for talking, and 24.2% use did for text messaging while cycling. Additionally, 32.4% reported being involved in a crash or fall. The data indicate that each additional unit of mobile phone talking frequency increases the odds of experiencing a crash or fall by 20% (95% CI: 1.061–1.352)[41]. In Shanghai, China, 50.2% of cyclists had used a mobile phone within one minute prior to their injury. The main analysis indicated that the use of a mobile phone during this one-minute period was related to a threefold likelihood of traffic injury among pedestrians, cyclists, and motorcyclists, with an odds ratio of 3.00, at a 95% confidence interval of 2.04 to 4.42[42]. Moreover, in the case of Spain, an investigation into cyclists' reports on their crashes found that as many as 89.3% out of 25,439 traffic crashes involving cyclists involved associated factors of distraction, including the use of mobile phones[43]. On the contrary, headphones were not correlated with traffic accidents in our survey. A Dutch internet survey found that 39% of the cyclists listened to music at least occasionally and for 55% of the cyclists, at least occasionally, a phone call had been made while cycling[44]. Overall, 22.7% (95% CI: 20.9–24.4%) of all cyclists were engaged in any secondary task; wearing headphones or earphones was most frequently observed (13.1%, 95% CI: 11.7–14.5%)[45]. In the period 2010-2023, speeding accounted for 34.2% of all recorded factors contributing to traffic accidents and retained its position as the leading cause. In the Skopje Department of Internal Affairs, 38.5% of all accidents recorded were due to speeding[21]. The design of the road system and the speed limits set for it must consider the forces the human body can tolerate and survive. In areas where motorized vehicles and vulnerable road users share the same space, such as in residential areas, 30 km/h is the recommended maximum speed limit[46]. Research indicates a significant relationship between reduced speed and lower accident risk and severity. In response, many cities have implemented lower speed limits, such as 30 km/h in residential areas and 50 to 70 km/h on major roads, to enhance safety and encourage cycling and public transit. Despite these safety improvements, comprehensive evaluations are crucial to assess the full impact of such measures. The European Parliament's 2021 endorsement of a 30 km/h limit in residential and high pedestrian zones underscored the importance of thorough assessments to ensure the effectiveness of speed limit changes[47]. Many European cities are adopting 30 km/h speed limits across their road networks. Research from 40 cities, including Brussels, Paris, and Zurich, found that these speed limits significantly enhanced road safety by reducing crash risk and severity—road crashes dropped by 23%, fatalities by 37%, and injuries by 38%. Environmental benefits included an 18% reduction in emissions, a 2.5 dB decrease in noise pollution, and a 7% cut in fuel consumption. Encouraging walking, cycling, and public transit further contributes to safer and more sustainable urban environments[48],[49].

Despite the valuable insights provided by this study, several methodological limitations should be considered. Although the sample size was substantial for an urban population

such as the city of Skopje, the use of a questionnaire-based survey may limit the representativeness of certain subgroups of cyclists, particularly occasional or recreational riders. Furthermore, reliance on self-reported data introduces the potential for recall bias and social desirability bias, especially with regard to behaviors such as mobile phone use, helmet use, and compliance with traffic regulations. Finally, due to the cross-sectional design of the study, the observed relationships should be interpreted as associations rather than causal effects. Future research employing longitudinal designs or objective exposure measures could provide a deeper understanding of causal pathways and strengthen the evidence base.

Conclusion

The findings of this study should be implemented in future policies for better public health and traffic safety, emphasizing the use of protective equipment and mobile phone distraction. We need to design and carry out public awareness campaigns highlighting the advantage of wearing protective equipment. Such campaigns should target all cyclists; however, special emphasis should be placed on lower educational attainment groups as they seem unlikely to make use of protective equipment. In addition, targeted education programs on safe cycling behaviors among children and youth should be introduced. These programs will enhance safety awareness across all education levels. Further development of national regulation in order to introduce more stringent penalties for phone use while cycling, and promote technology solutions that discourage phone usage during cycling. Identification of other contributing factors related to traffic safety at construction sites on the streets can help in the introduction of new measures for enhancement of cyclist safety around these construction areas. Addressing these aspects can help policymakers improve safety while cycling, reduce accidents in traffic flow, and contribute toward overall road safety improvements.

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