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FACTORS OF THE SAFETY IN BICYCLE TRAFFIC IN THE CITY OF ZAGREB AND ITS SURROUNDING

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Abstract: The aim of this study was to determine the differences in underlying factors of Zagreb cycling, compared to the "types of cyclists" (driving style), i.e. different ways of using bicycles as a means of transport. The study included over 3,000 frequent participants in urban traffic cycling, sample of members of the association Cyclist Union (N = 1259) and snowball sample of "typical" of cyclists, i.e. people who are using the bike, but are not the members of the Cyclist Union (N = 1831), using the conveniently assembled questionnaire. Study participants who bike used in various applications prefer the safest driving style (only on sidewalks and bike paths / lines). Barriers of the weather conditions are ubiquitous in the safest driving style. Daily, weekly and yearly riding a bicycle are more often found in those who prefer the safest driving style. Cyclists who drive with medium secure style (roads with less traffic and lower speeds), more often ride a bike, as compared with those who prefer the safest driving style. Having a better bike line / track and other infrastructure is the most often considered at those with the highest risk driving style. The results provide the guidance for local authorities and for the cyclists to improve the conditions for a safer and more often by bicycle circulation in the City of Zagreb and its surroundings.

Key words: barriers, bicycling, infrastructure, traffic accidents, safety

Introduction

The feeling of security during travelling by bike traffic is growing, with a more experience of cycling (Hunt J. & Abraham J., 2001). Safe cycling (real or perceived) is actually an emotional issue that is often studied (Forester J., 1986; Wilkinson W. et al., 1992). It seems that the relative accuracy of the perceptions about the safety of cycling depends on the different levels of experience and training. Some authors estimate that cycling on bike paths and lanes actually is less secure as a whole, rather than cycling in mixed traffic, at least for cyclists who know the basic rules of driving and have experience of effective cycling, which is contrary to the conventional view (Forester J., 1986, St Jacques K. & DeRobertis M., 1995). The impact of the sense of safety is affecting the behavior of cyclists, either directly due to the perceived conditions or by factors that affect the actual or perceived security. The length of the route while traveling proved to be a less important factor (Axhausen K. & Smith R., 1986, Aultman-Hall L., 1996). It is likely that the efforts of cyclists who seek a safer and more comfortable ride, is leading to longer journeys and greater delays, for the cyclists, as well as for the drivers of the motor cars (Forrester, 1996). An important role in overall safety is played by the existence of the place for safe parking for bikes (Hunt J. & Abraham J., 2001).

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The modern bicycle is a very widespread form of traffic, especially in developed countries, but also in less developed (Plaut P., 2005). As a means of transportation and as a form of recreation as well, cycling is more common in cities in developed countries, but also contributes to the raising the quality of life and humanization of urban spaces (Lukic A. et al., 2011). Even 37% of all daily trips within the city (at work, at universities and schools) are done by a bicycle in Copenhagen (Gehl J., 2010), while in Amsterdam, this percentage rises to 54%. In a large percentage of daily trips by bicycle are common in various German and Swedish, but also in other major European cities (London, Paris, Barcelona) (Pucher et al., 2010).

The trend of increasing the use of bicycles follows from a number of factors: changes in the lifestyle; the actions of the city governments in connection with investment funds in infrastructure and promotion of cycling; increasing awareness of individuals about the importance of the bike, while the use of the bicycle is generally not associated with gender, age and level of education (Pucher J. & Buehler R., 2008). Daily or frequent use of bicycles in order to travel to work, school or college, to go shopping or sports and recreational purposes, while improving the daily mobility of individuals and reduces air pollution and noise (mainly due to car traffic) and positive effect on health (Pooley C. et al, 2010; Pooley C. et al, 2011; Gatersleben & Haddad, 2010; Pucher J. & Buehler R., 2008; Pucher J. et al., 2010). In Edmonton, the time spent in combined forms of transport bike is much greater than the time spent driving on the 'bicycle paths" or "bike lanes" (Hunt J. & Abraham J., 2001). In urban planning, there is an increasing need for the introduction of an integrated transport system, which integrates and balances the use of various means of transportation: trains, cars and other motor vehicles, public transport, cycling and pedestrian traffic (Baker L., 2009).

Although modern trends support the idea of living without the noise in terms of sustainable development (including the revival of traffic walking, cycling and public transport), major barriers to bicycle traffic are existing. Tradition, culture, relief and climatic features are real obstacles to more frequent use of the bike, but it turned out that the enumerated factors need not necessarily be decisive (Nankervis M., 1999). An Australian research about the obstacles for regular cycling in Sydney and the region, concerns about the administration problems, direct obstacles for the cycling and about the ways how these barriers can be overcome (Research into Barriers to Cycling in New South Wales, 2009). There are four dominant barriers for cycling: negative image of cyclists and cycling among non-cyclists (a); perceived threat to urban and suburban cycling because of the perceived or real lack of safe places to ride a bike, with the fear of collisions with motor vehicles (b); lack of facilities for storage or lock bicycles (c); little or no understanding or confirmation on the benefits of cycling as a mode of traffic (d). Key issues that do not support cycling as transportation options are: the inconvenience of cycling circulation, or the need to use other forms of transport (1); lack of time (2); lack of storage facilities, parking (3); perception that cycling is not 'cool' (4); costs of the cycling (5) (Research into Barriers to Cycling in New South Wales, 2009). In the safety aspect, the cyclists are probably the most vulnerable and the most vulnerable traffic participants (Li G. et al., 2001), and children are most exposed to cycling injuries (Boström L. & Nilsson B., 2001). The most common type of accident involving deaths of cyclists' accidents is the result of the collisions of cars and bikes, even 81.3% in 1997 of the total number of accidents in which cyclists were died (Missoni E. & Kern J., 2003; 2007).

Cycling is also a great form of physical exercise and the instigator of physical development of children and youth, which helps in the prevention of cardiovascular disease for all age groups. Compared with walking, the health benefits of cycling are higher due to higher intensity of effort that needs to be invested (Oja P- et al., 1998). Cycling as a means of transport provides regular physical activity, which can be easily and with minimal costs

to integrate into your daily routine, which is time-saving (Croatian Ministry of Environmental Protection, Physical Planning and Construction, 2010). In a study in which the Croatian cyclists compared to the control group non- cyclists, cyclists showed higher quality of life expressed total personal well-being index (PWI), as well as in the field of health (Lovretic V. et al., 2013).

In other words, the bicycle as a means of transport has a positive impact on the health of the individual, does not pollute the environment or creates noise, while cycling infrastructure takes up much less space in relation to the motor road traffic (Pucher J. & Buehler R., 2008). Therefore, this form of transport can be considered a competitive urban transport, especially to small and medium distances. Overall, the above studies show that the bike, with a walk, really be considered an environmentally, socially and economically, the optimal mode of transportation (Plaut P., 2009, Buehler R. & Pucher J., 2010).

In Croatia, the bicycle traffic and bicycle rarely investigated. In a rare Croatian research, examining students at the University of Zagreb, stratified into the groups of cyclists and non-cyclists, it turned out that there are several differences in the manner of the use of bicycles and other transport equipment (Lukic A. et al. 2011). In their study, students are suggested measures to improve cycling infrastructure, but several other measures to increase the number of users of the bike. In terms of relief, Zagreb and its surroundings are very suitable area for the use of the bike, because Zagreb pretty lowland city, with most of the immediate urban area at altitudes between 110 and 125 m, which facilitates the utilization of the bicycle as a mean of transport (Bertic I., 1994).

However, to increase the frequency of cycling, the measures taken by (national, regional, municipal) authorities in the field of transport and economic policy and urban planning, have a significant impact, especially in cities (Pucher J. & Buehler R., 2008). Increasing road safety by bicycle can be increased by building constructive infrastructure, particularly clearly separate bicycle paths. Furthermore, it is important to ensure storage facilities (parking) for the bike, very close to the cyclist's workplace and their other relevant destinations. It is important to focus people to think more about the benefits, than about the disadvantages of cycling, while certain financial incentives will be welcome as a backup. Thus, to improve conditions for cycling, a major role can have the city government, academic and non-governmental organizations. In Zagreb, the activities of non-governmental organizations to popularize the use of bicycles for everyday personal transportation as a form of recreational sport (Association 'Bicycle' and Green Action), are increasingly apparent (Lukic A. et al. 2011). Particularly strong initiative to improve conditions for cycling gives the association 'Union of cyclists' (in Croatian „Sindikat biciklista“, abr. SB), who point out that the increased use of bicycles is one of the best environmentally friendly solutions to reduce traffic noise. This NGO has several objectives: the primary goal is to affirm her cycling as a healthy, environmentally friendly and fast mode of transport. SB protects the rights of cyclists, promoting cycling and fight for the improvement of cycling infrastructure. SB points out the desire to make the bike more appealing to the people, to transform the cities in the direction of reducing the number of motor vehicles, increasing the domination of pedestrians, cyclists and public transport. As a guideline in creating a successful program, SB initiated data collection for this research, including the most motivated participants regarding these issues.

The **goal** of this study was to determine the differences in the basic factors of Zagreb cycling, compared to the "types of cyclists" (driving style), i.e. exploring different ways of using bicycles as a means of transport. We have assumed that the preferred style of riding the bike will determine different perceptions of factors Zagreb cycling, and vice versa.

Methods

Participants

The study was conducted in Zagreb and its surroundings. Zagreb has a number of 790 017 inhabitants in the census of 2011, and over 50 kilometers of bicycle paths. The survey included a combination of deliberate, but representative sample of members of the association SB (N = 1259) and snowball sample of "typical" cyclists, i.e. people who are using the bike, but are not the members of the SB (N = 1831). At the time of the research, the sample included a large part of the population actually members of the association SB which at the time counted about 1,800 (response rate 70%). Age of participants was as follows: under 18 (46 or 1.6%), 18-24 years (619 or 20%), 25-34 years (1535 or 49.6%), 35-44 years (654 or 21.2%), 45-54 years (186 or 6%), 55-64 years (43 or 1.4%), 65 years and over (7 or 0.2%). Among the members of the Security Council, the age structure was: less than 18 (12 or 1.0%), 18-24 years (242 or 19.2%), 25-34 years (640 or 50.8%), 35- 44 years (281 or 22.3%), 45-54 years (68 or 5.4%), 55-64 years (12 or 1.0%), 65 and over (4 or 0.3%). Among non-members of the Security Council, the age structure was: less than 18 (36 or 2.0%), 18-24 years (380 or 20.8%), 25-34 years (891 or 48.7%), 35- 44 years (373 or 20.4%), 45-54 years (116 or 6.3%), 55-64 years (32 or 1.7%), 65 or older (3 or 0.2%). Of all the participants, there were a total of 1643 men and 1428 women: 642 men and 612 women who are members of the SB and 1,001 men and 816 women who are non-members of the Security Council. In terms of types of cyclists, cyclists distribution is as follows: major roads with heavy traffic and high speed (597); roads with less traffic and lower speeds and cycle paths / lanes (1676); only on sidewalks and bike paths / lanes (402).

Data collection method

Before the research, the participants were informed about the general purpose (the perception of cycling in Zagreb), but in a maneer to avoid the suggestions about the desired answer. The voluntary nature of participation was emphasized, as well as the information about the option that the participants can stop completing the poll at any time. The participants filled out questionnaires through the online survey exposed on the website of the SB (http://sindikatbiciklista.hr/), in 2012, after the e-mail received an offer to participate in the study. The members of the SB were asked to voluntarily fill out the online surveys, while they are additionaly asked to specifically contact at least two "typical" of cyclists who they knew personally, sending them to, in accordance with their capabilities, to meet an online survey (estimated response can be estimated around 50%). According to the criteria in the selection of participants own research (Lukic A. et al., 2011), participants who are not members of the SB and ride their bikes at least once a month on average (except possibly in the colder times of the year), either as a means of transport or in recreational purposes, were considered as "typical" cyclists. The same criterion was applied in the formation of the sample snowball "typical" of cyclists in this study. Questionnaire surveys Cycling Syndicate cyclists have put together the members of the SB: contains a number of topical issues with a group of ordinal scales of assessment, while the content of questions and assessment of the scale can be seen in the tables of results.

Statistical analysis

To determine the differences between a groups of variables belonging to certain thematic units (ie. the essential factors of Zagreb cycling) in relation to the driving style, ANOVA and Kruskal-Wallis test are used for the comparison of multiple independent

samples (with two exceptions, where χ2-tests are used for testing the differences for binomial dependent variables). In both types of analysis, ordinal variables are treated as quasi-quantitative (equidistant), because their distributions were relatively symmetric, and the sample is generally large enough sample sized. However, because of the plainness and simplicity of presentation of results, as well as measures of central tendency retained values of the means and standard deviations (medians frequently didn't reflect the differences, because of estimation scales with small number of levels). All analyzes were performed using the statistical package SPSS 20.0., while the differences are commented on the level of $p<0.05$.

Results

The differences in all purposes for the use of bicycles in relation to the driving style are presented. As a rule, all the highest values of means were found for the safest type of drive: only on sidewalks and bike paths / lanes. Also, all the lowest values of the means were found for the least secure type of driving: major roads with heavy traffic and higher speeds (Table 1).

Table 1. Differences in purposes of using the bike compared to driving style of cycling

Variable - purpose for use the bicycle (0 = never - 4 = almost every day)	**Style of driving**	Mean	Std. Dev.	ANOVA, Kruskal-Wallis test (df=2)
going to work ...	larger roads with heavy traffic and high speeds	**2.437**	1.557	**F=10.739**** **χ^2=28.718****
	roads with less traffic and lower speeds and cycle paths / lanes	2.765	1.522	
	only on sidewalks and bike paths / lanes	**2.818**	1.520	
going to school, college ...	larger roads with heavy traffic and high speeds	**1.574**	1.689	**F=7.745**** **χ^2=16.406****
	roads with less traffic and lower speeds and cycle paths / lanes	1.891	1.755	
	only on sidewalks and bike paths / lanes	**2.019**	1.780	
grocery shopping	larger roads with heavy traffic and high speeds	**2.087**	1.365	**F=7.173**** **χ^2=15.206****
	roads with less traffic and lower speeds and cycle paths / lanes	2.284	1.311	
	only on sidewalks and bike paths / lanes	**2.408**	1.427	
sports, recreation, trips	larger roads with heavy traffic and high speeds	**2.572**	1.034	**F=18.090**** **χ^2=37.174****
	roads with less traffic and lower speeds and cycle paths / lanes	2.554	1.013	
	only on sidewalks and bike paths / lanes	**2.891**	0.994	
other purposes	larger roads with heavy traffic and high speeds	**2.282**	1.299	**F=20.878**** **χ^2=45.019****
	roads with less traffic and lower speeds and cycle paths / lanes	2.547	1.278	
	only on sidewalks and bike paths / lanes	**2.852**	1.261	

*** difference statistically significant at $p<0.01$; * difference statistically significant at $p<0.05$*

There is only one statistically significant difference in all barriers to cycling, in relation to the driving style of cyclists. Barriers related to the weather conditions are more often found

in cyclists with the driving style *only on sidewalks and bike paths / lanes*, while at least they are present in driving along *larger roads with heavy traffic and higher speeds* (Table 2).

Table 2. Differences in barriers to cycling in relation to driving style of cycling

Variable – barriers to a cycling (0=without any influence 2=extreme influence)	**–Style of driving**	Mean	Std. Dev.	Kruskal-Wallis test (df=2)
The hilly terrain	larger roads with heavy traffic and high speeds	0.470	0.567	χ^2=1.370
	roads with less traffic and lower speeds and cycle paths / lanes	0.472	0.565	
	only on sidewalks and bike paths / lanes	0.430	0.535	
Non-affiliated or non-existent bike paths / lanes	larger roads with heavy traffic and high speeds	1.154	0.626	χ^2=0.007
	roads with less traffic and lower speeds and cycle paths / lanes	1.157	0.605	
	only on sidewalks and bike paths / lanes	1.156	0.605	
The lack of showers / locker rooms on site	larger roads with heavy traffic and high speeds	0.617	0.576	χ^2=0.814
	roads with less traffic and lower speeds and cycle paths / lanes	0.640	0.585	
	only on sidewalks and bike paths / lanes	0.651	0.591	
Distance to the destination	larger roads with heavy traffic and high speeds	0.799	0.643	χ^2=1.257
	roads with less traffic and lower speeds and cycle paths / lanes	0.834	0.656	
	only on sidewalks and bike paths / lanes	0.832	0.660	
Weather conditions	larger roads with heavy traffic and high speeds	**1.043**	0.550	**χ^2=6.273***
	roads with less traffic and lower speeds and cycle paths / lanes	1.103	0.539	
	only on sidewalks and bike paths / lanes	**1.123**	0.556	
I do not have a bike	larger roads with heavy traffic and high speeds	0.517	0.640	χ^2=3.490
	roads with less traffic and lower speeds and cycle paths / lanes	0.490	0.625	
	only on sidewalks and bike paths / lanes	0.421	0.558	
I do not have companions for a ride	larger roads with heavy traffic and high speeds	0.245	0.412	χ^2=4.118
	roads with less traffic and lower speeds and cycle paths / lanes	0.273	0.425	
	only on sidewalks and bike paths / lanes	0.278	0.433	
The feeling of insecurity due to motor vehicles	larger roads with heavy traffic and high speeds	1.182	0.663	χ^2=0.839
	roads with less traffic and lower speeds and cycle paths / lanes	1.198	0.650	
	only on sidewalks and bike paths / lanes	1.165	0.658	

*** difference statistically significant at p<0.01; * difference statistically significant at p<0.05*

There are three statistically significant differences in traffic accidents experienced in the last 3 years in relation to the driving style. The highest rates of road accidents with a motor vehicle while you manage the bike and the harassment (hoot, swearing, deliberate

dangerous driving, etc.) by the driver of a motor vehicle, appears in the *safest driving style (only on sidewalks and bike paths / lanes)*. The rarest rates of road accidents are found in the *highest risk style (large road with heavy traffic and higher speeds)*. The crash by the cyclist when you were a pedestrian is one of the most common accidents at the most roads with *heavy traffic and high speeds*, while the lowest number of accidents of this type occurred in the style *only on sidewalks and bike paths / lanes* (Table 3).

Table 3. Differences in traffic accidents experienced in the last 3 years in relation to the driving style of cycling

Variable – traffic accidents (0=never – 3=3 and more times)	Style of driving	Mean	Std. Dev.	**ANOVA, Kruskal-Wallis test (df=2)**
Traffic accident with a motor vehicle while you ride the bike	larger roads with heavy traffic and high speeds	**0.118**	0.372	**F=16.536**** χ^2**=31.143****
	roads with less traffic and lower speeds and cycle paths / lanes	0.186	0.454	
	only on sidewalks and bike paths / lanes	**0.289**	0.569	
Crash into the pedestrian while you are driving the bike	larger roads with heavy traffic and high speeds	0.938	1.137	F=1.792 χ^2=3.152
	roads with less traffic and lower speeds and cycle paths / lanes	0.840	1.118	
	only on sidewalks and bike paths / lanes	0.900	1.164	
Traffic accident with another cyclist while you control the bike	larger roads with heavy traffic and high speeds	0.268	0.605	F=0.409 χ^2=1.088
	roads with less traffic and lower speeds and cycle paths / lanes	0.260	0.590	
	only on sidewalks and bike paths / lanes	0.290	0.607	
Crash into the cyclist when you were a pedestrian	larger roads with heavy traffic and high speeds	**0.746**	1.075	**F=12.695**** χ^2**=25.606****
	roads with less traffic and lower speeds and cycle paths / lanes	0.524	0.935	
	only on sidewalks and bike paths / lanes	**0.501**	0.931	
Traffic accident with another cyclist while you drive a motor vehicle	larger roads with heavy traffic and high speeds	0.034	0.239	F=0.108 χ^2=1.468
	roads with less traffic and lower speeds and cycle paths / lanes	0.030	0.228	
	only on sidewalks and bike paths / lanes	0.029	0.167	
Harassment (hoot, swearing, deliberate dangerous driving ...) by the driver of the motor	larger roads with heavy traffic and high speeds	**1.832**	1.215	F=**20.336**** χ^2**=43.045****
	roads with less traffic and lower speeds and cycle paths / lanes	2.070	1.165	
	only on sidewalks and bike paths / lanes	**2.304**	1.064	
My bike was stolen	larger roads with heavy traffic and high speeds	0.307	0.644	F=1.172 χ^2=2.215
	roads with less traffic and lower speeds and cycle paths / lanes	0.309	0.623	
	only on sidewalks and bike paths / lanes	0.361	0.683	

*** difference statistically significant at p<0.01; * difference statistically significant at p<0.05*

There are three statistically significant differences in in the ways of participation in the traffic as in the area of Zagreb compared to driving style. The most frequent participation in the traffic as a pedestrian, as well as with ZET (Zagreb electric tram) or other bus transportation, appears in the *least safe driving style (large road with heavy traffic*

and higher speeds), while the least means are found for the cyclists with the *safest driving style (only on sidewalks and bike paths / lanes)*. The most frequent participation in the traffic as a cyclist is found in the *safest driving style* (*only on sidewalks and bike paths / lanes* rarest), while the rarest means are found in the *highest risk style (large road with heavy traffic and higher speeds)* (Table 4).

Table 4. Differences in the ways of participation in the traffic in the area of Zagreb compared to driving style of cycling

Variable – participation in the traffic in the area of Zagreb (0=never – 4=always)	Style of driving	Mean	Std. Dev.	ANOVA, Kruskal-Wallis test (df=2)
pedestrian	larger roads with heavy traffic and high speeds	**3.048**	1.018	**F=24.221**** **χ^2=45.019****
	roads with less traffic and lower speeds and cycle paths / lanes	2.811	1.035	
	only on sidewalks and bike paths / lanes	**2.585**	1.073	
bicycle	larger roads with heavy traffic and high speeds	**3.064**	0.900	**F=24.278**** **χ^2=57.458****
	roads with less traffic and lower speeds and cycle paths / lanes	3.317	0.836	
	only on sidewalks and bike paths / lanes	**3.401**	0.859	
car/ motocycle	larger roads with heavy traffic and high speeds	1.703	1.320	F=1.270 χ^2=2.722
	roads with less traffic and lower speeds and cycle paths / lanes	1.766	1.259	
	only on sidewalks and bike paths / lanes	1.837	1.256	
ZET (Zagreb electric tram) or other bus transportation	larger roads with heavy traffic and high speeds	**1.849**	1.205	**F=16.612**** **χ^2=28.995****
	roads with less traffic and lower speeds and cycle paths / lanes	1.613	1.074	
	only on sidewalks and bike paths / lanes	**1.439**	1.111	
train	larger roads with heavy traffic and high speeds	0.511	0.847	F=0.722 χ^2=1.681
	roads with less traffic and lower speeds and cycle paths / lanes	0.499	0.808	
	only on sidewalks and bike paths / lanes	0.557	0.843	
other ways of transportation	larger roads with heavy traffic and high speeds	0.238	0.535	F=4.224 χ^2=5.380
	roads with less traffic and lower speeds and cycle paths / lanes	0.281	0.584	
	only on sidewalks and bike paths / lanes	0.369	0.728	

*** difference statistically significant at p<0.01; * difference statistically significant at p<0.05*

Even five statistically significant differences are found in the factors in relation to the driving the bike in relation to the driving style of cyclists. Those who prefer *the most insecure driving style (major roads with heavy traffic and high speed)*, the more often they would like to combine transport by bicycle and other modes of transport, compared to those who prefer the medium *safe driving style (road with less traffic and lower speeds).* Annual

ride a bicycle more often those who prefer the *safest driving style (only on sidewalks and bike paths / lanes),* compared to those who prefer *the least secure driving style (major roads with heavy traffic and high speed)*, and the same situation is for daily driving distances and the weekly driving distances. Cyclists who are driving with the *safe medium style (road with less traffic and lower speeds)* are riding a bike more frequently in the year, than those who prefer *the safest driving style (only on sidewalks and bike paths / lanes)* (Table 5).

Table 5. Differences in factors of cycling compared to driving style of cycling

Variable – factors of cycling (0=never – 4=always)	Style of driving	Mean	Std. Dev.	ANOVA, Kruskal-Wallis test (df=2)
Would you combine cycling if suburban trains are simple input bike? (1 = yes, 0 = no) (X)	larger roads with heavy traffic and high speeds	0.752	0.432	$\chi2$=1.681
	roads with less traffic and lower speeds and cycle paths / lanes	0.777	0.416	
	only on sidewalks and bike paths / lanes	0.780	0.415	
By combining cycling with other modes of transport in one journey (Railways, ZET)? (1 = yes, 0 = no) (X)	larger roads with heavy traffic and high speeds	**0.175**	0.380	**$\chi2$=6.448***
	roads with less traffic and lower speeds and cycle paths / lanes	**0.134**	0.341	
	only on sidewalks and bike paths / lanes	0.132	0.339	
How often in 2012, drove the bike? (0 = not once - 4 = daily)	larger roads with heavy traffic and high speeds	**3.211**	0.712	**F=37.473**** $\chi2$=72.115**
	roads with less traffic and lower speeds and cycle paths / lanes	3.407	0.666	
	only on sidewalks and bike paths / lanes	**3.575**	0.587	
The most common distance (0 = 1-4 km - 4 = more than 10 km)	larger roads with heavy traffic and high speeds	**2.134**	0.966	**F=13.585**** **$\chi2$=24.464****
	roads with less traffic and lower speeds and cycle paths / lanes	2.236	1.006	
	only on sidewalks and bike paths / lanes	**2.468**	1.048	
Weekly distance (0 = less than 20 km - 2 = more than 70 km)	larger roads with heavy traffic and high speeds	**0.845**	0.662	**$\chi2$=148.185****
	roads with less traffic and lower speeds and cycle paths / lanes	1.081	0.658	
	only on sidewalks and bike paths / lanes	**1.374**	0.648	
At that time of the year you cycle? (1 = summer - 4 = all year)	larger roads with heavy traffic and high speeds	3.065	0.829	**$\chi2$=15.577****
	roads with less traffic and lower speeds and cycle paths / lanes	**3.141**	0.946	
	only on sidewalks and bike paths / lanes	**2.841**	1.257	

*** difference statistically significant at p<0.01; * difference statistically significant at p<0.05*
Note: (X) $\chi2$-test

Only one significant difference in the needs of bicycle traffic in the city of Zagreb is found in relation to the driving style of cyclists. Those who prefer *the least secure driving style (large road with heavy traffic and higher speeds)*, consider more often that more quality bicycle lane / tracks and other infrastructure should be constructed, while those who prefer *the safest driving style (only on sidewalks and bike paths / lanes)* won't be additionally encouraged to use the bike more with higher quality of cycling infrastructure (Table 6).

Table 6. Differences in the needs of bicycle traffic in relation to the style of cycling

Variable – Needs for the cyclists in Zagreb (0=absolutely not agree – 4=absolutely agree)	**Style of driving**	Mean	Std. Dev.	ANOVA, Kruskal-Wallis test (df=2)
More quality bicycle lane / track and other infrastructure will encourage me to use the bike more	larger roads with heavy traffic and high speeds	**3.725**	0.673	**F=29.700**** **χ^2=47.141**
	roads with less traffic and lower speeds and cycle paths / lanes	3.577	0.881	
	only on sidewalks and bike paths / lanes	**3.270**	1.165	
The city spends enough money for cyclists	larger roads with heavy traffic and high speeds	0.350	0.677	F=1.172 χ^2=2.846
	roads with less traffic and lower speeds and cycle paths / lanes	0.386	0.709	
	only on sidewalks and bike paths / lanes	0.382	0.834	
Yellow tape on too narrow sidewalks is not adequate bicycle path	larger roads with heavy traffic and high speeds	3.218	1.148	F=1.311 χ^2=5.154
	roads with less traffic and lower speeds and cycle paths / lanes	3.294	1.057	
	only on sidewalks and bike paths / lanes	3.330	1.158	
It is correct to reduce the number of parking spaces in certain locations in the city center, to improve conditions for cyclists and pedestrians	larger roads with heavy traffic and high speeds	3.565	0.877	F=0.154 χ^2=0.338
	roads with less traffic and lower speeds and cycle paths / lanes	3.576	0.824	
	only on sidewalks and bike paths / lanes	3.550	0.933	
Zagreb bicycle paths should be built primarily by subtracting the space motor traffic, not to the pedestrians	larger roads with heavy traffic and high speeds	3.373	0.981	F=2.469 χ^2=4.765
	roads with less traffic and lower speeds and cycle paths / lanes	3.460	0.895	
	only on sidewalks and bike paths / lanes	3.501	0.901	
Zagreb cycling routes are poorly maintained	larger roads with heavy traffic and high speeds	3.531	0.804	F=0.179 χ^2=2.415
	roads with less traffic and lower speeds and cycle paths / lanes	3.512	0.814	
	only on sidewalks and bike paths / lanes	3.535	0.898	

*** difference statistically significant at p<0.01; * difference statistically significant at p<0.05*

Discussion

Study participants who bike used in various applications prefer the safest driving style: only on sidewalks and bike paths / lanes. The most frequently, participating in the traffic as a cyclist appears with the safest driving style, while it is least often at the least safe driving style. Annually, more often ride a bicycle those who prefer the safest driving, compared to those who prefer the least secure driving style (the same trend is shown in those cyclists who are travelling on a maximum daily and weekly distance). In other words, it seems like that the greatest sense of safety have the cyclists who prefer the safest driving style, which stimulates them to use their bikes more often and for different purposes. In the conditions of living in the big city, a bicycle is estimated as a convenient way of

transportation and mean of recreation, what is emphasized also by international authors (Plaut P., 2009; Buehler R. & Pucher J., 2010), while for women the safety is especially important factor for driving (Forrester, in 1986; Wilkinson W. et al., 1992). This fact is confirmed in our previous study (Sindik J. et al., 2013), where it was evident that women prefer the safest driving style. The fact that the barriers about weather conditions are the most frequently observed in cyclists who prefer the safest driving style, is an additional argument that those who prefer safe driving, tend to avoid risky traffic situations.

The highest frequency of accidents with motor vehicle while driving a bicycle and harassment during the drive appears in cyclists with the safest driving style, while the rarest accidents are found in cycle riders with the most insecure style. This is a clear guideline to the city government should substantially improve the existing infrastructure of bicycle traffic, such as shown by the experiences of Australia (Research into Barriers to Cycling in New South Wales, 2009), but the previous survey conducted in Zagreb (Lukic A. et al., 2011).

Bicycle riding is the rarest in cyclists who prefer the least secure type of driving: large roads with heavy traffic and high speeds. In this style of driving, crash of cyclists into pedestrians is the most common accident, while participating in traffic as a pedestrian, and participation in trade ZET or other bus transport is also characteristic of the least secure driving style. All these results (and the fact that in our study was included the least number of cyclists who prefer the least secure type of drive) indicate that this style of driving actually have these cyclists who rarely ride a bicycle and that (most likely on weekends) recreate driving quickly and in the long run (which causes frequently crash into pedestrians, too). This is an additional argument of relative unsafety ride on Zagreb's existing bike paths and roads (Sindik J. et al., 2013). Furthermore, those who prefer the least secure driving style, often they would like to combine transport by bicycle and other modes of transport, but they also believe that we should have better bike lanes / paths and other infrastructure. It seems that in the current cycling environment is very difficult to combine with other modes of transport in Zagreb and its surroundings, and the improving of the cycling infrastructure in Zagreb and its surroundings is extremely important to implement (Lukic A. et al. 2011).
Finally, cyclists who are driving with medium secure style (roads with less traffic and lower speeds), more frequently in the year (in more seasons and in different weather conditions) ride a bicycle, as compared with those who prefer the safest driving style. In other words, cyclists who drive medium secure style are more likely to "force" a bike ride, even in cold, wet conditions in the winter, even in a relatively unsafe traffic.

It is likely that the length of the daily driving affects the rhythm of life, the distance of the workplace or school / college and the amount of free time. Thus, traffic safety bicycle, with the security of the parking stand out as the most important factors for the frequency of cycling in the world (Forester J., 1986; Wilkinson W. et al, 1992; Hunt J. & Abraham J., 2001). Interestingly, it is very likely that the barriers of bicycle traffic, are probably the least important group of factors that affect the frequency of cycling, which may indicate a special significance of cycling for the participants of this study, even in spite of the dangers to which they are exposed, due to unfavorable infrastructure (Sindik J. et al ., 2013).

The advantage of this study is the fact that this is the most comprehensive survey so far in Croatia, that was conducted in terms of the problems of cycling and cycling conditions in the city of Zagreb, but also in general in the Croatian urban environments (Sindik J. et al., 2013). Unlike studies in which they compared the attitudes of cyclists and non-cyclists (Lukic A. et al. 2011), all the participants of this study were cyclists, especially motivated to solve the problem of security for the cycling in Zagreb and its surroundings. The implementation of this empirical research is important to create clear orientation program of the Association "Union of cyclists", as well as other non-governmental organizations dealing with these issues, and also serves as the evaluation already achieved goals similar

projects carried out in major European countries (Pooley C. et al., 2010; Pooley C. et al., 2011; Gatersleben & Haddad, 2010; Pucher J. & Buehler R., 2008; Pucher J. et al., 2010) and World Cities (Hunt J. & Abraham J., 2001; Research into Barriers to Cycling in New South Wales, 2009).

The main disadvantage of research is relatively less representative sample (using snowball sampling) in the subsample of average cyclists (ie. non-members of the association SB) (Sindik J. et al., 2013). In future research, while improving the representativeness of the sample of cyclists in general, we could ask additional questions to the participants, for example, the image of cyclists and cycling among non-cyclists, adding the indicators of the advantages of bicycle traffic in relation to other forms of traffic (Research into Barriers to Cycling in New South Wales, 2009).

The practical application of research results is multiple: findings from the results can be exported to the guidelines for taking constructive social action at the level of not only the local community, but also at the level of regions and states. These guidelines could serve to improve the conditions for the operation of a bicycle and for the development of the necessary transport for cyclists' infrastructure, but also to promote awareness of sustainable development of cities and about healthy lifestyles. Marketing activities should be directed to: encourage public debate on the issues of bicycle traffic; highlighting current achievements made in the area of bicycle traffic; providing information on safe cycling traffic to those who would like to actively involved in cycling circulation; employers would be able to point out the desirability of bicycle traffic for the purpose of commuting; encouraging responsibility of (local) communities, by creating and offering different types of programs that can be imported; highlighting the benefits of cycling compared to other forms of traffic; informing cyclists (current and potential) on safer routes for cycling circulation (Research into Barriers to Cycling in New South Wales, 2009; Baker L., 2009).

Conclusions

Study participants who are using the cycle in various applications, prefer the safest driving style (only on sidewalks and bike paths / lanes), while the least often using cycle in various applications is found in those who prefer the least secure style of driving (higher road with heavy traffic and higher speeds). Barriers about weather conditions are most present at the safest driving style, while the least often they are observed at the least secure style of driving. The highest frequency of accidents with motor vehicle while driving a bicycle and harassment while driving occurs in cyclists with the safest driving style. The crash of cyclists into pedestrians is the most common accident at the least secure style of driving and rarest in those with the safest driving style. The most frequently participation in traffic as a pedestrian, and participation using ZET or other bus transfers, is used by those with the highest risk driving style, while the most frequently are involved in traffic as a cyclist those with the safest driving style. Those who prefer the most insecure driving style often would like to combine transport by bicycle and other modes of transport. Daily, weekly and yearly ride a bicycle more often those who prefer the safest driving, compared to those who prefer the least secure driving style. Cyclists who ride safe medium style (road with less traffic and lower speeds), more frequently in the year are riding a bike, than those who prefer the safest driving style. Those who prefer the least secure driving style, often think that Zagreb should have better bike lanes / paths and other infrastructure, while the least often the same think those who prefer the safest driving style. The results provide the guidance for local authorities, but also for the cyclists, to improve conditions for safer and more frequent bicycle circulation in the City of Zagreb and its surroundings.

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