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CYCLING AS RECREATION AND TRANSPORTATION NECESSITY

ABSTRACT

This paper considers the actual problematic of cycling in traffic. It emphasises possible bigger role of the bicycle in urban centres as transport device that could be one of the ways of reducing traffic jams. The author also considers bicycle influence on health and environment. Special emphasis is on the danger of bicycle riding in unsettled traffic conditions and failure to use protective measures especially regarding the role of helmets on every ride.

KEY WORDS

cycling, traffic, recreation, prevention

1. INTRODUCTION

Bicycle has become a very popular vehicle in the modern times. Its purposes are multifunctional. On the one hand, bicycle is a transportation device and serves people to commute to work or for work, such as professional racing drivers, bike messengers, driving tourists, pupils, students, housewives going to shop and workers going to work from suburban areas. The other side of biking is just for fun, recreation or as a nice sport. In western countries, bicycle has more different roles, sports, commuting to work etc., yet, on the other hand, in the countries of the third world its role is more as a transportation device. It can also be ridden on all sorts of terrain, asphalt, concrete, dirt, gravel, grass, ground etc.

The increasing popularity of bicycle in the last 10 to 15 years is due to the appearance of mountain bikes. These bikes are made of steel, aluminium or carbon fibres, they are very strong, durable, with big tyres and special amortisation. All that makes them perfect for cities because they are immune to the architectonic barriers, which is important, especially in Croatia.

Prevention of injuries is very important, because the potentially injured people had been more or less healthy before and they can make greater influence to stay in that state than in any other diseases. Prevention means learning and changing some wrong habits that

may have been present for a longer time. It is very important to understand and to start applying some new rules that can eventually reduce the negative side effects of cycling.

2. BICYCLE TRAFFIC

Bicycle traffic is a form of transportation that includes bicycle as a transportation device. The first vehicle similar to the bicycle called "célérifere" was invented in 1790 in France by a man called Comte de Sivrac. That was actually a model of an animal on two wooden wheels connected with a wooden pole. The word bicycle has been in use since 1868 starting in France as well as the first bicycle race in St. Cloud Park in Paris. Today, it is a very popular transport device and it has got multiple applications. Bicycles have lots of advantages compared to other transportation devices. They are simple to maintain, not expensive and ecologically the most acceptable traffic device.

Bicycle usage is different in various parts of the world. In countries with lower economic standards, like China and India, it is mass transportation device. In western countries, it is mostly used as a way of recreation, but its transportation purpose is starting to grow. The streets of large cities are crowded and often jammed with cars, and it takes a lot of time to travel sometimes just a few kilometres. Public road transportation is also in a bad position because of that. Such situation is present here in Croatia, especially in Zagreb, which is a relatively small city by area, with a large number of people living and working in it.

One of the solutions for traffic improvement in Zagreb, apart from the railway, could be bicycle. It takes about one sixth of space occupied by car. This is important in traffic flow but also in parking. In everyday traffic one or two persons usually travel together in the car which is economically and ecologically unjustifiable, and that kind of transportation takes 3 – 5 times more space than cycling in the already crowded streets. Bike riding produces no exhaust gases, that means clearer air in the city centres and some positive

contribution to the global saving of the ozone layer and all the benefits that come from that. Bicycles also reduce the living costs by saving gas, parking tickets, so that it represents an investment that rapidly pays off. Finally, the indirect saving of medical resources that comes from increasing resistance to cardiovascular incidents and reducing hospitalisation and clinical treatment costs that can be enormously big should also be kept in mind.

Introducing bicycle into traffic in urban centres leads to more investment, technological and administrative resolutions. Especially in Zagreb which, contrary to other western cities is not friendly to the bikers. It has many architectonic barriers, few bicycle paths and car drivers in general are not used to bike riders. So the roads should be marked with yellow or some other lines, or special bicycle paths should be constructed where it is possible to accommodate the sidewalk's end, build bike parking where they can be locked. These are not too expensive investments, especially considering the other group of citizens who have similar problems, and they are the handicapped persons in wheelchairs.

Bicycle traffic can also be organised in outer downtown area with small "bicycle terminals" in suburban places. The "bicycle terminal" is practically a parking space where bicycles can be locked, near railway or bus stations. That can be organised in circles. The first circle would be the wider Zagreb centre, area where the streetcar operates. The average speed by bike is about 15 to 20 km per hour. That means that the distances of 10 km can easily be ridden in about 30 minutes by almost everyone. Zagreb is about 16 km from Črnomerec to Dubrava, and less than that, about 10 from Novi Zagreb to Jelačić Square. The second circle would include the small towns near Zagreb, Zaprešić, Samobor, Lučko, Velika Gorica, Dugo Selo. The same distance could be used around the centres of the second circle.

Something like "rent-a-bike" could be organised in the city centre. It would be possible to rent a bike, ride it to a desired destination and then leave it there. A system like that exists already in Munich, Germany. Bicycles have electronic locks on them which are operated by plastic cards that have certain credit on them. Each ride takes some money off the credit. Locks signalise with red and green lights if the bike is free or occupied. When they are not needed they are locked and ready for the following user. Locks should have some kind of electronic surveillance on them so the position of the bicycle could be known.

Other traffic participants, especially car drivers should be warned about cyclists. That could be done by propaganda through public media. The message would be that the bike riders have at least the same, if not even greater rights in traffic because they are

weaker. The media could also be used to invite people to use bicycles instead of cars.

These are some of the ideas that could alleviate the crowded city traffic. Examples of pretty good "bicycle towns" are Varaždin and Čakovec, with bike paths and awareness of other participants in traffic. Many people of different ages ride bikes there and there is no reason why this could not be the same in the rest of Croatia.

3. HEALTH BENEFITS OF BIKE RIDING

Bicycle riding is both fun and a great way to exercise. It has very good effects on cardiovascular system by increasing body fitness. Cardiovascular diseases are the leading cause of death in western civilisation, mostly high blood pressure, arteriosclerosis, myocardial infraction and brain stroke.

Regularly performed endurance exercises like cycling, swimming, walking result in major cardiovascular, muscular and metabolic adaptations that lead to an increase in work capacity and endurance, as well as a decrease in heart rate and blood pressure. These adaptive benefits begin accruing with exercise at about 60% of maximum heart rate for 30 minutes, 4 times a week.

Cardiac system

The major factor in increased exercise capacity with aerobic exercise is the rise in maximal cardiac output, amount of blood pumped by the heart per minute. And in young and middle aged men and women, this increase in the cardiac output plays a greater role in increasing maximal exercise performance than does an increased oxygen utilisation by the skeletal muscles. Since our maximal heart rate does not change, and may even be lower, following exercise training, the increase in cardiac output is solely due to a higher stroke volume (amount of blood pumped per heart beat). Cardiac output = stroke volume x heart rate. The increase in stroke volume is a result of a hypertrophy of the left ventricle (athlete's heart), and an enhancement of the heart's contractile state, probably mediated by the autonomic nervous system.

The skeletal muscles

Skeletal muscles make up over one half of the body weight in a slim individual. These muscle cells contain two proteins - actin and myosin - which chemically interact to shorten the muscle fibre when stimulated by nerve impulses. There are two types of fibres: type I, or slow twitch, and type II or fast twitch. The slow twitch fibres are more efficient, using both fats and carbohydrates for energy and are the major muscle fibre in use at 70-80% VO₂ max. (explanation follows).

Fast twitch fibres, on the other hand are less efficient, using mainly glycogen as fuel, and are called into action for sprints as the athlete approaches 100% of maximum performance. Although the ratio of slow to fast twitch fibres is mainly controlled by genetic factors, this ratio will gradually change (often over years) with an ongoing training program.

While riding a bike body is in good, relieving position while sitting on the saddle, so that contrary to running there is no stress on leg joints which leads to reducing overstrain injuries.

Oxygen consumption

Oxygen consumption by muscle, expressed as VO_2 , reflects the amount of oxygen utilised for cell metabolism and energy production during a specified period of time. Maximum oxygen consumption, VO_2 max., is an individual's upper limit of aerobic or oxygen dependent metabolism. It depends on several factors including lung capacity, heart rate, number of red blood cells and their amount of oxygen that is hemoglobin, and the ability of the muscle to extract oxygen from the blood. Increased oxygen extraction by the working muscle is, along with the increase in cardiac output, the main factor in an increased VO_2 max. with training. It is the result of an increase in the size and number of the muscle cell mitochondria, an increase in the activity of the metabolic enzymes in the muscle cells, and an increase in the number of capillaries that supply blood to muscle cells. The net result is an increase in the amount of oxygen extracted from the blood in a single pass through the muscle (the arterial - venous oxygen difference). At levels of exertion greater than the VO_2 max., the energy requirements of the cells exceed the ability of the cardiovascular system to deliver the required oxygen, and oxygen independent or anaerobic energy production begins. It is not only less efficient, with a more rapid depletion of muscle glycogen stores, but also results in build-up of lactic acid and other acid metabolites that ultimately limit performance because of fatigue and occurrence of pain in the muscles even when adequate glycogen stores remain. The degradation of lactic acid after oxygen again becomes available is responsible for the "oxygen debt" or recovery phase that follows the anaerobic exercise.

All that has been mentioned improves the quality of everyday living and significantly decreases the risks of cardiovascular diseases, the number one killer today. The great feeling after physical training should also be mentioned. This feeling is not just mental, virtual, but occurs due to the release of certain molecules in brain called endorphins, whose targets are the receptors on the centres of pleasure in the brain, like limbic system and mesencephalon.

And last but not least, cycling is a great way of losing body weight. That also reduces the risk of car-

diovascular diseases and at the same time gives very important emotion of feeling well as result of losing extra kilograms and having a better body figure.

4. BICYCLE ACCIDENTS

Unfortunately, cycling has also its dark side because of the risk of injuries and death for which cyclists are not all that guilty in most cases as other traffic participants like car drivers, then unprotected railway road crossings and roads unfitted to bike riders. In the year 1997, 813 persons were killed and an estimated 567,000 persons were injured badly enough to need emergency medical care as result of bike crashes in the United States. The toll on young people is especially high, 31% of bike-related deaths were among riders younger than the age of 16, and two-thirds of those injured were children or young teens¹.

In Croatia in 1997, 67 persons were killed and 835 injured who needed medical assistance. The percentage of fatalities is 0.0017% of the total number of citizens, compared to the USA where that percentage is 0.00029%. Comparing the absolute numbers, the situation does not look so bad, but in relative ratios there are 5.8 times more fatalities in Croatia. Considering that in the U.S.A., there are more cars per capita the situation is even worse. The toll of children was 5.9 %, which is fortunately much lower than in U.S.A.

Table 1 - The number of killed and injured in Croatia.

year		1995	1996	1997	1998	1999
Adults	killed	53	69	67	48	56
	injured	1117	903	835	875	921
Children	killed	6	4	4	/	/
	injured	92	42	37	/	/

Data from "Bilten o sigurnosti cestovnog prometa Ministarstva unutarnjih poslova Republike Hrvatske".

The risk of serious injuries due to bike crashes has not been understood well enough. Injuries to the head are particularly dangerous and are the lead-

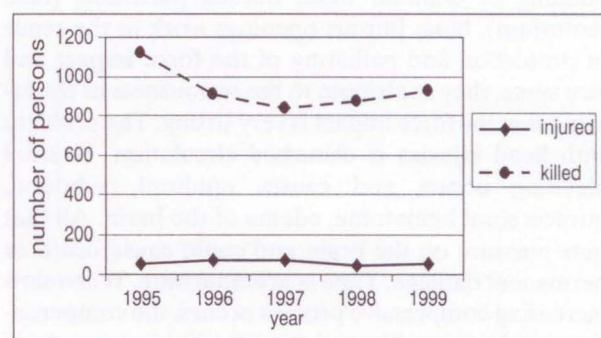


Figure 1 - Graphical view of the injured

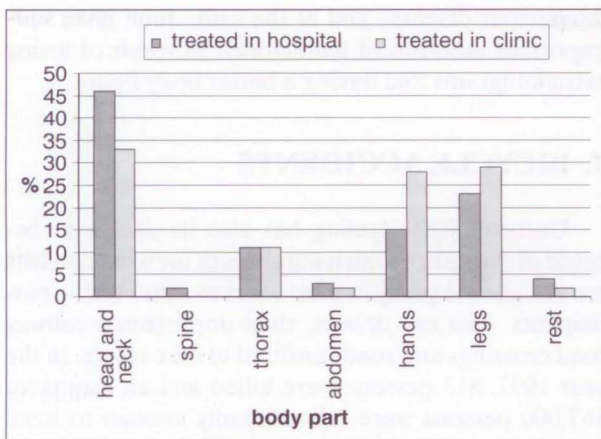


Figure 2 - injured body parts

ing cause of death and permanent disability in bike riders².

Most of the bike-related injuries and deaths are connected with falling. Injuries of cranium and cerebrum are most common. They are also the most dangerous. The degree and extension of injuries depend on kinetic energy that is produced from the force effect, anatomical characteristic of cranium and brain, state of the muscle tonus, bike velocity, surface, age, visibility and it is important for the cyclist to be seen by other traffic participants. There is also the factor of other participants in traffic, car drivers especially. Alcohol plays a big role when talking about bike accidents, considering drunk drivers or drinking by cyclists, primarily elderly males.

Age also has influence on the injuries. In children the bones are elastic and reduce the intensity of injuries, opposed to old age with rigid bones that break much easily. Low muscle tonus or relaxed muscles at the moment of injury have direct impact on its seriousness. Lower tonus allows higher acceleration of the body so the injuries are more severe and happen more often. Surface and velocity at which cyclists ride is also important. Falling at higher velocity onto the asphalt or concrete causes much more severe damages than on the ground or grass at lower speed.

Anatomical characteristics of the cranium condition the variability of the injuries. Oval shape, special building of cranium base, fibrous partitions (falx, tentorium), bone fibrous openings work in the sense of protection and palliating of the force impact and vice versa, they contribute to the seriousness of the injury when the force impact is very strong. The problem with head injuries is disturbed circulation. Internal bleeding occurs and causes epidural, subdural, intracerebral hematoma, edema of the brain. All that puts pressure on the brain and could cause death or permanent damage. Time is essential here. When slow increasing compressive process occurs, the compensatory mechanisms, like reducing the liquor space have time to react. But that does not last long. Soon, the

brain starts to move, adding more problems to its circulation, the person loses conscience and falls into a coma. The results could be fatal or permanent damage if there is no emergency surgery to reduce that pressure.

Injuries of the locomotive system are common among cyclists. One of the specific injuries is clavicle fracture. The cyclists often fall direct on the shoulder or extended arm and that is when the clavicle breaks. Dislocations or distortion of the shoulders and other arm joints could also happen. All these injuries need surgical examination and after that surgery or conservative therapy. Leg injuries also include fractures, dislocations, distortions and one of the most common are superficial wounds which do not need special treatment but disinfecting and dressing, if needed.

One of the problems that can occur is dehydration. It is especially important for the sport cyclists, who ride for several hours. Dehydration results when the body's fluid balance drops below normal. In the early stages, dehydration saps person's strength. In its extreme form, dehydration can be life threatening. Human body is two-thirds of water by weight. Ideally, individuals should drink adequate amounts of fluid to replace the water lost through body processes, which include breathing, sweating, perspiration and production of urine and stool. In doing so, healthy people maintain a balance of water in their blood and tissues. Even adults who are confined to bed still need at least two litres of fluid daily to maintain water balance in the body. An active cyclist on the other hand, requires much more.

Dehydration can spell trouble. Even a mild form (a loss of three to five percent of body weight) decreases cyclist performance, which is a good reason for bikers to stay fully hydrated. As dehydration progresses to moderate levels (five to ten percent of body weight), thirst, light-headedness, dizziness, headache and nausea develop. Urine turns dark yellow, and urine output decreases. A person with moderate dehydration may collapse when he or she stops exercising. At severe levels of dehydration (ten to 15 percent of body weight) a person may become confused, lose consciousness, or fall into shock. Pulse may become very rapid and blood pressure may fall. Such extreme dehydration usually is seen only in people lost without water for several days, or those who are severely ill with diarrhoea and vomiting.

5. PREVENTION AND TREATMENT

Prevention is the basic measure that should be promoted. Most of the accidents occur in full health. All of a sudden, injured people depend on the others and bike riding is not fun any more.

Wearing a bike helmet is essential. Studies in the USA show that wearing a bike helmet reduces the risk of brain injury from a bike crash by as much as 88% and reduces the injury of the face by 65% and yet only 18% of all bicycle riders wear them. That percentage in Croatia is without doubt even lower. In some other countries like the Netherlands, Belgium, Germany, helmets are obligatory. In Croatia there is no such law for cyclist. Helmets are not worn even by all motorcycle riders. Bicycle helmets are obligatory in mountain bike races, and mountain bikers along with a few road cyclists are the only ones who wear them. This should change.

It should start with little children. Learning to ride a bike is a developmental milestone in the life of a child. Bicycle, the child's first vehicle, is a source of pride and a symbol of independence and freedom. Yet all too often, children get seriously injured, or even killed when they fail to follow the basic bicycle safety rules. A child needs to wear a helmet on every bike ride, no matter how short or how close to home. Many accidents happen in driveways, on sidewalks, and on bike paths, not just on the streets. In fact, the majority of bike crashes happen near home. A helmet protects the child from serious injury, and should be always worn. Wearing a helmet at all times helps children develop the helmet habit. A helmet should be worn squarely on top of the head, covering the top of the forehead. If it is tipped back, it will not protect the forehead. The helmet fits well if it does not move around on the head or slide down over the wearer's eyes when pushed or pulled. The chinstrap should be adjusted to fit snugly. Small children must not be left without surveillance while riding. They should never wear headphones and listen to music while riding but rather listen to the traffic. The use of mobile phones is also out of the question while riding.

Based on all the mentioned, here are some basic and not complicated rules to teach children, and not just children, how to ride safely³:

1. Always ride on the right side. Remember to go with the flow, never, ever ride against traffic. Cars will not be expecting to find a biker when they round a corner or go over a hill.
2. Always check behind when changing lanes.
3. Watch out for dangerous things in the roadway. Road litter, potholes and gravel can all cause losing control.
4. Stop at all stops signs and at all streetlights. Be extra careful at crossroads.
5. Always signal before making a left or right turn. To make a left turn look behind you, hold your left arm straight out and proceed carefully. For a right turn hold you left arm out and up in an 'L' shape.
6. Keep control of bike. Do not swerve or make sudden turns. Drivers may not be able to react fast enough to avoid colliding with you.
7. Ride at least one meter away from parked cars. Someone could open the door unexpectedly.
8. Listen for cars approaching from the side or behind you.
9. Do not follow cars too closely, you may be in their blind spot.
10. Know your road signs and obey them. A smart biker follows the rules of the road.
11. Always be prepared to stop. Keep your hands on or close to the brakes.
12. Fluorescent green, yellow or orange are all great choices of clothing colours. If you are wearing these colours, other bikers, motorists, car drivers and pedestrians will be able to see you better.
13. Do not ride at night, if it is necessary you will need clothing with retro-reflective materials sewn onto it. You will also need lights on the bike.
14. If it is cool outside, dress in layers. You can peel off clothing as you start to get warmer.

Beside injuries, dehydration could be a problem, especially in hot weather. To avoid dehydration, the frequency and amount of urine should be checked. While scant, dark urine signals dehydration, the opposite, a large volume of light-coloured urine indicates good hydration.

How much to drink? Some bikers allow their thirst to guide them, but studies have revealed that thirst is an unreliable indicator to prevent dehydration. Sweat evaporates quickly in hot, dry, or windy climates, so it is very easy to underestimate the fluid loss under these conditions. The fluid should be taken regularly, regardless of thirst. Regularly means 0.75 l of fluid every hour or 1 l in hot conditions. While sweating the electrolytes are also lost, drinking plain water is enough only if the ride takes 1.5 hour maximum. After that special drinks should be taken. These drinks are specially formulated as replacement fluids for exercise, so they contain proper amount of salts. They can be made at home by adding half a teaspoon of salt to 0.75 l of water, then three to four teaspoons of sugar or a flavoured drink mix to improve the taste.

Stretching is very important. It helps the body to prepare for physical exertion and prevents the so-called overstrained injuries. Every group of muscles and joints in legs and back should be stretched at least 20 minutes, before riding and it would be good to stretch them after exercise. That allows more blood supply to the connections between muscle and tendons and tendons with bones and ligaments so that this makes them ready for exertion. This is very important because these spots are the weakest in the locomotive system.

Finally, it should be said that alcohol never goes along with any sort of transportation. Riding a bike, with balance being essential, alcohol consumption causes tragic consequences. This is a well-known fact, but needs to be repeated all the time.

6. CONCLUSION

The discussed situations of bicycles in traffic indicate their increasing role in urban traffic. They have lots of advantages on relatively small areas in city centres. Most of our city centres are very old and at times when they were built such traffic growth had not been foreseen. Therefore, there is no space for all the cars today. One of the ways that can reduce the pressure of cars in the centre could be the bicycle.

To make that possible, changes are necessary. Marking the bike paths, levelling the sidewalks' end are not big investments and could be done. Also, other traffic participants, primarily car drivers, should be warned that cyclists have at least equal if not greater rights in traffic than they do. This could be done through public media and also by inviting people to use bicycles.

Next thing that should be done is to make the use of bike helmets obligatory. Its usage reduces the percentage of head injuries by 88%. Wearing bike helmets must start at children's age, and should be worn constantly, even on short rides, and never ride at night. Kids must understand that the bicycle is fun but it must be safe.

During the planning of new streets in cities or in suburbs, the bicycle paths need to be included in design like the ones in Germany, for example.

Bike ride should be taken seriously and follow the rules of the traffic. Liquid should be taken regularly, before the feeling of thirst occurs. The use of headphones or mobile phones should be left for the period of resting or after riding.

However, all these rules do not mean that bicycles should belong to cellars. Cycling is a very healthy sport, good for every system in the body. The most important one is cardiovascular, the number-one killer today, because cycling reduces blood pressure and thus the risk of getting heart attack or brain stroke. All this is the reason why experts from lots of different fields must engage to promote bicycle riding as a healthy way of life.

Cyclists, in general, live very healthy lives. They do not smoke, take drugs or alcohol, so the promotion of

cycling is important in that aspect as well, especially today when all that has been mentioned is increasing, primarily among teenagers and children. Cycling gives meaning to life, feeling of completion and satisfaction that leaves no room for alcohol, drugs and cigarettes. Therefore, it is very important to promote cycling as one of the ways of preventing not just cardiovascular diseases but all that has been mentioned.

SAŽETAK

BICIKLIZAM KAO REKREACIJSKA I PRIJEVOZNA POTREBA

U radu se promatra aktualna problematika biciklizma u prometu. Naglašava se moguća veća uloga bicikla u urbanim centrima kao prijevoznog sredstva koje bi moglo biti jedan od načina smanjenja prometne gužve.

Autor naglašava utjecaj biciklizma na zdravlje i ljudski okoliš. Kod toga posebno naglašava i opasnost vožnje biciklom u nesređenim prometnim uvjetima te nekorištenju zaštitnih mjera pri čemu posebno ističe ulogu kacige pri svakoj vožnji.

REFERENCES

1. According to the American Academy of Pediatrics, <http://www.cdc.gov>
2. E. Missoni, E. Missoni-Mlinarić: *Prometna medicina*, Fakultet prometnih znanosti, Zagreb 2000, page 35. Figure 2 - shows the most common injuries; over 45% are head related, legs (29%) and hands (28%).
3. Recommended by the American Academy of Pediatrics, <http://www.cdc.gov>.

LITERATURE

- [1] I. Mlinarić, T. Mlinarić: *Utjecaj željezničkog gradskog i prigradskog prometa na smanjenje prometnih nesreća u gradu Zagrebu*. Proceedings, Znanstveni savjet za promet HAZU, 1992. pp.42-45.
- [2] E. Missoni, E. Missoni-Mlinarić: *Prometna medicina*, Fakultet prometnih znanosti, Zagreb 2000.
- [3] I. Prpić: *Kirurgija*, Medicinska knjiga Zagreb-Beograd, 1986.
- [4] F. Guyton: *Fiziologija*, Medicinska knjiga Zagreb-Beograd, 1986.
- [5] *Enciklopedija leskikografskog zavoda*, Zagreb 1966., Vol. 1, p.387.
- [6] H. Backer: *Preventing dehydration*, <http://www.MedicinePlanet.com>, 14.07.2000.
- [7] American Academy of Paediatrics: *Bicycle Safety: Myths and Facts*, <http://www.cdc.gov>, 14.07.2000.