SAFETY SCIENCE Monitor
Issue 2 2013 VOL 17
Article 5

INJURIES BEFORE AND AFTER THE IMPLEMENTATION OF TRAFFIC SAFETY COUNTERMEASURES – A CASE STUDY OF A PEDESTRIAN AND BICYCLE BRIDGE

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ABSTRACT

The implementation of community injury prevention programs in order to reduce injuries caused by road traffic incidents has been a public health priority for many years. The purpose of this case-study was to investigate whether the implementation of traffic safety countermeasures on a bridge for bicyclists and pedestrians was effective in reducing the number and severity of injuries. The study was based on data from the injury database at the University Hospital of Umeå and includes data from 74 injured persons. Injury incidence, injury severity and the circumstances associated with injury incidences are reported. There was an increase in the incidence of both moderate and more serious injuries, such as brain injuries and fractures of upper extremities, after the safety countermeasures were put in place. Falls due to overturning with the bicycle dominated among single crashes. Collisions and crashes caused by giving way to pedestrians or other bicyclists were the most common types of crash. The main finding is that the modification of the bridge, which aimed to reduce injuries, has not been successful, in particular with reference to the incidence of severe injuries.

Keywords: Before-after study, Bicyclists, Injuries, Pedestrians, Safety countermeasures, Traffic environment, Road layout

1. INTRODUCTION

Injury prevention programs aimed at reducing injuries caused by road traffic incidents have been a public health priority for many years. In Sweden, the Swedish Transport Administration (STA) (former Swedish Road Administration, SRA) and local municipalities have worked for decades towards reducing fatal and serious injuries among pedestrians and bicyclists by separating the vulnerable road users from motorised traffic. Special pedestrian and bicycle paths have been built alongside roads and streets in urban areas, and these paths are even common in rural areas nowadays. Pedestrians often have the perception that it is dangerous to walk in the same lane as is used by bicyclists, and bicyclists may consider pedestrians to constitute a hindrance to their use of shared paths. However, from the pedestrian's point of view, the problem is more one of their sense of security, than a genuine risk of injury (Gibrand et al., 2009; Swedish Association of Local Authorities and Regions & Swedish Transport Administration, 2010). The number of injured pedestrians treated in hospital who slipped or tripped in a traffic environment are many more than those who were hit by a bicycle or moped (Björnstig &

Björnstig, 2000; Bylund et al., 2011). In a study by Rolfsman et al. (2012) it was shown that bicyclists reported environmental and human factors as contributing to bicycle crashes. It was discussed how it is necessary to implement specific adaptations of traffic safety countermeasures directed towards various groups, such as bicyclists and pedestrians.

In order to reduce injures in traffic environments, various methods, such as speed controls, observations and interviews are used to analyse the effects of these programs (Towliat, 2002). Altering the road layout, for example, by adding median barriers (2+1 roads), has been shown to decrease death rates by about 75 - 80% (Carlsson, 2009). It is not only the fatal injuries involving motor vehicles that are the focus of community injury preventive programs, but also countermeasures which aim to reduce less severe injuries among, for example, bicyclists and pedestrians in single crashes, i.e. involving only one person or in collisions. In order to achieve these goals it is necessary to rely on empirical data of good quality, i.e. not simply theory-based approaches (Nilsen, 2007); empirical in- and outpatient injury data (Bjerre & Shelp, 2000; Ozanne-Smith et al., 2002) and exposure data (Towliat, 2002) are crucial in order to evaluate the effects of intervention programs. In a Cochrane-review of area-wide traffic calming, aimed at preventing traffic related injuries (Bunn et al., 2009), it was concluded that further rigorous evaluations of traffic safety interventions was required.

Nilsen et al. (2007) found, in their longitudinal study of inpatient injury data, that the effects of community based prevention programs varied between municipalities and displayed an inconsistent pattern, and also that only a few of them exhibited positive trends.

Ytterstad (1995) tested the feasibility of a hospital-based injury data base (IDB) in the context of an outcome evaluation program for the reduction of injuries among bicyclists and pedestrians. He found a reduction of injuries among both bicyclists and pedestrians after introducing a comprehensive community program. Furthermore, he concluded that a hospital-based injury register may help develop the knowledge required for community intervention programmes. However, there seems to be a lack of studies that have analysed traffic safety countermeasures which are specifically for bicyclists and pedestrians using a shared designated bridge. Moreover, there seems to be a lack of studies evaluating countermeasures by using sufficient injury data from both in- and outpatient medical records. Therefore, the purpose of this case study is to investigate if traffic safety countermeasures on a bridge for bicyclists and pedestrians resulted in fewer injuries.

The bridge

To improve traffic flow and the safety of bicyclists and pedestrians in one of the busiest areas of Umeå Municipality, a new pedestrian and bicycle bridge was built in September 1998. The bridge connects non-motorised traffic from the hospital and university area with the east side of the city, bypassing a busy road near the hospital (Picture 1). In April 2003, a bicyclist was killed on the bridge after a collision with another bicyclist. This fatal crash led to an investigation regarding safety issues on the bridge which was led by the SRA together with Umeå Municipality, traffic police and medical personnel.

The bridge is 350 metres long and the gradient is five per cent, which means that bicyclists can reach high speeds on the descent. A measurement of the speed of bicyclists was conducted in November 2003 and it was found that it was commonplace to reach speeds of 20-30 km/h at the end of the bridge. These findings resulted in Umeå Municipality carrying out conflict studies to investigate how different road users interact, and the uncertainty which arises. At the end of September 2005 the road markings were re-painted in order to separate pedestrians from bicyclists and thus improve the safety of all road users (Picture 2). In a report from the SRA, Nilsson and Söderström (2009) recommended that an evaluation of all changes to the pedestrian and bicycle path layout should be performed. One tool for evaluation is the use of good quality long-term data from traffic injury registration gathered by the health sector (cf. Ozanne-Smith et al., 2002).

Changes made to the bridge

When the bridge was built it was divided into two paths where pedestrians and bicyclists were advised to share the same path. Picture 1 shows a bicyclist cycling up the bridge and some pedestrians walking down on the left side and meeting the bicyclist.

Picture 1: Design of the bridge from January 1999 to September 2005 (period 1).

Photographer: Per-Olof Bylund

After the changes were made of the path layout, the pedestrians and bicyclists were directed to separate paths on the bridge. In the lower part of the bicycle path, ribs were added to the surface in order to reduce the speed of bicycles (Picture 2).

Picture 2. Design of the bridge from October 2005 (period 2).

Photographer: Per-Olof Bylund

2. MATERIAL AND METHODS

Data includes 84 persons, injured on the bridge during the period from 1999 to 2011, extracted from the IDB. Ten persons were excluded from the study due to their injuries not being the result of factors relating to the environment of the bridge, e.g. falls when getting on or off the bicycle, slipping on the pedal, bags or other items getting caught in a wheel. The remaining 74 injured persons, 71 bicyclists, two moped riders and one pedestrian hit by a bicyclist were analysed in this study.

The University Hospital of Umeå has an IDB with a long history of injury registration of persons who have sought medical care following injury in various types of incidents. The majority of the patients are treated at the Emergency Department (ED). When an injured person seeking care they are asked to answer a questionnaire focusing on when, where and how the injury occurred. Medical and ambulance records, as well as any available police reports supplement the questionnaire. In order to minimise the number of missed cases of hospitalised patients, a check was made against the hospital's compulsory E-number (External cause of inpatient treatment-ICD-10) (National Board of Health and Welfare, 1997). The continuously performed quality check indicated approximately 5% external dropouts.

The injuries have been graded according to the Abbreviated Injury Scale (AIS) (International Injury Scaling Committee, 2005). MAIS denotes Maximum AIS, i.e. the AIS-value for the most severe injury. Minor injuries are classified as AIS1 (e.g. bruises, small wounds, fractured fingers), moderate injuries as AIS2 (e.g. concussion with loss of consciousness, radius fracture), and serious injuries as AIS3 (e.g. fracture of the femur or a moderate spleen rupture). AIS 4–6 indicates severe, critical and maximal injuries. Data regarding the influence of alcohol is mainly based on information from either the medical records or cases where the patients themselves indicated the involvement of alcohol in the questionnaire.

Descriptive statistics for numbers and proportions were used, as well as Pearson's chi-square test with Fisher's exact test. The significant level was set to .05.

Data regarding the number of bicyclists using the bridge

In order to compare the number of injured persons to the number of bicyclists crossing the bridge, traffic count data was obtained from the Community Planning Office at Umeå Municipality (Table 1). When comparing the number of bicyclists crossing the bridge, there was an increase of 13% from period 1 to period 2.

Table 1. Dates, numbers of traffic measurements and mean number of bicyclists crossing the bridge per day, distributed across the two periods.

Periods	Dates of measurement	Number of measurements	Mean number of bicyclists
Period 1	11/5/2005 – 18/5/2005	4	5205
Period 2	16/5/2006 – 24/5/2006 13/5/2008 – 27/5/2008	15	5873

Definitions

Single crash: e.g. fall due to ice/snow, gravel, stone, pothole or braking

Collision: e.g. a bicyclist in collision with another bicyclist or a pedestrian

Give way crash: e.g. a bicyclist gives way to another bicyclist or a pedestrian

3. RESULTS

3.1. Injury incidence, road users, time of the incident

Of the 74 persons injured on the bridge, 29 were injured before the modification (period 1) and 45 after the modification of the bridge (period 2). The incidence rate per month was 0.36 during period 1 and 0.60 during period 2. Almost all those injured were bicyclists (96%), two were moped riders and one was a pedestrian who was involved in a collision with a bicyclist. The proportion of women and men was evenly distributed during period 1. In period 2, the proportion of injured women was slightly higher than that of men. In total, the mean age was 28 years (SD 13.8). Most injuries occurred during evenings and nights over the course of period 1 (62%). However, in period 2 the opposite was the case, with incidents occurring predominantly during daytime (63%). Regarding season, there were no significant differences between the two periods.

3.2 Crash mechanisms, injury severity and involvement of alcohol

Single crashes predominantly involved falls due to overturning with the bicycle. Among collisions and give way crashes the most common type of crash was a bicycle colliding with another bicycle. The incidence of all types of crashes (collisions, give way crashes and single crashes) increased between period 1 and period 2 (Table 2). However, single crashes exhibit the largest increase, in particular those resulting in moderate or more serious (MAIS2+) injuries. Nine (31%) of the 29 persons injured during period 1 sustained MAIS2+ injuries, such as brain injuries and fractures of upper extremities, compared with 22 (49%) of the 45 injured during period 2. When comparing moderate or more serious (MAIS2+) injuries to the number of months per period, the incidence of MAIS2+ injuries was more than twice as high in period 2 than in period 1 (Table 2).

Fifteen (42%) of the 36 persons injured in single crashes and three (8%) of the 37 injured in collisions and give way crashes were under the influence of alcohol. A greater proportion of the males injured were under the influence of alcohol (35%) than females (16%) ($p = 0.06$). There was no difference in alcohol involvement when comparing period 1 to period 2 ($p = 0.60$).

Table 2. Number of incidents, incidence per month, crash mechanisms and injury severity distributed across the two periods.

Crash mechanisms	Period 1		Period 2		Total
	MAIS1	MAIS2+	MAIS1	MAIS2+	
Single crashes	**9**	**3**	**11**	**13**	**36 (49%)**
Incidence per month	0.11	0.04	0.15	0.17	
Collisions and give way crashes	**11**	**5**	**12**	**9**	**37 (50%)**
Incidence per month	0.14	0.06	0.16	0.12	
Unknown	**-**	**1**	**-**	**-**	**1 (1 %)**
Total	**20**	**9**	**23**	**22**	**74 (100 %)**

4. DISCUSSION AND CONCLUSION

This study presents results derived from injury data from a hospital IDB, before and after changes were made to the pedestrian and bicycle path layout, with specific reference to a pedestrian and bicycle bridge. The main finding is that the modifications made to the bridge, which aimed to reduce injuries, have not been a success. In particular, this is true with reference to more severe injuries. Data regarding the number of injured bicyclists in the city, as a whole, over the course of the same two periods examined in this study indicate that bicycle injuries in the city of Umeå are stable over time (Bylund et al., 2011). However, in this study the available data on the number of bicyclists crossing the bridge indicated an increase of 13% from period 1 to period 2, which may offer one explanation for the higher number of injured persons during period 2.

Using a hospital IDB to evaluate the results of traffic countermeasures taken in specific environments do not appear to be common. We have not found any other study with the same approach as in this case study. One reason may be that few hospitals have long-term injury registration of such a quality that it describes the circumstances and geographical location of the incident which led to the injury. Using only police records when analysing traffic injuries among bicyclists is not appropriate since they may exclude a large number of unreported cases, such as single bicycle crashes (Björketun, 2006; Bylund et al., 2011; Juhra et al., 2012).

Even if there are relatively few injuries analysed in this case report, we argue that the evaluation of the changes made to this path layout is trustworthy and robust. The existence of a well-established hospital IDB system, containing long-term data is crucial in enabling a trustworthy analysis of the effects of changes to the road layout (Swedish Association of Local Authorities and Regions & Swedish Transport Administration, 2010). In recent years a new traffic injury data registration, Swedish Traffic Accident Data Acquisition (STRADA), was implemented by the Swedish Transport Agency in most Swedish hospitals which have an ED. Thereby, researchers in other parts of Sweden should, in the future, have access to more reliable data for the evaluation of traffic safety measures.

In a focus group study by Niska (2007), bicyclists were interviewed regarding their opinion of the standard of bicycle paths in Umeå Municipality. The bicycle and pedestrian bridge which is the subject of this study was often mentioned as a “dangerous area”. The bicyclists appreciated that they no longer need to cross one of the busiest roads near the university and the hospital. However, the bridge is still too narrow which often leads to conflicts with pedestrians and other bicyclists, particular if the bicyclists accelerate to a high speed when descending the bridge. The opinion was that the situation has improved since the road markings were painted to separate pedestrians from bicyclists, but the speed among some bicyclists is still too high. Our results show that about half of the bicyclists were injured in collisions or give way crashes. This can be compared with data covering all injured bicyclists in the Umeå area over the same period which shows that only 20% of injured bicyclists were involved in collisions or give way crashes (Björnstig et al., 2001, 2006; Bylund et al., 2011).

Alcohol was one important issue, since data show that half of the bicyclists injured during late evenings and nights were under the influence of alcohol. However, there was no difference in alcohol involvement when comparing period 1 with period 2. We, in line with other researchers (Airaksinen et al., 2010; Andersson & Bunketorp, 2002; Bylund & Björnstig, 2004; Juhra et al., 2012; Rolfsman et al., 2012) argue that the influence of alcohol when biking is common, but is a factor often neglected in bicycle injury prevention strategies, so we wish to highlight this fact. In a recent national report (Swedish Government Official Report, 2012) regarding rules for safe bicycling, there was no mention of the importance of being sober when using a bicycle, such as is legislated for drivers of motor vehicles. The influence of alcohol is therefore a factor that should be further investigated. The information regarding whether the injured person was under the influence of alcohol was, in most cases, either based on the physician’s assessment or self-reported in the questionnaire. Accordingly, the ability of physicians to assess whether or not injured persons are under the influence of alcohol is a factor that should be taken into account. A Finnish study (Honkanen, 1977) found that physicians during the clinical examination were only able to identify about two thirds of patients who was later confirmed in a blood test, had consumed an excess of alcohol. Therefore we have reason to believe that the findings in this study regarding the influence of alcohol probably are underestimated.

5. CONCLUSION

The results in this study do not indicate any reduction in the incidences or in the severity of injuries following the change to the bicycle and pedestrian path layout in this case, which would have been preferable. Using various data together to analyse the effects on incidences and severity of injuries after traffic countermeasures are implemented, as in this case study, is one example of how further research can be conducted.

ACKNOWLEDGEMENTS

We thank the staff at the Emergency Department for their participation in the data collection process and the Accident Analysis Group at the University Hospital of Umeå, especially Asta Strandberg and Johanna Björnstig, for being helpful in processing the data.

DECLARATION OF INTEREST

Per-Olof Bylund is responsible for the injury data base at the University Hospital of Umeå. No conflict of interest is reported for Ewa Rolfsman and Britt-Inger Saveman.

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