Single-bicycle crashes in Finland – characteristics, risk factors, and safety recommendations

Roni Utriainen[*], Markus Pöllänen[*], Steve O'Hern[*#], Niina Sihvola[†]

[*]Transport Research Centre Verne
Tampere University
P.O. Box 600, FI-33014, Tampere, Finland
email: roni.utriainen@tuni.fi
email: markus.pollanen@tuni.fi

[#]Accident Research Centre
Monash University
Clayton, 3800, Australia
email: steve.ohern@tuni.fi

[†]Finnish Crash Data Institute (OTI)
Itämerenkatu 11–13, FI-00180, Helsinki, Finland
email: niina.sihvola@oti.fi

Keywords: cycling safety, bicycling, crash, road safety, single-bicycle crash.

1 INTRODUCTION

Physical inactivity increases the risk of multiple diseases with extensive personal and societal effects [1]. For instance, the annual economic cost of physical inactivity is estimated to be more than 80 billion euros in the European Union (EU) [2]. One measure to increase physical activity is the promotion of active transport modes, such as cycling.

Finland is aiming to increase the mode share of active transport modes to 35–38% by 2030 [3]. In the most recent national travel survey 8% of daily trips were made by bicycle and 22% of daily trips involved walking [4]. A shift from cars to more sustainable transport modes is desirable, however more work is needed to promote cycling safety, with cyclists over-represented in fatal (11%) and serious injuries (32%) when compared to mode share [5].

Amongst cyclist crashes in Finland, single-bicycle crashes (SBCs), where other road users are not collided with, represent more than half of non-fatal injuries [6–7] and 46% of fatal injuries [8–9]. This proportion of non-fatal injuries is similar to findings from other jurisdictions [6]. However, the rate of fatal injuries in SBCs is substantially higher in Finland compared to the average rate in Europe [10], highlighting the importance of understanding SBCs in a Finnish context.

Analyses of SBCs are usually more challenging than crashes between bicycles and motor vehicles because SBCs are typically underreported in police-reported crash data [11]. However, in Finland, road crash investigation teams investigate almost all fatal road crashes, including SBCs. This captures high-quality information on SBCs including their contributory and background risk factors, as well as safety recommendations. Identifying the contributory factors that enable the occurrence of crashes and implementing actions to prevent these crashes can help promote cycling safety [12]. Such analyses and actions are particularly needed in Finland, where there are targets to increase the mode share of cycling.

Given the robust data available through the in-depth investigations undertaken in Finland, this study aims to increase knowledge on SBCs and their safety recommendations by analysing data on fatal cycling crashes in Finland. The study compares the key characteristics, risk factors and safety recommendations regarding SBCs and other cyclist crashes. Although the data for this study is sourced from Finland, the findings are useful in other countries with similar bicycle infrastructure and weather conditions.

2 DATA AND METHOD

This study analyses in-depth investigated crash data on fatal cyclist crashes in Finland from 2010 to 2019. Data was collected from investigations undertaken by the multidisciplinary road crash investigation teams.

In total, 2,442 fatal crashes were investigated between 2010 and 2019, of which 232 involved a fatal injury to a person riding a bicycle. Of the 232 cyclist cases, 82 (35.3%) were SBCs. Of other cyclist crashes (n=150, 64.7%), 137 involved a collision with a motor vehicle, eight cases were collisions with other cyclists and five cases were collisions with pedestrians.

This study presents descriptive analysis of key crash characteristics including cyclists' age, gender, weather conditions, road conditions, location of the crash, and time of the crash. In addition, immediate risk factors (factor that actively influences on the occurrence of the crash), crash mechanisms, background risk factors, and safety recommendations documented by the investigation teams are compared between SBCs and other cyclist crashes. Logistic regression analysis was performed to identify differences between SBCs and other cyclist crashes. Chi-squared tests ($\chi 2$) or Fisher's exact test were performed to identify differences in risk factors and safety recommendations between SBCs and other cyclist crashes. Effect size was assessed using Cramer's V statistic (φc). Statistical analysis was executed using IBM SPSS v.28.

3 RESULTS

3.1 Characteristics of fatal cyclist crashes

Fatal SBCs commonly involved people aged 60–79 (48.8%), males (86.6%), and cyclists not wearing a helmet (76.5%). In addition, these crashes typically occurred in bright or cloudy weather (92.6%), in dry road surface conditions (79.5%) and on a cycle path or a sidewalk (47.6%). In 32.1% of SBCs, a cyclist was under the influence of alcohol. SBCs occurred typically between 8:00 AM and 8:00 PM (61.2%) and during daylight (72.0%). SBCs were most common in summer (45.1%) compared to other seasons and on weekdays (65.9%) compared to weekends.

The results of the logistic regression presenting the differences between SBCs and other cyclists crashes show that males were more often involved in SBCs. In addition, SBCs occurred more commonly on cycle paths or sidewalks, or on the roadway, compared to other cyclist crashes which most commonly occurred at intersections. SBCs were also more common on weekends than on weekdays compared to other cyclist crashes. No other statistically significant differences were identified.

Statistically significant differences were identified when comparing immediate risk factors between SBCs and other cyclist crashes ($\chi 2$ (4) = 159.54, $p < 0.001$, $\varphi c = 0.83$). Cyclist's health issues were the most common immediate risk factors in SBCs (62.2%), but they were not common in other cyclist crashes (1.3%). In other cyclist crashes, the most common immediate risk factor was an observation or anticipation error (74.0%), which only contributed to 7.3% of SBCs.

3.2 Background risk factors in SBCs

Background risk factors are classified as factors that enable the occurrence of the immediate risk factors. The investigation teams identified human factors as the most common contributing factor in both SBCs and other crash types (53.2% in SBCs and 49.0% in other cyclist crashes). The next most common factor was related to the bicycle and equipment (24.3% in SBCs and 24.9% in other cyclist crashes). No statistically significant differences were identified between the main groups of background risk factors ($p = 0.47$, Fisher's exact test).

3.3 Safety recommendations in SBCs

Recommendations regarding the human factors were the most frequent for both crash types (57.5% in SBCs and 43.6% in other cyclist crashes). For SBCs, the next most common recommendations related to regulation (17.3%) and the traffic environment (15.8%). For other cyclist crashes traffic environment was the next most common (30.7%) before regulation (15.5%). The differences between SBCs and other cyclist crashes in the main groups of safety recommendations were statistically significant ($\chi 2$ (3) = 25.36, $p < 0.001$, $\varphi c = 0.16$).

4 DISCUSSION AND CONCLUSIONS

This study presented an analysis of fatal cyclist crashes in Finland between 2010 and 2019 highlighting the characteristics, background risk factors, and recommendations for safety made by the crash investigation teams

who investigated each crash. The focus was to explore SBCs and draw comparisons between SBCs and other cyclist crashes. The findings provide insight into the unique characteristics of SBCs.

The study found that SBCs commonly involved people aged 60–79, males, and cyclists not wearing a helmet. Human factors were reported as background risk factors in most SBCs and other cyclist crashes. Risk factors related to illness and use of alcohol in particular were highlighted in SBCs.

Recommendations by the investigation teams related to human factors in SBCs highlight informing cyclists about the risk factors regarding cycling under the influence of alcohol and while fatigued. Sober cycling could also be promoted by introducing a blood alcohol limit for cyclists, which is currently under consideration in Finland. Other recommendations related to human factors included informing cyclists about the use of helmets and better surveillance of underlying medical conditions.

The findings from this study will be further discussed considering the Safe System approach with recommendations regarding the human factors, the bicycle, the traffic environment, and the regulation. Actions regarding all these factors are needed to reduce SBCs and improve cyclist safety.

REFERENCES

[1] T. Vasankari, P. Kolu, J. Kari, J. Pehkonen, E. Havas, T. Tammelin, et al., *Costs of physical activity are increasing – the societal costs of physical inactivity and poor physical fitness*, Publications of the Finnish Government's analysis, assessment and research activities, 2018.
[2] CEBR, *The economic cost of physical inactivity in Europe*, Centre for Economics and Business Research, Available (accessed 25.3.2022): https://inactivity-time-bomb.nowwemove.com/.
[3] S. Jääskeläinen, *Programme for the promotion of walking and cycling*, Ministry of Transport and Communications, Helsinki, Finland, 2018.
[4] Finnish Transport Agency, *Finnish National Travel Survey 2016*, Helsinki, Finland, 2018.
[5] Official Statistics of Finland, *Statistics on road traffic accidents*. Helsinki, Finland. Available (accessed 1.2.2022.): https://www.stat.fi/til/ton/2021/12/index_en.html.
[6] R. Utriainen, S. O'Hern and M. Pöllänen, "Review on single-bicycle crashes in the recent scientific literature", *Transport Reviews*, (2022).
[7] N.K. Airaksinen, I.S. Nurmi-Lüthje, J.M. Kataja, H.P.J. Kröger and P.M.J. Lüthje, "Cycling injuries and alcohol", *Injury*, 19:5 (2018), pp. 945–952.
[8] S. Salenius and N. Sihvola, *OTI annual report 2018*, Finnish Crash Data Institute, Helsinki, Finland, 2020.
[9] N. Sihvola, *OTI annual report 2019*, Finnish Crash Data Institute, Helsinki, Finland, 2021
[10] P. Schepers, N. Agerholm, E. Amoros, R. Benington, T. Bjørnskau, S. Dhondt, B. de Geus, C. Hagemeister, B.P.Y. Loo and A. Niska, "An international review of the frequency of single-bicycle crashes (SBCs) and their relation to bicycle modal share", *Injury Prevention*, 21 (2015), pp. 138–143.
[11] K. Gildea and C. Simms, "Characteristics of cyclist collisions in Ireland: Analysis of a self-reported survey", *Accident Analysis & Prevention*, 151 (2021), 105948
[12] L.B. Meuleners, M. Fraser, M. Johnson, M. Stevenson, G. Rose and J. Oxley, J, "Characteristics of the road infrastructure and injurious cyclist crashes resulting in a hospitalisation", *Accident Analysis & Prevention*, 136 (2020), 105407.