Risk Assessment of Cyclist Falls in Snowy and Icy Conditions

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1 BACKGROUND

Cycling as a mean of active mobility comes along with numerous benefits. It is environmentally friendly, inclusive, inexpensive, flexible, space efficient and improves public health thanks to the physical activity related to active mobility [1]. Increased cycling levels can thus help to mitigate the adverse effects caused by motorized private vehicles, particularly in urban areas with their dense structures, mixed land use and multi-modal transport supply. These transport-related problems include congestion, climate change, air pollution, noise, and land consumption. Cycling should therefore be promoted throughout the year. Particularly in wintertime in snowy and icy conditions, high quality cycling facilities are a precondition for encouraging people to cycle and for minimizing risks to fall or to get involved into an accident.

Experience and key data suggest that snow and ice lead to increased numbers of cyclist falls during the winter months. Reliable in-depth data concerning the extent and characteristics of this issue are currently not available in most countries. In Germany, this is due to the high level of under-reporting in official statistics, particularly for incidents involving only one bicyclist. In combination with the lack of knowledge on exposure this causes difficulties to quantify risks for cyclist falls.

2 AIM

This study addresses these gaps. It aims at quantifying the risk of single bicycle accidents in inclement weather conditions. This study focusses on icy and snowy conditions as these are of relevance for the risk to fall. Cyclists are particularly affected by slippery icy and snowy road conditions; these might exist in clear, cloudy, or foggy weather, in situations with high or low humidity and with higher or lower wind speed. Variables from official weather data are purposefully combined in this study to identify time periods with snow or ice on the roads and to allow for the comparison of those with all other time periods (“other weather”).

We address the above-mentioned problems of exposure and underreporting by using multiple data sources for quantifying the risk of falls. This approach allows to compute clear risk ratios for icy/snowy and the other weather conditions and thus contributes to the scarce and fragmented literature that has generated such values so far.

3 METHOD

A total of 5,298 participants reported 5,709 bicycle falls on public roads, paths, and sidewalks from a 5-year period in a retrospective survey. The survey was conducted both online (3,208 respondents) and as a field study in both snowy/icy and other conditions (2,099 respondents). All respondents were also asked about the kind of medical treatment they received and whether the fall was reported to official databases.

We used meteorological data to assign falls and exposure to snowy/icy and other weather conditions and to account for the substantial differences in the number of days for these two situations. We defined days as "snow or ice" when either previously fallen snow has not yet thawed, new snow has fallen and/or liquid precipitation falls during the day with minimum temperatures close to freezing point.

For quantifying risk exposure, we analyzed data from the trip-based household travel survey (HTS) "Mobility in Cities – SrV" [2]. For this purpose, the daily distances travelled by bicycle by all 22,772 respondents in either snowy/icy or other conditions on their respective reporting day were calculated.

We then calculated the risk in the form of cyclist falls per distance by dividing (1) the mean number of falls per person and study period by (2) the mean distance travelled by a person on a day with specific weather conditions and (3) the number of days with such weather conditions per period.

$$Risk = \frac{Falls}{Distance} = \frac{\frac{Falls}{Person * Period}}{\frac{Distance}{Person * Day} * \frac{Days}{Period}} \quad (1)$$

4 RESULTS

4.1 Distances travelled by bicycle

HTS respondents reported an average distance travelled by bicycle of about 1.5 km per person per day. When there was snow or ice on the reporting day, this average distance was only about 0.8 km per person per day (see figure 1). This is a statistically significant decrease of about 50 %, which is in line with findings from literature, e.g., 47 % reduction in number of bicycle trips by Bergström and Magnusson [3].

Overall, women reported cycling an average of 40 % less distance than men. Among the age groups, the 18–44-year-old reported the greatest average daily cycling distance of about 2.3 km per person. In contrast, those over 65 reported significantly shorter distances of 0.7 km per person per day on average.

Due to the smaller sample sizes of reporting days with snow or ice (around 15 % of respondents), no significant difference between genders or age groups can be observed in the decrease in average cycling distance per person per day with snow or ice. However, respondents aged 65 or older reported the highest average decrease at 70 %.

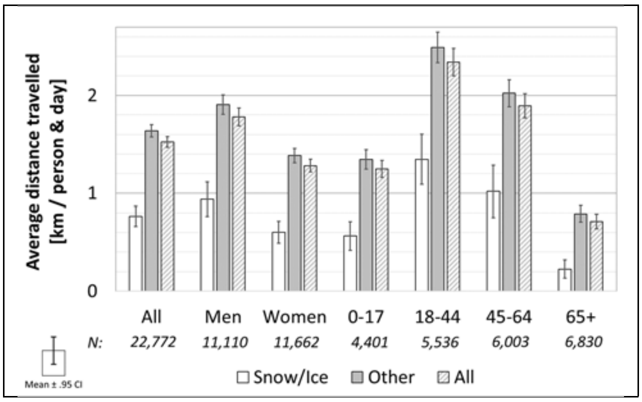

Figure 1: Average daily cycling distances covered by HTS respondents in various weather conditions, by gender and age (N=HTS respondents)

4.2 Risk of falling with a bicycle

On average, all respondents in our field surveys reported 57 crashes per 1,000 person-years. A similar rate of 55 per 1,000 person-years was found by Olesen et al. [4] for single bicycle crashes, but among active cyclists in Denmark. In contrast, participants in our supplementary online survey, which also took place during a period of snow and ice, reported an average of 319 falls per 1,000 person-years. We suspect a non-response bias as the reason for this difference, since due to the topic of the survey (winter service on footpaths and cycle paths) more active cyclists with many experienced bicycle falls may have participated.

Taking exposure into account (traffic volume and temporal proportion of weather conditions), 0.9 falls per 10,000 km travelled were reported during the field surveys conducted in snow/ice (see figure 2). This was less than during the field surveys conducted in other weather conditions (1.2 falls per 10,000 km travelled). During the online survey, an average of 5.7 falls per 10,000 km travelled were reported.

Results from all three surveys show a significantly higher average risk of falling by bicycle in snow/ice than in other weather conditions. However, the main differences in snow/ice risk ratios are not between online and field surveys, as is the case with the total falls per distance travelled, but between the weather conditions at the time of the field surveys: The average risk ratio based on the online survey is 38 and based on the field survey during snow/ice 36, while it is only 20 based on the field survey during other weather. There is a tendency of lower risk ratios among respondents aged 45 and older, but these differences are not statistically significant.

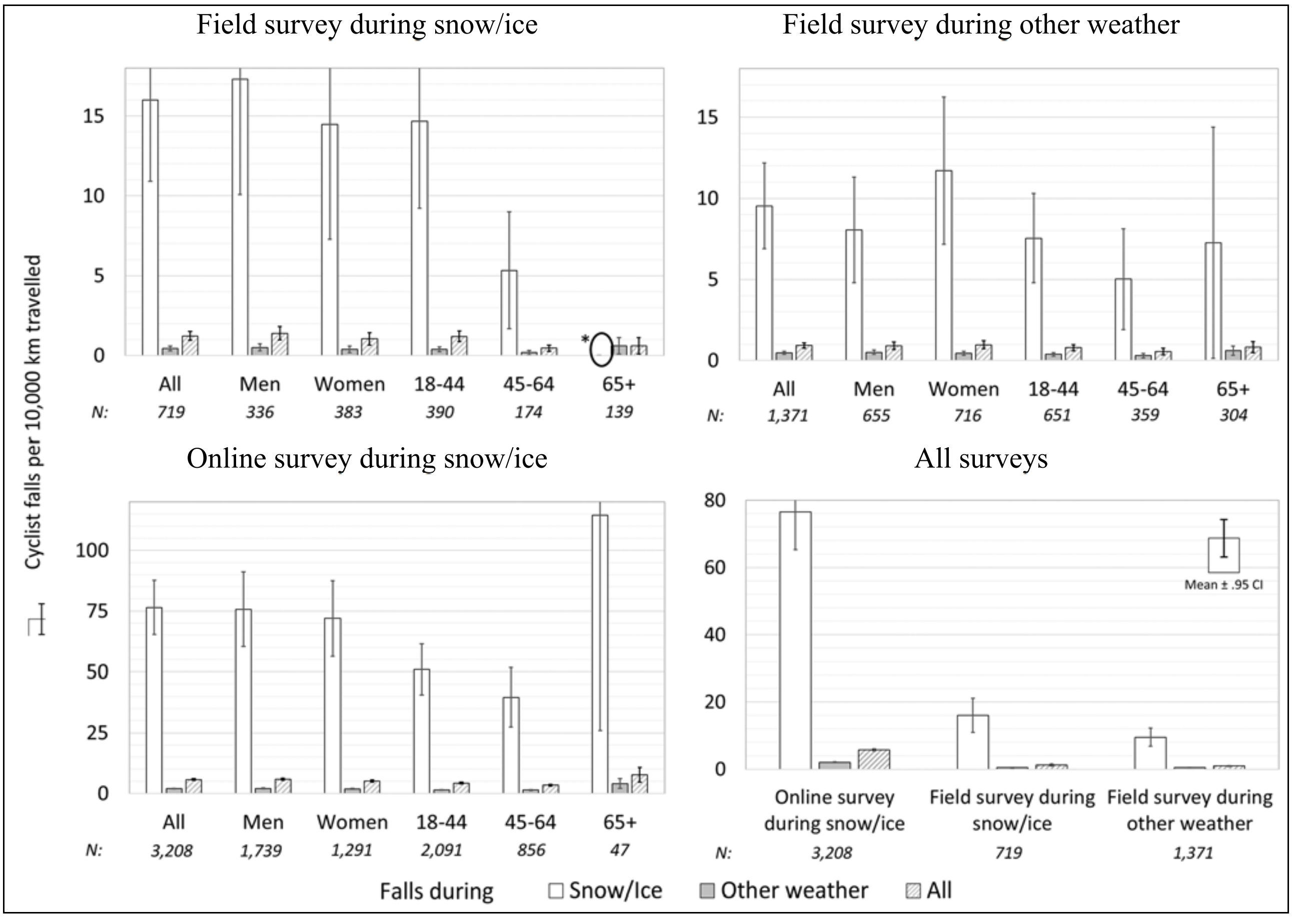

*Figure 2: Cyclist falls per 10,000 km travelled in different weather conditions by gender and age reported in field survey during snow/ice (top left), field survey during other weather (top right), online survey during snow/ice (bottom left), and compared for the three surveys (bottom right, total only). (N=Respondents, *No data about falls on snow/ice)*

5 CONCLUSIONS

With this study, we provide data on cyclist falls and exposure to address the mentioned lack of knowledge. The risk ratios calculated from different data sources underline the high importance of improving winter maintenance on cycling facilities. Also, the findings provide helpful insight into the extent of survey effects, which can be taken into consideration when designing future studies.

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