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Risk compensation? – The relationship between helmet use and cycling speed under naturalistic conditions

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1 INTRODUCTION

Habitual helmet use is still the exception, rather than the rule, among cyclists. In 2015, only 18% of observed German cyclists wore a helmet [1]. Making helmet use mandatory through corresponding legislation, however, is highly controversial, since the positive effects of helmets (such as the reduction of head injuries in the event of a crash) could be offset by additional negative effects. It has been argued that bicycle helmet laws reduce the amount of cycling and as a consequence eliminate the positive effects on health [2]. Another argument against mandatory helmet use is based on the idea of risk compensation, i.e. cyclists might adapt their behaviour in accordance to the perceived risk in a given situation [3], [4]. It has been suggested that cyclists who wear a helmet might compensate for the perceived increase in safety by cycling more risky, e.g., by cycling faster, and hence objectively increasing their risk of being involved in a crash [5]. Evidence for this suggestion, however, is hard to find. In Norway, about 1,500 cyclists were asked about helmet use, risk perception and cycling at high speed [6]. The findings indicate that fast cycling is the reason for helmet use, and not the other way around, as faster cyclists are aware of their increased risk, and actively try to reduce it through helmet use. Based on the participants self-reports, helmet use also did not appear to be associated with accident involvement. In an experimental study, the cycling speed of routine helmet user was compared to the speed of cyclists who never wear a helmet. In one experimental block, all participants were required to wear a helmet, in a second one, none of them did. The results show that routine helmet users cycled slower when not wearing a helmet compared to the condition in which they wore a helmet. However, there was no comparable effect for non-helmet users. The authors concluded that cycling with a helmet did not lead to increased speed [7]. However, so far there is no investigation of the relationship between helmet use and cycling speed under natural conditions. Also the role of other contributing factors, such as trip length, is not well understood. It is known that trip length plays an important role for helmet use. In interviews and questionnaires cyclists stated that they use a helmet particularly for longer trips [8], [9]. Furthermore trip length is correlated with the cycling context (e.g., type of road, frequency of intersections, presence of other road users), which also has an impact on cycling speed. Other relevant factors might be cyclist characteristics, such as age or gender, as well as characteristics of the bicycle. The goal of this study was to investigate the relationship between helmet use and cycling speed under naturalistic conditions while taking characteristics of cyclists and bicycles into account.

2 METHOD

The analysis was based on the data collected in a naturalistic cycling study [10]. The participants' bicycles / pedelecs were equipped with a data acquisition system, which included wheel sensors to record speed and distance, as well as two cameras on the handlebar of the bicycle. One camera recorded the face of the participant and the other one the forward scenery. For each participant, data was collected over a period of four weeks. They were instructed to use their bicycle or pedelec as they normally would do including wearing / not wearing a helmet. Participants were asked to record each trip they made.

We used the data of 76 participants (32 female, 44 male). Twenty-eight of them were riders of a conventional bicycle, 48 rode a pedelec (e-bike with 250 W, motor assistance up to 25 km/h). The cyclists were on average 53 years old (*SD* = 17.2), the pedelec riders 54 years (*SD* = 16.6). They cycled on average on 5 days per week. In total, the participants recorded nearly 12,700 kilometres of cycling. The videos of the riders' face were used to address the question of helmet use. This information was then linked to information on trip length, cycling speed and other data in a database.

3 RESULTS

The data of 3,416 trips were included in the analysis, 1,902 trips with helmet and 1,514 trips without helmet. This corresponds to a helmet usage rate of 56%. Pedelec riders used a helmet significantly more often than riders of conventional bicycles (66% vs. 42%; $U = 445.5$, $p = .013$). Overall, trips in which participants wore a helmet were longer ($M = 3.8$ km, $SD = 3.6$, 95% CI [3.0., 4.6]) compared to trips without helmet ($M = 1.9$ km, $SD = 1.9$, 95% CI [1.5, 2.3]). Speed was slightly higher in trips in which participants wore a helmet ($M = 12.6$ km/h, $SD = 8.0$, 95% CI [10.8, 14.4]) compared to trips without helmet ($M = 10.2$ km/h, $SD = 7.5$, 95% CI [8.4, 11.9]).

A multiple linear regression analysis was conducted to predict cycling speed with helmet use, trip length, age, gender, and bicycle type. These five predictors explain a significant amount of the variance in cycling speed ($F(5;70) = 24.12$; $p < .001$; $R^2 = .633$; $R^2_{adj} = .606$). Age exhibits the largest effect on cycling speed (see Table 1). The older the riders, the slower they travelled. Trip length had a moderate effect. Longer trips were accompanied by higher speed. Gender and bicycle type had a small effect as well. Men rode faster than women, and pedelec riders faster than riders of conventional bicycles. Helmet use, however, had not significant effect on speed.

Table 1: Results of the multiple regression analysis for predictor variables on speed, N = 76.

Predictor	*b*	*SE b*	β	*p*	r_{part}
Age	-0.141	.018	-.575	< .001	-.688
Trip length	0.576	.112	.407	< .001	.522
Gender	0.866	.311	.209	.007	.316
Bicycle type	0.670	.318	.158	.039	.244
Helmet use	0.470	.316	.115	.142	.175

4 CONCLUSION

In line with the results of previous investigations on cyclists' helmet use [9], cycling trips were longer when riders wore a helmet, compared to when they did not. At the same time, the regression analysis showed that trip length can be a good predictor of cycling speed. Apparently, helmet use does not affect cycling speed. Instead, other factors such as rider age, gender or bicycle type seem to have a significant influence. In fact, it appears reasonable to assume that these same factors might influence the riders' choice to wear or not wear a helmet, which in turn might explain the slightly increased speed when a helmet was worn. The assumption that there would be behavioural compensation as a result of the use of a helmet could not be confirmed. Instead, the findings seem to support the suggestion that faster cyclists are aware of their increased risk, and actively try to reduce it through the use of a helmet [6].

It has to be acknowledged that our participants' helmet usage rate was higher compared to other observations in Germany [1]. One potential explanation might be found in the subject sample for this investigation. It can be assumed that the reliance on volunteer participants has resulted in a rather safety conscious sample, as a high cycling frequency and an interest in safety related issues might certainly be prevalent in those willing to participate. Nevertheless, the fact that most of our participants could be frequently observed both with and without helmet suggests that the mechanism of risk compensation would have been uncovered if it played a role in cyclists' choice of speed.

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