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Sport Cycling Crashes among Males on Public Roads, the Influence of Bunch Riding, Experience and Competitiveness

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Abstract: Introduction: Since 2006, the number of seriously injured bicyclists in The Netherlands has increased significantly. This is also the case for sport cyclists. Over 80% of sport cyclists are male. We propose three factors that may contribute to involvement in sport cycling crashes among males: Bunch riding (cycling in a group), the inflow of sport cyclists with little experience and a competitive attitude. Methods: Early 2014, a questionnaire was sent to 2625 members of the Dutch Tour Cycling Union to obtain data on involvement in sport cycling crashes in the year 2013 and possible contributing factors (e.g., bunch riding, experience, competitiveness, distance travelled). Binary logistic regression analysis was applied to compare data from male respondents (N = 744). Contrast was made between those who reported involvement in a crash (N = 313) and those who did not (N = 431). Results: Male sport cyclists who are involved in bunch riding and those who are relatively inexperienced (less than three years compared to more than 10 years) have a higher crash involvement (Odds Ratio (OR) = 1.79; 95% Confidence Interval (CI) = 1.26 – 2.54) and (OR = 2.93; 95% CI = 1.42 – 6.06) regardless of age, annual distance travelled and competitive attitude. Annual distance travelled was not related to crash involvement over the year 2013, indicating that cyclists who travel a longer annual distance have a lower risk (persons involved in at least one crash per km). Conclusions: We recommend that the efficacy of bunch riding training interventions among males is evaluated, with the focus on promoting safety among inexperienced sport cyclists and bunch riding.

Keywords: sport cycling among males; bunch riding; cycling experience; competitiveness; road crash prevention

1. Introduction

The evidence of the health benefits of cycling are well documented and many international initiatives promote this mode of transport [1]. However, casualty data of the year 2009 indicate that the proportion of deaths (26%; 185/720) and seriously injured (55%; 10,802/18,576) among cyclists in The Netherlands is substantial [2,3]. Although road safety in The Netherlands has improved by a factor of five over the past 40 years, this is most pronounced with respect to casualties in crashes involving motorized vehicles (fatalities, seriously injured) [2,4]. Over the past eight years the situation has not improved much for injuries sustained by cyclists in crashes not involving motorized vehicles.

Cycling is a common mode of transport in The Netherlands, especially for short distance trips and for everyday purposes like traveling to school, shopping or commuting to work [5]. A special group among cyclists in The Netherlands are the about 600,000 sport cyclists (18 years and older),

who use the public road infrastructure. They are mainly men (83%), their mean age is 42 and their average annual distance cycled is about 3000 km. About 10% perform their sport as a member of a sport cycling club, the other 90% are not cycling club members. Sport cyclists in both groups have an average of eight years of experience [6]. Statistics from the emergency department of Dutch hospitals indicate that the number of injured sport cyclists treated at the emergency ward increased from about 2000 (average 2007–2010) to 4200 in 2012 [6].

The increasing popularity of sport cycling is reflected in the about 35% increase in members of the Dutch Tour Cycling Union (NTFU) over the past five years. This trend implies an increased influx of inexperienced sport cyclists. Several road safety studies indicate that inexperienced road users have a relatively high risk of crash involvement [7,8]. However, only very limited evidence is available for the association between sport cycling experience and crash involvement. The possible impact of experience on crash involvement may be due to the relatively high cycling speed while cycling at short distances from one another in a bunch (cycling in a group); especially among those who cycle with a competitive attitude [9]. Bunch riding itself has been reported to have relatively high crash involvement compared to cycling alone [10,11]; however, little is known about the impact of bunch riding in a sports context. All kinds of crash type risks could be affected by bunch riding in sport cycling due to for instance short distances and limited view on the road. These circumstances require potentially a high level of concentration and skills to avoid a crash in case of unexpected changes in speed or direction of the sport cyclists in the bunch. Just touching a fellow sport cyclist could initiate a complete loss of balance (fall) or will make a cyclist swerve and crash with an obstacle or other road user.

Crash involvement among sport cyclists is expected to be related both to their level of experience and to how they usually perform their cycling sport; individually or in a bunch with a more or less competitive attitude.

2. Methods

2.1. Sample

All 2625 Dutch sport cyclists included in the survey had a membership at the NTFU, and were recruited in 2014. The Dutch Tour Cycling Union provides several services to their sport cycling members like an agenda for cycling tours, providing information about cycling safety and insurance facilities. Of the invitees, 718 were part of a regular research panel of the NTFU, 261 others had previously expressed an interest in participating in future research, and 1645 received the invitation because they had filed an insurance claim related to their cycling activities in 2013. The latter group was invited as a means to increase the number of sport cyclists who experienced a sport cycling related crash in 2013. The survey recruitment was conducted based on the mail addresses of members of the NTFU. They received from the NTFU an email invitation containing a hyperlink to the questionnaire webpage from which they could start. This procedure implied that the privacy of the members was respected. The questionnaire was completed by 1049 respondents; a response rate of 40%. Those who did not finish the questionnaire, those younger than 10 years or those reporting not being a sport cyclist were excluded from the analysis (Total N = 142). We also excluded off-road sport cyclists (N = 121), leaving 786 respondents; 744 men and 42 women. For further analysis we selected only the male respondents. The main argument is the well-documented difference in the traffic crash risk between men and women [2,4]. As such, it is not justifiable to include the small number of women in our analysis. Therefore, the analyses were performed on 744 male sport cyclists.

2.2. Instrument

The questionnaire that was used consisted of three sections: general information, sport cycling behaviour, and crash involvement.

The general section asked questions on, among others, demographic information: Sex and age (in years), education level.

The sport cycling behaviour section included questions on, among others, the most common type of sport cycling (on/off the road, other), an estimate of the annual distance cycled (calculated from frequency of sport cycling in 2013 and the average distance per cycling trip), cycling experience (in the number of years the respondents had performed sport cycling). Respondents were asked if they almost always cycled alone; if so, they are regarded as non-bunch riders. In contrast, those who reported cycling mostly with others are regarded as bunch riders in a group of at least 2 cyclists. Respondents were also asked to indicate whether they cycle with a competitive attitude: "for winning/competition" and "for improving my performance".

In the crash involvement section respondents reported their crash involvement while sport cycling retrospectively over the year 2013, as well as some details (like riding in a bunch in general and at the time of the crash) about the crash or the most prominent crash if there were more than one. Crashes to be reported included any event in which the cyclist fell down or collided.

2.3. Analyses

Using Statistical Package for the Social Sciences (SPSS), analysis was performed on the data of 744 men. First the "annual distance travelled" was estimated by multiplying "trip frequency" and "average trip distance". The outcome was divided by two as the sports cycling season has a duration of approximately six months. We categorised the outcomes into four categories of equal exposure intervals to discriminate between subjects cycling relative short and long yearly distances, as shown in Table 1.

Table 1. Characteristics of the male respondents and their crash involvement in 2013 in The Netherlands.

Variable	Value	Respondents N, (%)	Crashes N, (%)
Bunch riding	Yes	540 (72.6)	246 (78.6)
	No	204 (27.4)	67 (21.4)
Cycling experience (year)	<3	39 (5.2)	24 (7.7)
	3–10	258 (34.7)	128 (40.9)
	>10	447 (60.1)	161 (51.4)
Age (year)	<35	60 (8.1)	30 (9.7)
	35–45	121 (16.3)	61 (19.7)
	45–55	228 (30.6)	97 (31.3)
	55–65	230 (30.9)	84 (27.1)
	>65+	100 (13.4)	38 (12.3)
	Missing	5 (0.7)	-
Annual distance cycled (km)	<3000	267 (35.9)	111 (35.5)
	3000–6000	107 (14.4)	46 (14.7)
	6000–9000	240 (32.3)	105 (33.5)
	>9000	130 (17.4)	51 (16.3)
Cycling motivation	Competitive	243 (32.7)	114 (36.4)
	Non-competitive	501 (67.3)	199 (63.6)

Note: *: Flags a significant effect ($p < 0.01$).

The variable "cycling motivation (competitive, non-competitive)" was created by contrasting the respondents who did and those who did not select one or both of the competitive attitude arguments for sport cycling.

The relationship between experience, bunch riding, competitiveness and possible confounders (distance travelled and age), as well as the dependent variable (reported involvement in a sport bicycle crash in 2013), were analysed in a binary logistic regression model.

3. Results

3.1. General Characteristics of the Respondents

The distribution of the characteristics of the male respondents is presented in Table 1. Most sport cyclists engage in bunch riding; 72.6% (n = 540). 39 respondents (5.2%) had less than three years of experience and 447 (60.1%) respondents had been involved in the sport for 10 years or more. The age distribution shows that most respondents are between 45 and 65 years of age (62%; n = 458); their average age is 52.7 years old. The estimated distance travelled (exposure) varies from <3000 km (35.9%) to >9000 km (17.4%) per year, with an estimated average of approximately 5500 km per year.

3.2. Characteristics of Reported Sport Bike Crashes

Involvement in a public road crash was reported by 313 of the 744 male respondents. Table 2 presents some characteristics of the reported crashes; disaggregated into sport cyclists who reported regular bunch riding and those that did not. The results indicate that frequent bunch riders are mostly involved in bunch riding crashes (76.4%) and frequent non-bunch riders mostly in non-bunch crashes (62.5%) ($p < 0.00$). Bunch riders were also more often involved in crashes involving regular cyclists ($p < 0.05$). Non-bunch riders reported bunch riding crashes (37.3%) as well as bunch riders reported non-bunch riding crashes (23.6%) because members of each category did not exclusively perform one way of cycling.

Table 2. Types of sport cycling crashes and circumstances disaggregated into male bunch riders and non-bunch riders in The Netherlands in 2013.

Variable	Bunch Rider:		
	Yes N (%)	**No N (%)**	**Chi-Square**
Crash type:			
Bunch riding crash	188 (76.4)	25 (37.3)	$p < 0.001$
Non-bunch riding crash	58 (23.6)	42 (62.5)	-
Total (N = 313; 100%)	246 (78.6)	67 (21.4)	-
Circumstances			
Collision with:			
Sport cyclist	47 (21.1)	8 (12.5)	ns*
Car	21 (9.4)	6 (9.4)	ns
Regular cyclist	8 (3.6)	6 (9.4)	$p < 0.05$
Other	8 (3.6)	7 (10.9)	$p < 0.05$
Single sided crash:			
Hit object	34 (15.2)	8 (12.5)	ns
Lost balance	83 (37.2)	21 (32.8)	ns
Poor road quality	14 (6.3)	2 (3.1)	ns
Other	8 (3.6)	6 (9.4)	$p < 0.05$
Total (N = 287)	223 (100.0)	64 (100.0)	-
Unknown (N = 26)	23	3	-
Total (N = 313; 100%)	246(78.6)	67 (21.4)	-

Note: *: not statistical significant ($p > 0.05$).

In three quarters (75.7%; n = 237) of all crashes (N = 313) an injury was reported. Most frequent were abrasions (58.5%; n = 183), bruises (37.1%; n = 116) and/or fractures (16.6%; n = 52). Of the injured persons 60% (n = 142) received medical treatment. Almost half were treated at the emergency department of a hospital (48%; n = 68) and about a quarter were admitted to the hospital (27%; n = 38). Due to the impact of the injury, those reporting injury indicated frequently that they had not been able

to participate in further cycling (61.6%, n = 146), occupational work (26.2%, n = 62) and/or household work (23.2%, n = 55) for some time.

3.3. Logistic Regression Model of Crash Involvement

Table 3 displays the univariate odds ratios (OR) between each variable and the crash involvement. The results indicate that relatively inexperienced cyclists (for both categories less than 10 years of experience), as well as those who frequently engage in bunch riding were more often involved in biking crashes. Competitive cycling motivation showed a trend towards higher crash involvement, however this trend failed to reach levels of significance. Both age and distance travelled showed mixed results, none of which was significant.

Table 3. Odds ratios and 95% confidence intervals (95% CI) of the univariate and multiple logistic regression analyses including all three predictors (Experience, Bunch, Competitiveness) controlling for age and exposure, and involvement in a sport cycling crash in 2013 in The Netherlands as dependent variable.

Independent Variables	Categories	Univariate Results		Multiple Results	
		Odds (95% CI)	Sig.**	Odds (95% CI)	Sig.
Bunch riding	Yes	1.71 (1.22,2.40)*	<0.01	1.79 (1.26, 2.54)*	<0.01
	No	-	-	-	-
Experience	<3 year	2.84 (1.45, 5.57)*	<0.01	2.93 (1.42, 6.06)*	0.01
	3–10 year	1.75 (1.28, 2.39)*	<0.01	1.58 (1.11, 2.24)*	0.02
	>10 year	-	-	-	-
Age	<35	-	-	-	-
	35–45	0.61 (0.32, 1.17)	0.14	0.87 (0.42, 1.79)	0.71
	45–55	0.58 (0.32, 1.02)	0.06	0.83 (0.44, 1.57)	0.57
	55–65	0.74 (0.42, 1.31)	0.30	0.86 (0.47, 1.58)	0.63
	>65	1.02 (0.55, 1.89)	0.96	1.14 (0.61, 2.16)	0.68
Exposure	<3000 km/year	-	-	-	-
	3000–6000 km/year	0.91 (0.59, 1.39)	0.66	1.23 (0.71, 1.77)	0.62
	6000–9000 km/year	1.09 (0.77, 1.56)	0.62	1.22 (0.84, 1.78)	0.29
	>9000 km/year	1.06 (0.67, 1.67)	0.80	1.23 (0.77, 1.96)	0.40
Cycling motivation	Competitive	1.34 (0.99, 1.83)	0.06	1.19 (0.85, 1.66)	0.31
	Non-competitive	-	-	-	-

Notes: Cox and Snell R^2 = 0.045; Nagelkerke R^2 = 0.06. *: Flags a significant effect ($p < 0.05$). **: Level of significance.

Table 3 also shows the odds ratios for the multiple logistic regression model, including all three variables (experience, bunch, competitiveness), while controlling for the possible covariates "age" and "exposure".

The model shows that both "bunch riding" and "experience" (for all categories) independently contribute significantly towards explaining crash involvement. The variables cycling motivation, age and exposure do not contribute significantly.

4. Discussion

4.1. Main Findings

Male sport cyclists who frequently engage in bunch riding have higher crash involvement while performing their cycling sport compared to those who mostly cycle alone. In addition, relatively inexperienced male sport cyclists appear to be more likely to become involved in sport cycling crashes, irrespective of their age. The likely association between experience and distance cycled was controlled in multiple logistic regression analyses (Table 3). We also found an indication (univariate) that having a competitive attitude towards sport cycling increases crash involvement; although this relation did

not reach statistically significance. Age and distance travelled did not contribute significantly to crash involvement. Injuries due to crashes restricted almost two thirds of the male casualties from further sport cycling for at least some time, and about a quarter in the participation in their household and occupational work for at least one day.

4.2. Strengths and Limitations

We conducted a cross-sectional study, therefore the associations between factors cannot be considered as causal relations.

The data collected and analysed in this study were obtained through self-reporting of male respondents. It is conceivable that errors of recall resulted in an over- or underreporting of cycling crashes; for instance respondents may fail to report crashes or falls without serious injury consequences. Additionally, the annual distance cycled was based on self-report and could therefore be biased to some extent. Despite this, self-reporting as a data gathering technique is cited as being more complete than using injury registration based on police records or hospital databases. These databases are in fact documented as grossly underestimating the frequency of bicycle crashes, because less serious injuries are not included in these registrations [12].

We applied a questionnaire and asked retrospectively about accident involvement in the past year. This approach does not result in reliable (multiple) accident involvement data due to recall bias. We therefore considered that the most reliable indicator, based on our retrospective data, is to categorize accident involvement dichotomously (yes/no) and not to specify and include possible multiple accident involvement in our study.

We know the proportion of crashes during bunch riding for both the bunch and the non-bunch riders, but we do not have data on what proportion of the exposure (distance travelled) was ridden in a bunch or was not, assuming frequent bunch riders also cycle alone from time to time. Because of this we could not compute the actual crash risk statistic for the proportion of time spent bunch riding. Therefore we took the involvement of (non-)bunch riders in crashes as an indication of risk. In future studies, more detailed information about the distance travelled both in a bunch as well as riding alone could give a more specific indication of the actual crash risk during (non-)bunch riding.

Possible sources of bias are another possible limitation in this study. First, because the data was sampled from members of the NTFU, these cyclists may be more than averagely committed to the sport. In addition, compared to the known characteristics of the general population of sport cyclists (18 years and over), our study population was older (average of 52.7 years compared to 42 years old), more experienced and reported cycling greater distances on a yearly basis (mean of about 5500 compared to 3000). This could also be a consequence of the group from which our sample was drawn. A third possible source of bias comes from the sport cyclists reporting crashes. We included a group of respondents that reported a sport cycling accident to their insurance company in 2013. This provided us with a relatively large group of sport cyclists with crashes in our study population. The number of crashes in the current sample is most probably higher than in the population at large. Therefore our respondents cannot be regarded as fully representative for sport cyclists in The Netherlands, but we succeeded in including respondents, which were well distributed among each of the categories of the factors we analysed. This made it possible to study possible associations between those factors, although the magnitude of the associations might be different when studied in another population of sport cyclists (e.g., among women). The magnitude of the association may also be different if data from additional relevant factors was available to include in the multiple logistic regression analysis. For example factors like speed of cycling, characteristics of cycling infrastructure and flow of other road users. Obtaining these data was, however, beyond the scope of the current study.

4.3. Interpretations

First of all, this study identified two major factors associated to crash involvement among sport cyclists; bunch riding and experience. The bunch riding factor is in line with previous research [11–13],

which indicated a higher crash risk for bunch riding among regular cyclists. The present study extends this finding to the Dutch sport cycling community.

Increased sport cycling experience was found to be associated with reduced crash involvement, irrespective of age. The influx of new and inexperienced sport cyclists in The Netherlands due to increased popularity of sport cycling may contribute to an increase in future crashes and injuries. Therefore, prevention of sport cycling crashes requires further attention. One way to reduce crash involvement among inexperienced bunch riding sport cyclists could be an intervention in the form of training. One advantage of this approach is that there are already several online sources available [14]. These are often training videos in which experienced sport cyclists explain best practices and techniques for riding in a bunch safely. Another advantage of this approach is that the costs are relatively low and the interventions can be implemented relatively easy through existing sport cycling communities. However, the efficacy of such interventions is not scientifically established [6,15], and further research is required to fully understand whether and in what form these interventions are effective in reducing crashes on public roads.

Competitiveness did not show a significant effect on crash involvement, but a trend was visible in which competitiveness led to a slightly increased level of crash involvement. This finding is in agreement with earlier findings among car drivers [9]. The measuring of competitiveness in our study was based on self-reported motives for cycling, not on the actual behaviour itself. It is therefore unclear to what degree the applied measure actually represents the occurrence of competitive cycling behaviours, such as riding at high speed, frequent overtaking and maintaining a short following distance (headway) in a bunch. Future research focusing more on the actual behaviour is required to further clarify the role of competitiveness for sport cyclists.

The annual distance cycled had no significant effect on crash involvement and showed no clear trend in either the multiple or univariate models. This finding deserves some consideration. As there is no difference in the number of crashes regardless of distance travelled annually, the crash risk (persons involved in at least one crash per km) is lower for cyclists who travel greater distances on an annual basis. One explanation for this effect could be a higher level of skills due to experience for those who travel greater distances. Additional analysis provided some support for this idea; more experienced cyclists generally travel greater distances, while less experienced cyclists generally travel shorter distances annually. This tendency could explain the lack of a statistically significant effect for the distance travelled annually.

5. Conclusions

Both bunch riding and having relatively few years of sport cycling experience were found to increase sport cyclist crash involvement on public roads.

We recommend evaluation of the effectiveness of available training material aimed to help new inexperienced sport cyclists ride in a bunch safely, as this could help reduce crash involvement for new bunch riding sport cyclists. Future research focusing on the actual behaviour is required to further clarify the role of competitiveness related to crash involvement.

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