DiVA
http://www.diva-portal.org

This is the published version of a paper presented at *International IRCOBI Conference on the Biomechanics of Injury, 11 – 13 September 2019. Florence, Italy.*.

Citation for the original published paper:

Stigson, H., Åman, M., Larsson, M. (2019)
Incidence of Acute Injuries among Licensed and Non-Licensed Cyclists using Insurance Registry Data
In: International Research Council on Biomechanics of Injury, IRCOBI (ed.), *2019 IRCOBI Conference Proceedings: International Research Council on the Biomechanics of Injury*

N.B. When citing this work, cite the original published paper.

Permanent link to this version:
http://urn.kb.se/resolve?urn=urn:nbn:se:gih:diva-5856

Incidence of Acute Injuries among Licensed and Non-Licensed Cyclists using Insurance Registry Data

Helena Stigson, Malin Åman and Magnus Larsson

Abstract Few previous studies have examined acute injuries in competitive cycling or training as compared to other sports. By using nationwide insurance data including all injured cyclist registered in the Swedish Cycling Federation and all reported injuries during exercise race in Sweden, the objective was to examine acute injuries during competitive cycling or training for different types of cyclists. The injury incidence and injuries leading to permanent medical impairment were examined. All cyclists that were injured during 2008-2017 were included (n=1937).

Among the 2666 licensed cyclists the incidence of cyclists injured during training or competition was 44 per 1000 licensed cyclists per year. Focusing on participants in exercise races, the incidence was annually 1.5 injured cyclists per 1000 participants per year. The most commonly injured body region was the upper extremity (41%), followed by head and neck (18%). In total 9.4% of all injured cyclists sustained a permanent medical impairment. Given an injury, non-licensed participants in exercise races were slightly older, and the proportion of females were higher (30% vs. 16%), than among licensed cyclists. The injury incidence among the cyclists was high, and to maintain a healthy and physically active population it is important to make efforts to prevent injuries.

Keywords Bicycles, Injury, Mountain biking, Road cycling, Sports.

I. INTRODUCTION

Cycling has become a popular competitive and recreational activity. In Sweden, cycling as a sport is the fourth most popular sport activity in the population aged 6 to 80 years, according to the National Sports Association [1]. Compared to other sports few studies of acute injuries in competitive cycling or training have been conducted. Most studies have evaluated injuries that occur during every-day cycling, rather than competitive and exercise cycling. The causes of the accidents in road cycling differ a lot from that of everyday cycling. A previous study based on self-reported crashes among road cyclists during training on rural roads showed that 35% were single bicycle crashes, 39% occurred in interaction with other cyclists, and 12% took place in interactions with motor vehicles [2]. The amount of crashes that occur in interactions with other cyclists is therefore much higher among road cyclists during training as compared to all bicycle crashes resulting in hospital-reported injuries in Sweden. In total, almost 80% of all bicycle crashes in Sweden (all ages included) are single bicycle crashes, and only 7% occur in interactions with other cyclists [3]. Decock et al. [4] studied acute injuries occurring during competition among members of Flanders Cycling Federation, using insurance data. They also found that more than half of the crashes were caused by interactions with another cyclist(s). The most common injury was abrasion, and hand and shoulder were the most common locations. According to this study almost one out of six non-professional road cyclists had had an accident during cycling races. There was no difference between the injuries that had occurred during 2002 vs. 2012. However, Barrios et al. [5] found that the risk of traumatic injuries among professional road cyclists has doubled from the 1980s and early 1990s to the period 2003 to 2009 (from 0.523 to 1.151). During both these study periods more than half of the injuries were to the upper extremities.

Associate Professor H. Stigson (email: helena.stigson@folksam.setel:+46 70-831 62 04)is affiliated with Folksam Insurance Group, Sweden, the Vehicle Safety Division, Mechanics and Maritime Sciences, Chalmers University of Technology, Sweden and the Division of Insurance Medicine, Department of Clinical Neuroscience, Karolinska Institutet, Sweden.
Malin Åman is affiliated with the Swedish School of Sport and Health Sciences, Department of Physical activity and Health and the Department of Molecular Medicine and Surgery, Stockholm Sports Trauma Research Center at Karolinska Institutet.
Magnus Larsson is affiliated with the Norwegian Public Roads Administration, Norway and Swedish National Road and Transport Research Institute, Sweden.

Cycling as sport also includes mountain biking (MTB) that compared to road cycling, is a sport of riding bicycles off-road. MTB can be subdivided into cross-country, trail, enduro and downhill. The biggest cross-country races in Scandinavia, Cykelvasan, has grown from 2000 participants in 2008 to more than 24,000 participants 2018, reflecting the increasing popularity of this sport [6]. Previous studies of competitive and recreational MTB cyclists have found that young males are dominating [7]. Most of the injured cyclists were engaged in the sport for recreational rather than competitive purposes. The injury rate differs, depending on whether the purpose is competitive or recreational, as well as the type of activity and geographic location. For example, Aitken et al. [8] found that, among recreational MTB in Scotland, the injury rate was 1.54 injuries per 100 bikers. For downhill mountain bikers the overall injury rate was 16.8 injuries/1000 hours of exposure [9]. However, there was a fourfold increase in the risk of getting injured in races [10]. In general, upper extremity injuries are the most common (26.9-74.2%) followed by lower extremity (5.9-38.8%) and head/neck/face (6.4-29.4%) among MTB cyclists [7]. Studies have indicated that the distribution differs by age and gender. A previous study has shown that the injury patterns for road and trail cyclist differ [11]. Road cyclists were more likely to sustain head injuries, while trail cyclists were more likely to sustain thoracic injuries.

So far, there is limited scientific knowledge about competitive cycling. Studies regarding competitive cycling have mainly focused on MTB [7][4]. Therefore, the objective was to examine acute traumatic injuries during competitive cycling or training for different types of cyclists using nationwide data.

II. METHODS

The sport injury database of Folksam Insurance Group (Folksam) was used to conduct this cross-sectional study involving a ten-year retrospective investigation of all cyclists (n=1937) who were injured during competitive cycling or training. Three different levels of performance were included: cyclists licensed through the Swedish Cycling Federation (competition riders both professional cyclists and amateurs), youth (<16 years) members of the Swedish Cycling Federation, and non-licensed participants in exercise races. The subgroup "*non-licensed participants in exercise races"* included all participants in exercise races without result lists without a license for competition. In an exercise race without result list, all participants get their own time registered by a chip. The participants time in the race does not get published in public, and therefore not sorted by race time in a result list, which is done in competitions.

All members of the Swedish Cycling Federation, including competition riders both professional cyclists and amateurs, were insured by Folksam from 2008 to 2017. During that time, the number of registered cyclists increased from 2200 to 3369. The insurance covers every member during training, Swedish Cycling Federation activities, as well as during competitive cycling. To participate in competitions, cyclist need a license from the federation. Furthermore, during Swedish Cycling Federation activities, such as exercise races without result lists, all participants (including non-licensed cyclists) were insured by Folksam. Annually, approximately 64,000 men and women participated in exercise races without result lists in Sweden. From 2008 to 2017 the number of participants has grown from 43,171 to 93,571. In the present study both individual-level exposure and injury data were used.

Definition of injury

The definition of injury is an acute physical damage to the cyclist related to sport activity, training, or competition organized by the federation or cycling club and reported to the insurance company Folksam. An acute injury is defined as an injury resulting from a specific identifiable event. Multiple injuries that occurred on one and the same occasion were recorded as one injury category "Cyclist with multiple injuries". Occasionally, an acute injury can result in a permanent medical impairment (PMI) leading to lifelong complications [12]. The insurance covers the cyclist's for costs in association to the injury and pays a non-recurring amount if it results in PMI. The PMI is assessed by the insurance company at the earliest two years following an injury, thus PMI was based on data for the years 2008–2015. The incidence of PMI was calculated as a proportion of all registered injuries.

The incidence rate, injury type, body region, age, sex and level of performance were evaluated. To evaluate type of cycling (road cyclist, MTB, BMX), circumstances why the crashes had occurred, type of crash (fall, interaction with other cyclist, interaction with motor vehicle and other) a random sample of injured cyclists (n=

940) was selected and studied in detail. Each accident description in the insurance claims handling system was evaluated and used to classify the main cause of the crash. Type of cycling was subdivided into road cycling, MTB (including downhill, enduro), BMX, cyclocross and velodrome. Furthermore, injured licensed cyclists were compared to other injured non-licensed participants during all exercise race without result list data in Sweden. Injury incidence was then calculated separately for licensed cyclist by using licensed member data from the Swedish Cycling Federation for each year. A mean value for all years was calculated. To study the incidence rate during an exercise race without result list data from Vätternrundan, one of the biggest bicycle races, was used. The race runs along Sweden's second largest lake and is 300 km with approximately 18,522 participants annually (including both licensed and non-licensed riders). No exposure data regarding proportion of licensed and non-licensed cyclists was available for evaluation.

Analysis

Descriptive statistics, including frequencies and percentages, were conducted on all available variables using SPSS statistics 24. Injury incidence was then calculated separately for licensed cyclists and number of all participants including both licensed as well as non-licensed cyclists during the bicycle race Vätternrundan by dividing the number of insurance claims by the number of licensed cyclist/participants and multiplying by 1000. This were expressed as "the number of injured cyclist per 1000 licensed cyclist per year" and "the number of injured cyclist per 1000 participants during the exercise race Vätternrundan per year". The Pearson's chi-squared tests for equal distributions was used.

III. RESULTS

During the time between 2008 and 2017, 1937 cyclist made a claim to Folksam following an acute traumatic injury while participating in cycling activities. In total 1390 licensed or youth member of the Swedish Cycling Federation were injured during competition or training, five occurred during the Swedish Cycling Federation events for potential beginners and 542 were participants that were injured during an exercise race without result list (Table I). Within the study period in total three licensed cyclists and three participants in exercise races were fatally injured. Four of these were sudden cardiac arrest. The average age of the injured licensed cyclists was 38.0 years, with a range of 10 to 81 years. Mean age for female licensed cyclists was 37 year and 38 years for male licensed cyclist. In total 16% of the licensed cyclists were females. The average age of the injured participants in exercise races without result list was 45.5 years, with a range of 15 to 78 years. The mean age of female participants in exercise races was 43 years and 47 years for male where females stand for 30% of the injured cyclists.

Table I
AGE DISTRIBUTION AMONG INJURED CYCLISTS

	Injured Licensed Cyclists			*Injured Non-licensed Participants in Exercise Races*			*Injured Youth Cyclists*		
Age group	Total	Male	Female	Total	Male	Female	Total	Male	Female
<16 years	69	60	9	4		4	85	69	16
16-22 years	164	145	19	9	3	6			
23-30 years	143	104	39	49	32	17			
30-39 years	274	236	38	90	60	30			
40-49 years	381	313	68	179	128	51			
50-69 years	258	224	34	190	147	43			
70 years +	15	14	1	13	10	3			
Unknown	1	1		8	3	5			
Total	1305	1097	208	542	383	159	85	69	16

Out of approximately 2666 insured licensed cyclists in Sweden the incidences was annually 44 injured cyclists per 1000 licensed cyclists occurring during training or competition. Among participants in the exercise race without result list Vätternrundan, the incidence was annually 1.5 injured cyclists per 1000 participants (Table II). Most of the injured cyclists during Vätternrundan were cyclists without a license for competition (193 out of

277). No exposure data regarding proportion of licensed and non-licensed cyclists were evaluable.

Table II
NUMBER OF INJURIES DURING THE VÄTTERNRUNDAN BICYCLE COMPETITION

Year	Participants Vätternrundan	Licensed Cyclists	Non-licensed Cyclists	Total Injured Cyclists	Incidence
2008	15 945	0	15	15	0.94
2009	15 491	4	23	27	1.74
2010	17 611	2	17	19	1.08
2011	19 114	11	24	35	1.83
2012	19 055	6	23	29	1.52
2013	19 406	3	19	22	1.13
2014	19 452	7	20	27	1.39
2015	20 002	11	28	39	1.95
2016	19 653	24	9	33	1.68
2017	19 487	16	15	31	1.59
Total	185 216	84	193	277	

Aggregated data on body region for injuries for all cyclist shows that the most common injured body region was the upper extremity (41%) followed by head and neck injuries (18%) (Table III). The most frequently seen injury types were fractures (38.4%) and soft tissue injuries (34.1%) (Fig. 1). The most common injury diagnose was a clavicle fracture. In total 9.4% of all cyclists sustained a PMI. Given an injury, there was no difference between non-licensed cyclists and licensed cyclists regarding risk of sustaining a PMI (Table IV).

By studying the subset of 940 cases it was possible to identify type of cycling in all except from 3%. Road cycling accounts for 62% of the injured cyclists, followed by MTB with 25% and BMX with 10%. For licensed cyclists 48% of the acute injuries occurred during a bicycle race competition, 22% during exercise races without result list and 31% occurred during training. The majority of non-licensed cyclists were road cyclists. In 674 cases it was possible to identify the type of crash (fall, interaction with another cyclist(s), interaction with motor vehicle and other). Road cyclists were more often involved in collisions with another rider while mountain bikers and BMX were more often injured in a fall where no other was involved (Table V).

Table III

INJURIES DIVIDED INTO BODY REGION AND NUMBER OF INJURIES LEADING TO PERMANENT MEDICAL IMPAIRMENT (PMI)

Body region	Licensed Cyclists	Non-licensed Participants in Exercise Races	Youth Cyclists	Number of injuries resulting in PMI (2008-2015)	Total (2008-2017)
Head, neck, eye				***20***	***352***
Head	92	32	14	3	138
Face	91	50	7	3	148
Cervical spine	37	17	3	14	57
Undefined	2	3	1		6
Multiple head/ neck injuries	1	1	1		3
Upper extremity				***59***	***801***
Shoulder	277	112	8	30	397
Arm	79	36	13	10	128
Wrist, hand and finger	181	67	13	18	261
Undefined	4	0	0		4
Multiple upper limb injuries	9	2	0		11
Trunk and back				***16***	***185***
Sternum, ribs and upper back	67	30	1	7	98
Abdomen incl. organs	26	10	0	4	36
Lower back, pelvis and sacrum	15	8	1	1	24
Undefined	1	0	0		1
Multiple trunk injuries	19	3	0	3	22
Spine, undefined	3	1	0	1	4
Lower extremity				***11***	***189***
Hip	39	14	0	4	53
Knee	55	16	4	4	75
Lower leg	14	5	3	2	22
Ankle, foot and toe	23	8	2	1	33
Multiple leg injuries	2	0	0		2
Undefined	2	2	0		4
Unknown body location	19	9			28
Cyclists with multiple injuries	244	113	14	***16***	***371***
Head, neck, eye	75	40	4	12	119
Upper extremity	160	71	9	4	240
Trunk and back	119	48	3	11	170
Lower extremity	127	42	6	3	175
Unknown body location	34	27	4		65
Total Injuries	1573	654	97		2324
Fatalities	3	3			6
Total cyclists	1305	542	85	121	1932

Table IV

NUMBER AND PROPORTION OF INJURIES LEADING TO PERMANENT MEDICAL IMPAIRMENT AMONG INJURED CYCLISTS (2008-2015)

	n	**n PMI**	**Proportion of PMI**	**95% CI**
Licensed Cyclists	939	76	8.1%	1.7%
Non-licensed Participants in Exercise Races	464	46	9.9%	2.7%
Total	1282	121	9.4%	1.6%

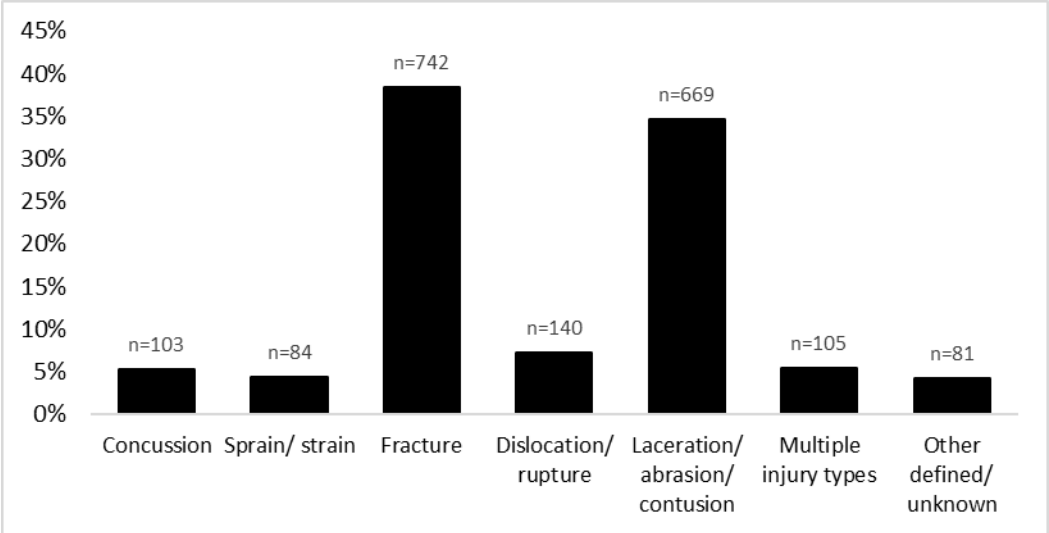

FIG. 1. FREQUENCY OF THE DIFFERENT TYPES OF INJURIES

Table V

CRASH TYPE DISTRIBUTION AMONG ROAD CYCLISTS. MTB AND BMX

	Licensed Cyclists			Non-licensed Participants in Exercise Races	
	Road cyclists	MTB	BMX	Road cyclists	MTB
Crash type (n=581)	192	121	32	199	37
Single Bicycle Crash	*48%*	*82%*	*84%*	*45%*	*81%*
Bicycle - Bicycle	*44%*	*17%*	*13%*	*48%*	*16%*
Bicycle - Motor Vehicle	*4%*	*0%*	*0%*	*4%*	*0%*
Other	*5%*	*2%*	*3%*	*4%*	*3%*

IV. DISCUSSION

Using this unique nationwide insurance database including all injured cyclists registered in the Swedish Cycling Federation and all reported injuries during exercise races without result list in Sweden, the incidence and proportion of acute injuries and injuries leading to PMI at each body location was established. The incidences were 44 injured cyclists per 1000 licensed cyclists per year occurring during training or competition. When compared to previous investigations of other sports injuries in the Folksam database, the total injury incidence for all sports was 10.2 injuries/1000 licensed athlete years [12]. Cycling was the seventh high risk sport out of the 35 sports. The high incidence shows that to maintaining a healthy and physically active population it is important to prevent these crash related injuries[4][5]. Several studies have found that injuries to the upper extremities are the most common [7][4][3][5]. In the present study, 9.4 % of all injurie resulted in PMI where the cyclist will have lifelong complications. Upper extremity was the most frequently injured body region and these injuries account for almost 50% of all impairing injuries in the present study as well as in a previous study [3]. The falling mechanisms in road cycling is often caused by that the shoulder is the first contact point with the ground [13]. Barrios et al [5] found that professional cyclists have a high occurrence of traumatic injuries at the shoulder and the upper extremities. These injuries could be prevented and to reduce these injuries it is recommended to develop and implement protection for the upper extremity [14].

It is likely to believe that all injured cyclists used helmets at the time of crash since helmets were mandatory in all competitions. Furthermore, a close to 100% helmet use during training is to be assumed because it is a part of the cycling uniform. To minimize the risk that cyclists without helmets were included in the data the authors read the files to ensure that helmet was used when the cyclist suffered a head injury. The protective effects of bicycle helmets for head and facial injuries have been confirmed by several studies conducted in different countries [3][15]. In the present study the head and neck injuries accounted for 18.2%. Skull fractures as well as brain injuries were included in the data set. It could therefore be argued that there is potential to

improve helmets. Several studies have stated that the protective effect of helmets needs to be improved [16-18].

For licensed cyclists 48% of the injuries occurred during competition, 22% during exercise races without result list and 31% during training. It could be assumed that the time that a cyclist spend on training is much more extensive although no exposure data was available in the present study. This is supported by previous study that has seen a fourfold increased risk of getting injured while competing [10]. However, only a few need medical care after getting injured during a cycling race [19-21]. This indicates that these studies were based on less severe injuries than in the present study. The insurance database used in the present study is limited to those cyclists who make an insurance claim and the reason for a claim is often to get economic compensation. Most certainly the total injury incidence in the present study is therefore underestimated as cyclists with minor injuries might not make a claim.

For road cyclist 44% of the crashes were caused by interaction with another cyclist(s). Slightly higher proportion was found when studying the Flanders Cycling Federations reported crashes during competition [4]. Compared to that study the present study included both training and competition and therefore it is likely to believe that the cycling is less hectic during training. Furthermore, some of the races were performed without blocking motor traffic. This may also affect the proportion and distribution of the crashes. However, a Swedish study based on self-reported crashes among road cyclists during training on rural roads saw an even higher proportion of crashes that occurred in interaction with a motor vehicle [2].

Most of the injured cyclists were road cyclists. However, no exposure data regarding the proportion of different branches of cycling among the licensed cyclists was available. Therefore, it is not possible to calculate the risk for different branches. Another limitation was that no exposure data regarding age and gender were available. Given an injury, participants in exercise races were slightly older and the proportion of females were higher than among licensed cyclists (30% vs 16%). It is known that females in general have a higher risk of sustaining PMI [12][22].

Despite the quality of the sports injury surveillance system one will always be confronted with some sort of bias; over- or underestimation of sports participation, incomplete responses, non-response, invalid injury description etc. [23]. Variations in definitions and methodologies create differences in the results and conclusions of studies on sport injuries, hence comparisons between studies are difficult [24][25]. The insurance data collection is structured and routinely kept in a systematic manner and the insurance company works to keep the data accurate and truthful. But when using insurance data it is most certain that the total injury incidence is underestimated as mild injuries might not require medical attention and thus there is no reimbursement of financial cost for the injured cyclist, hence they are not reported to the insurance company. Medical costs associated with injury are only reimbursed by one insurance company and if the injured cyclist holds additional insurance in another company providing a more financially advantageous compensation he/she may choose not to claim the insurance company used in the present study. On the other hand, if the injury result in a PMI the compensation will be paid by all insurance companies in which the injured cyclist holds an insurance policy. The economic benefits may thus increase the reports of more severe injuries and hence influence the results in the present study.

V. CONCLUSIONS

The injury incidence among cyclists were high, and to maintain a healthy and physically active population it is important to make effort to prevent crash related injuries. The majority of acute injuries were located in the upper body, and the most common injury diagnose was a clavicle fracture. Therefore, injury prevention should be directed towards developing and implementing shoulder protection, and it should target different accident scenarios for different types of cyclists. For road cyclists, interactions with other cyclists were the most common cause of injury, while other cyclists were more often injured in situations where no other person was involved.

VI. ACKNOWLEDGEMENT

This study was partly financially supported by the Folksam Insurance Group Research Foundation.

VII. REFERENCES

[1] Riksidrottsförbundet. (2017) *In Swedish: Idrotten i siffror*

[2] Kröyer, H.R.G. (2016) *In Swedish: Trafiksäkerhetsutmaningar för den cykeltäta staden. Trafiksäkerhet vid cykeltävlingar och vad kan vi lära oss av dessa?* Trafikon AB Trafikkonsult

[3] Rizzi, M., Stigson, H., Krafft, M. (2013) Cyclist injuries leading to permanent medical impairment in Sweden and the effect of bicycle helmets. *Proceedings of IRCOBI Conference*, 2013, Gothenburg, Sweden

[4] Decock, M., De Wilde, L., Vanden Bossche, L., Steyaert, A., Van Tongel, A. (2016) Incidence and aetiology of acute injuries during competitive road cycling. *British Journal of Sports Medicine*. 50 (11): p. 669-72

[5] Barrios, C., Bernardo, N.D., Vera, P., Laiz, C., Hadala, M. (2015) Changes in sports injuries incidence over time in world-class road cyclists. *International Journal of Sports Medicine*. 36 (3): p. 241-8

[6] Vasaloppet. "In Swedish: Inför Cykelvasan 2017 – Nordens största MTB-lopp som växer varje år" Internet http://www.vasaloppet.se/nyheter/infor-cykelvasan-2017-nordens-storsta-mtb-lopp-som-vaxer-varje-ar/.

[7] Caine, D.J., Young, K., Provance, A.J. (2018) Pediatric and adolescent injury in mountain biking. *Res Sports Med*. 26 (sup1): p. 71-90

[8] Aitken, S.A., Biant, L.C., Court-Brown, C.M. (2011) Recreational mountain biking injuries. *Emerg Med J*. 28 (4): p. 274-9

[9] Becker, J., Runer, A., et al. (2013) A prospective study of downhill mountain biking injuries. *British Journal of Sports Medicine*. 47 (7): p. 458-62

[10] Kronisch, R.L., Chow, T.K., Simon, L.M., Wong, P.F. (1996) Acute injuries in off-road bicycle racing. *American Journal of Sports Medicine*. 24 (1): p. 88-93

[11] Kotlyar, S. (2016) Cycling Injuries in Southwest Colorado: A Comparison of Road vs Trail Riding Injury Patterns. *Wilderness and Environmental Medicine*. 27 (2): p. 316-20

[12] Åman, M., Forssblad, M., Henriksson-Larsen, K. (2016) Incidence and severity of reported acute sports injuries in 35 sports using insurance registry data. *Scandinavian Journal of Medicine and Science in Sports*. 26 (4): p. 451-62

[13] Stigson, H., Krafft, M., Rizzi, M., Kullgren, A. (2014) Shoulder Injuries in Single Bicycle Crashes. *Proceedings of The 3rd International Cycling Safety Conference* 2014, Gothenburg, Sweden

[14] Stigson, H., Svensson, M., Fahlstedt, M. (2016) Preventing Shoulder Injuries in Bicycle Crashes. *Proceedings of International Cycling Safety Conference 2016*, 2016, Bologna, Italy

[15] Olivier, J. ,Creighton, P. (2016) Bicycle injuries and helmet use: a systematic review and meta-analysis. *International Journal of Epidemiology*

[16] Stigson, H., Rizzi, M., Ydenius, A., Engström, E., Kullgren, A. (2017) Consumer Testing of Bicycle Helmets. *Proceedings of Int. IRCOBI Conf. on the Biomechanics of Injury*, 2017, Antwerpen, Belgium

[17] Bland, M.L., McNally, C., Rowson, S. (2018) Differences in Impact Performance of Bicycle Helmets During Oblique Impacts. *Journal of Biomechanical Engineering*. 140 (9)

[18] Willinger, R., Deck, C., Halldin, P., Otte, D. (2014) Towards advanced bicycle helmet test methods. *Proceedings of International Cycling Safety Conference 2014*, 2014, Göteborg, Sweden

[19] Yanturali, S., Canacik, O., Karsli, E., Suner, S. (2015) Injury and illness among athletes during a multi-day elite cycling road race. *Phys Sportsmed*. 43 (4): p. 348-54

[20] Emond, S., Tayoun, P., Bedolla, J., Camargo, C. (1999) Injuries in a 1-day recreational cycling tour: Bike New York. . *Annals of Emergency Medicine*. 33: p. 56-61

[21] Haeberle, H.S., Navarro, S.M., et al. (2018) Prevalence and Epidemiology of Injuries Among Elite Cyclists in the Tour de France. *Orthop J Sports Med*. 6 (9)

[22] Gustafsson, M., Stigson, H., Krafft, M., Kullgren, A. (2015) Risk of Permanent Medical Impairment (RPMI) in Car Crashes Correlated to Age and Gender. *Traffic Inj Prev*. 16 (4): p. 353-61

[23] Åman, M. Acute sports injuries in Sweden and their possible prevention: an epidemiological study using insurance data, in *Department of Sport and Health Sciences*. 2017, Swedish School of Sport and Health Sciences, GIH: Stockholm.

[24] Finch, C.F. (1997) An overview of some definitional issues for sports injury surveillance. *Sports Medicine*. 24 (3): p. 157-63

[25] van Mechelen, W., Hlobil, H., Kemper, H.C. (1992) Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Medicine*. 14 (2): p. 82-99