

Appendix 1. The incidence and prevalence of injuries and illnesses in road and track cycling, mountain biking, BMX and para-cycling

Reference	Discipline	Sex	n	Level	Age	Recordable injury or illness	Study design	Incidence and prevalence	
Aitken, 2011 [1]	MTB	M/F	130900	Recreational	31.5 (men) (range 10-66) 32.0 (women) (range 11-63)	Injuries for which participants sought medical care at one of five medical facilities	One-year prospective study	1.54/1000 biker exposures (overall) 1.64/1000 biker exposures (M) 1.08/1000 biker exposures (F)	
Barrios, 1997 [2]	Road	M	65	Professional	25 (range 21-32)	Overuse and traumatic lesions diagnosed by team doctors, trainers and physiotherapists	Retrospective study of injuries recorded from 1983 to 1995	<i>Overuse</i> 0.17/year 0.86/5 years 0.005/1000 km 0.002/comp day	<i>Trauma</i> 0.11/year 0.54/5 years 0.003/1000 km 0.001/comp day
Becker, 2013 [3]	MTB (DH)	M/F	249	Different levels	23.5 ± 6.8 (range 14-53)	Any injury resulting from training or competition, irrespective of medical treatment requirement or time loss from sports activities	Monthly e-mail prospective survey over 6 months (April-September 2011)	Overall Experts Professionals Competition Practice	16.8/1000 h 17.9/1000 h 13.4/1000 h 20/1000 h 13/1000 h
Brøgger-Jensen, 1990 [4]	BMX	M/F	976	Elite	Range 6 - 40	Injuries for which participants received medical assistance by first aid on-site	Injuries during 2-day BMX Cycling European Championship 1989	2-day cumulative incidence 6.3% (61/976 riders) 5.6% (men); 9.4% (women) <i>Incidence</i> 1190/1000 h*	
Chow, 1993 [5]	MTB	M/F	222 M 46 F	Different levels	36.2 ± 9.4 (range 14-68)	The presence of pain, discomfort or disability	Retrospective survey over the last year	1-year cumulative incidence 51.1% (137/268)	
Clarsen, 2010 [6]	Road	M	109	Professional	26 ± 4	Injuries that required attention from medical personnel or time loss from cycling were registered	Retrospective survey with interviews on overuse injuries during the last year	1-year cumulative incidence 58% (63/109) low back pain 36% (39/109) anterior knee pain <i>Incidence</i> 0.862/year 0.954/1000 h	
Clarsen, 2015 [7]	Road	M/F	98	Junior, semi-professional	NR	All physical complaints, regardless of their	Weekly e-mail prospective	<i>Body part</i> Knee	13-week average prevalence (95% CI)

				and professional		consequence on sports participation or performance	survey during 13 weeks	Lower back Shoulder Anterior thigh	23% (17-28) 16% (12-20) 7% (4-10) 8% (7-9)	
De Bernardo, 2012 [8]	Road	M	51	Professional	25.8 ± 4.4	Injuries that resulted in a time-loss of at least one day from training or competition	Retrospective study with interviews of injuries during the last 4 years	<i>Overuse</i> 0.259/year 1.039/racer 0.010/1000 km 0.0036/comp day	<i>Trauma</i> 0.245/year 0.980/racer 0.008/1000km 0.0034/comp day	<i>Overall</i> 0.5/year 2.02/racer 0.018/1000 km 0.007/comp day
Decock, 2016 [9]	Road	M/F	3311 (in 2002) 4487 (in 2012)	Different levels	NR	All reported accident files	Retrospective study on reported injuries in 2002 and 2012	<i>Year</i> 2002	<i>1-year cumulative incidence</i> 15.8% (525/3311)	
Derman, 2018a [10]	Para-Cycling (track and road)	M/F	138 66	Paralympic	NR	Any new injury or exacerbation of previous injury that required medical attention	Prospective study during Rio 2016 Summer Paralympic Games	<i>Cumulative incidence during Paralympic Games</i> 9.8%		7.0/1000 athlete days (range 4.5-10.9)
Derman, 2018b [11]	Para-Cycling (track and road)	M/F	138 66	Paralympic	NR	Any new illness or exacerbation of pre-existing illness that required medical attention	Prospective study during Rio 2016 Summer Paralympic Games	<i>Cumulative incidence during Paralympic Games</i> 13.2%		10.5/1000 athlete days (range 7.3-15.0)
Engebretsen, 2013 [12]	BMX MTB Road Track	M/F	48 76 210 167	Professional	NR	All musculoskeletal complaints or concussions (injuries) incurred during competition or training, receiving medical attention	Prospective study during the Olympic Games, London 2012	<i>Cumulative incidence during Olympic Games</i> 31.1% (15/48) 21.1% (16/76) 9.0% (19/210) 3.0% (5/167)		
Gaulrapp, 2001 [13]	MTB	M/F	3873	Different levels	25 (range 8 - 80)	All injuries that prevented the athlete from at least one day of mountain biking	Retrospective survey of all injuries sustained during their period of participation in	<i>Incidence</i> 0.6/year 1.1/1000 h		

							the sport		
Haeblerle, 2018 [14]	Road	M	1584	Professional	30	All injuries that forced the cyclist to withdraw from the Tour de France	Retrospective study of injuries during the Tour de France 2010-2017	<i>Cumulative incidence over 8 Tour de France races</i> 16% (259/1584)	
Himmelreich, 2007 [15]	MTB	M/F	106	Professional	23.1	Acute injuries that occurred during competition and that prevented riders from finishing the race	Retrospective survey of severe injuries during the last 2 years	<i>Incidence</i> <i>Downhill:</i> 1.08/1000 h <i>Cross-country:</i> 0.39/1000 h	
Kronisch, 1996a [16]	MTB	M/F	3624	Different levels	NR	Any episode of acute trauma sustained during competition that required medical attention and rendered the rider unable to complete the event	Prospective study during 5 days of off-road cycling events	<i>5-day cumulative incidence</i> 0.4% (16/3624)	
Kronisch, 1996b [17]	MTB	M/F	4074 (CC) 2158 (DH)	NR	NR	Injuries that occurred during competition and that prevented riders from finishing the race	Prospective study at three multi-day cycling events in 1995	<i>Incidence</i> <i>Cross-country</i> 3.1/1000 h (M) 7.5/1000 h (F)	<i>Incidence</i> <i>Downhill</i> 42.7/1000 h (M) 46.8/1000 h (F)
Kronisch, 2002 [18]	MTB	M/F	20769	Elite	28.4 (range 15-59) 30.8 (range 22-52)	Injuries that occurred during competition and that prevented riders from finishing the race	Annual study during 4-day event, from 1994 to 2001	<i>Cumulative incidence over eight 4-day races</i> 0.40% (71/17900) (M) 0.77% (22/2869) (F)	
Kronisch, 1994 [19]	MTB	M/F	200 M 65 F	Different levels	30.2 (range 10-56)	All injuries sustained while mountain biking during the preceding 12 months	Retrospective survey of injuries during the last year	<i>1-year cumulative incidence</i> 22.6% (60/265)	
Lareau, 2011 [20]	MTB	M/F	448	Different levels	NR	Injuries for which medical attention was sought plus obvious injuries	Survey of injuries during several endurance and cross-country races	<i>Race incidence</i> <i>Cross-country</i> 7.2% (8/111)	<i>Race incidence</i> <i>Endurance</i> 5.0% (17/337)
McGrath,	MTB	NR	52	NR	NR		Prospective	<i>Cumulative incidence during 7-stage race</i>	

2012 [21]							study during 7-stage race 2010	42.3% (22/52)
Pfeiffer, 1994** [22]	MTB (CC)	M/F						6.8 (per 1000 h) 12 (per 1000 h)
Roi, 2014 [23]	Road	NR	NR	Different levels	NR	Request for medical assistance	Study during 6 consecutive annual amateur cycling races, from 2006 - 2011	<i>Cumulative incidence during 6 races</i> 1.7% 0.11inj/1000 km 0.011 withdrawals/1000 km
Soligard, 2017 [24]	BMX MTB Road Track	M/F	NR	Professional	NR	All musculoskeletal complaints or concussions (injuries) incurred during competition or training, receiving medical attention	Prospective study during the Olympic Games, Rio de Janeiro 2016	<i>Cumulative incidence during Olympic Games 2016</i> BMX 38% MTB 24% Road 6% Track 6%
Stoop, 2019 [25]	MTB	M	15 41	Elite Amateur	32.5 ± 12.1 40.7 ± 7.6	The presence of pain, discomfort or disability	Retrospective survey on cycling years	<i>Incidence</i> 39/1000 h 0.52/1000 h
Taylor, 1995 [26]	Wheelchair racing	M/F	41 M 12 F	Elite and non-elite	NR	Pain in any part of the body that prevented the athlete from training or competing for at least 1 day	Retrospective survey on injuries in the last 12 months	<i>1-year cumulative incidence</i> 72% (38/53)
Wilber, 1995 [27]	Road & MTB	M/F	294 M 224 F	Recreational	40.4 ± 10.7 36.6 ± 9.1	Overuse: any discomfort, pain, swelling, bruising, which occurred before, during, or after cycling.	Retrospective survey of injuries during the last year	<i>1-year cumulative incidence</i> 24.5% acute (127/518) 84.9% overuse (440/518)
Willick, 2013 [28]	Para-cycling Track Road	M/F	92	Paralympic	NR	Any sport-related musculoskeletal or neurological complaint prompting an athlete to seek medical attention	Prospective study during the Paralympic Games, London 2012	<i>Cumulative incidence</i> Track 13.0% 9.3/1000 athlete days (range 4.8-16.2) <i>during Paralympic Games</i> Road 9.3% 9.3/1000 athlete days (range 3.9-10.7)
Yanturali, 2015 [29]	Road	M	166	Professional	28.7	Injury: a physical complaint or observable damage to body tissue produced by the transfer	Prospective study during 8-day tour	<i>Incidence during 8-day competition</i> 2.82 injuries /1000 h 3.01 illnesses /1000 h

of energy experienced or
sustained during a race.

Illness: a physical
complaint or
presentation not related
to injury.

Note. CC = cross-country; comp = competition; DH = downhill; F = female; h = hour; inj = injury; M = male; MTB = mountain bike; n = number of participants; NR = not reported

*Reported incidence is not in line with other research findings

**Original data not available, data is from Ansari and colleagues [30]

References

1. Aitken SA, Biant LC. Recreational mountain biking injuries. *Emerg Med* 2011;28:274-9.
2. Barrios C, Sala D, Terrados N, Valenti JR. Traumatic and overuse injuries in elite professional cyclists. *Sports Exerc Inj* 1997;3:176-9.
3. Becker J, Runer A, Neunhäuserer D, et al. A prospective study of downhill mountain biking injuries. *Br J Sports Med* 2013;47:458-62.
4. Brøgger-Jensen T, Hyass I, Bugge S. Injuries at the BMX Cycling European Championship. *Br J Sports Med* 1990;24:269-70.
5. Chow TK, Bracker MD, Patrick K. Acute injuries from mountain biking. *West J Med* 1993;159:145-8.
6. Clarsen B, Krosshaug T, Bahr R. Overuse injuries in professional road cyclists. *Am J Sports Med* 2010;38:2494-501.
7. Clarsen B, Bahr R, Heymans MW, et al. The prevalence and impact of overuse injuries in five Norwegian sports: Application of a new surveillance method. *Scand J Med Sci Sport* 2015;25:323-30.
8. De Bernardo N, Barrios C, Vera P, et al. Incidence and risk for traumatic and overuse injuries in top-level road cyclists. *J Sports Sci* 2012;30:1047-53.
9. Decock M, De Wilde L, Vanden Bossche L, et al. Incidence and aetiology of acute injuries during competitive road cycling. *Br J Sports Med* 2016;50:669-72.
10. Derman W, Runciman P, Schwellnus M, et al. High precompetition injury rate dominates the injury profile at the RIO 2016 Summer Paralympic Games: a prospective cohort study of 51198 athlete days. *Br J Sports Med* 2018;52:24-31.
11. Derman W, Schwellnus MP, Jordaan E, et al. Sport, Sex and age increase risk of illness at the Rio 2016 Summer Paralympic Games: a prospective cohort study of 51 198 athlete days. *Br J Sports*

- Med 2018;52:17-23.
12. Engebretsen L, Soligard T, Steffen K, et al. Sports injuries and illnesses during the London Summer Olympic Games 2012. *Br J Sports Med* 2013;47:407-14.
 13. Gaulrapp H, Weber A, Rosemeyer B. Injuries in mountain biking. *Knee Surg Sports Traumatol Arthrosc* 2001;9:48-53.
 14. Haeberle HS, Navarro SM, Power EJ, et al. Prevalence and epidemiology of injuries among elite cyclists in the Tour de France. *Orthop J Sports Med* 2018;6:2325967118793392.
 15. Himmelreich H, Pralle H, Vogt L, Banzer W. Mountainbikeverletzungen bei Leistungs- und Breitensportlern. *Sportverletzung Sportschaden* 2007;21:180-4.
 16. Kronisch RL, Chow TK, Simon LM, Wong PF. Acute injuries in off-road bicycle racing. *Am J Sports Med* 1996a;24:88-93.
 17. Kronisch RL, Pfeiffer RP, Chow TK. Acute injuries in cross-country and downhill off-road bicycle racing. *Med Sci Sports Exerc* 1996b;28:1351-5.
 18. Kronisch RL, Pfeiffer RP, Chow TK, Hummel CB. Gender differences in acute mountain bike racing injuries. *Clin J Sports Med* 2002;12:158-64.
 19. Kronisch RL, Rubin AL. Traumatic injuries in off-road bicycling. *Clin J Sport Med* 1994;4:240.
 20. Lareau SA, McGinnis HD. Injuries in mountain bike racing: frequency of injuries in endurance versus cross country mountain bike races. *Wilderness Environ Med* 2011;22:222-7.
 21. McGrath TM, Yehl MA. Injury and illness in mountain bicycle stage racing: experience from the Trans-Sylvania Mountain Bike Epic Race. *Wilderness Environ Med* 2012;23:356-9.
 22. Pfeiffer RP. Off-road bicycle racing injuries - the NORBA Pro/Elite category. Care and Prevention. *Clin Sports Med* 1994;13:207-18.
 23. Roi GS, Tinti R. Requests for medical assistance during an amateur road cycling race. *Accid Anal Prev* 2014;73:170-3.
 24. Soligard T, Steffen K, Palmer D, et al. Sports Injury and illness incidence in the Rio de Janeiro

- 2016 Olympic Summer Games: a prospective study of 11274 athletes from 207 countries. *Br J Sports Med* 2017;51:1265-71.
25. Stoop R, Hohenaue E, Vetsch T, et al. Acute injuries in male elite and amateur mountain Bikers: results of a survey. *J Sports Sci Med* 2019;18:207-12.
26. Taylor D, Williams T. Sports injuries in athletes with disabilities: wheelchair racing. *Paraplegia* 1995;33:296-9.
27. Wilber CA, Holland GJ, Madison RE, Loy SF. An epidemiological analysis of overuse injuries among recreational cyclists. *Int J Sports Med* 1995;16:201-6.
28. Willick SE, Webborn N, Emery C, et al. The epidemiology of injuries at the London 2012 Paralympic Games. *Br J Sports Med* 2013;47:426-32.
29. Yanturali S, Canacik O, Karsli E, Sumer S. Injury and illness among athletes during a multi-day elite cycling road race. *Phys Sportsmed* 2015;43:348-54.
30. Ansari M, Nourian R, Khodae M. Traumatic and overuse injuries in elite professional cyclists. *Curr Sports Med Rep* 2017;16:404-12.