Clinical characteristics of gradual onset injuries in recreational road cyclists - SAFER XXVII study over 5 years in 62758 race entrants

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Abstract

Objective: Gradual onset injuries (GOIs) in recreational cyclists are common but not well described. The aim of this study is to describe the clinical characteristics of GOIs (main anatomical regions, specific anatomical sites, specific GOIs, tissue type, severity of GOIs, and treatment modalities) of GOIs among entrants participating in a community-based mass participation-cycling event over 5 years.

Methods: During the 2016–2020 Cape Town Cycle Tour, 62,758 consenting race entrants completed an online pre-race medical screening questionnaire. 1879 reported GOIs in the previous 12 months. In this descriptive epidemiological study, we report frequency (% entrants) of GOIs by anatomical region/sites, specific GOI, tissue type, GOI severity, and treatment modalities used.

Results: The main anatomical regions affected by GOIs were lower limb (47.4%), upper limb (20.1%), hip/groin/pelvis (10.0%), and lower back (7.8%). Specifically, GOI were common in the knee (32.1%), shoulder (10.6%), lower back (7.8%) and the hip/buttock muscles (5.2%). The most common specific GOI was anterior knee pain (17.2%). 57.0% of GOIs were in soft tissue. Almost half (43.9%) of cyclists with a GOI reported symptom duration >12 months, and 40.3% of GOIs were severe enough to reduce/prevent cycling. Main treatment modalities used for GOIs were rest (45.9%), physiotherapy (43.0%), stretches (33.2%), and strength exercises (33.1%).

Conclusion: In recreational cyclists, >50% of GOIs affect the knees, shoulders, hip/buttock muscles and lower back, and 40% are severe enough to reduce/prevent cycling. Almost 45% of cyclists with GOIs in the lower back; or hip/groin/pelvis; or lower limbs; or upper limb reported a symptom duration of >12 months. Risk factors associated with GOIs need to be determined and preventative programs for GOIs need to be designed, implemented, and evaluated.

Keywords: Gradual onset injuries; overuse injuries; epidemiology; severity of injuries; SAFER

Introduction

Regular physical activity, including cycling, is recommended to improve health and wellness [1–3]. The increase in popularity of cycling thus has obvious public health benefits, but cycling is associated with risk of injury in both recreational and professional cyclists [4–6]. Cycling injuries can be classified as acute (e.g. falls and crashes) or be of gradual onset injuries (GOIs: chronic injuries) [7].

GOIs appear to be common in recreational cyclists [8,9], and in one study, it was reported that 88% of cyclists entering for the 1-day, 94.7 km cycle challenge reported a GOI [10]. Most cyclists are recreational or amateur cyclists, but there are few studies reporting the clinical characteristics of gradual onset injuries (GOIs) amongst this population. Methods to record and report GOIs in studies vary and there are differences in cycling populations studied (e.g. professional and recreational). Cyclist also differ significantly in annual cycling exposure, their training history and equipment selection [11]. These differences make it difficult to compare data on clinical characteristics of GOIs in cyclists [11–13].

The main anatomical areas affected by GOIs in recreational cyclists have been described in a few studies, but vary between studies [8,10,14]. In one review, GOIs in cyclists affect the knee, ankle, back, neck/shoulders, hands/wrists, and the buttocks/perineum [5]. A study, in a large group of recreational cyclists that entered a 109 km community-based mass participation cycling event (n = 21824, 1 year data), showed that GOIs mostly affect the knee (26.3%), shoulder (13%), and the lower back (11.5%) [14]. Although there are some studies describing the main anatomical areas affected by GOIs in recreational cyclists, there are none that describe clinical characteristics of GOIs such as the frequency of specific GOIs, the severity of these injuries, and treatment modalities used by cyclists with GOIs over 5 years.

The aim of this study is to describe the clinical characteristics of GOIs among entrants participating in a community-based mass participation-cycling event over 5 years. More specifically, we describe the frequency of GOIs in recreational cyclists by main anatomical regions, specific anatomical sites, specific GOIs, tissue type, severity of GOIs (duration of symptoms and severity grade), and treatment modalities. This study is an extension of previous work [14] and includes data that we collected in a large population of recreational cyclists over 5 years (2016–2020).

Methods

This descriptive cross-sectional study formed part of a series of on-going SAFER studies [15]. The study was approved by the Research Ethics Committee of the Faculty of Health Sciences (REC numbers **431/2015** and **749/2019)**.

Data collection for SAFER studies is ongoing, and this study was an analysis of data collected over a five-year period (2016–2020) in the 109 km Cape Town Cycle Tour (CTCT). Race entrants completed online pre-race medical questionnaires at the time of registration. This questionnaire was compulsory in one year (2016) and voluntary in other years (2017–2020). However, in each of these years the questionnaire was the same and included a statement on providing consent (ticking ‘yes’ or ‘no’) for their data to be used for research. We did not have accurate data on all entrants in each year, but the total entrants each year were consistently capped at 35000(estimated total entrants over the 5-year period of 175 000). A total of 62758 cyclists gave informed consent for their data to be used for research purposes, indicating a

crude response rate of 35.9%. For each year, the crude response rates were as follows: 2016 (62.5%), 2017 (24.4%), 2018 (27.2%), 2019 (25.0%) and 2020 (40.0%).

To improve the medical care provided on race days, an online medical screening tool comprising of a series of questions was developed to provide distinct clinical information for the medical staff. The development of this screening tool was based on the guidelines for cardiovascular evaluation of middle-aged/senior individuals that were engaging in leisure-time sport activities (Position stand from the European Association of Cardiovascular Prevention and Rehabilitation) [16], and adapted from previous studies done in distance runners [17,18]. Previous SAFER studies described this detailed methodology of the online medical screening tool development and implementation [14,17–19]. In order to ensure that the screening tool was specific to the current population, additional questions were added, which were related to history of injuries in cyclists (current, or in the last 12 months). In our medical screening tool, which was designed prior to the IOC consensus statements [7,20], cyclists were specifically asked the following question related to injury: *'Do you or did you suffer from any symptoms of a CHRONIC (no accident) cycling injury (muscles tendons bones ligaments or joints) IN YOUR CYCLING CAREER?'*

In accordance with the 2020 general IOC consensus statement on 'Recording and Reporting of Epidemiological Data on Injury and Illness in Sports' [20], we refer to the mode of onset of these chronic injuries as gradual onset injuries (GOIs) in cyclists. The definition of this mode of onset as '*gradual onset'* is also in accordance with the original and the extension of the IOC consensus statement on methods for reporting injuries in competitive cycling [7,20]. In a third recently published international consensus statement on injury reporting in professional road cycling, all non-acute injuries were sub classified as gradual onset, insidious onset or chronic onset [13]. Our definition of gradual onset injuries (GOIs) does not distinguish between these three potential modes of onset for non-acute injuries. Therefore, gradual onset injuries reported in our study are inclusive of all three modes of onset according to this consensus statement [13].

The severity of a GOI was defined as: '*An injury that is/was severe enough to interfere with cycling or require treatment, for example, use medication or require you to seek medical advice from a health professional.'* In response to a 'yes' answer to this question, participants were required to complete additional questions with drop-down boxes that were related to the GOIs, including: anatomical site, type of anatomical structure, severity, duration of symptoms, whether the injury was one of the more commonly known GOIs and treatment modalities that entrants used for the GOI. A total of 1879 GOIs was reported by cyclists.

Outcome variables

For the 1879 GOIs, the following outcome variables are reported:

1. Frequency (%) of main anatomical region and specific anatomical site of GOIs.
2. Frequency (%) of specific common GOIs and
3. GOIs by tissue type affected (muscle, tendon, ligament, bone, joint, nerve).
4. Severity of GOIs (n = 1879) were reported as follows: duration of symptoms (0–3 months, 4–12 months and >12 months), and injury severity grading (Grade I–IV: I only experience symptoms after exercise; I experience symptoms during exercise, but it does not interfere with exercise; I experience symptoms during exercise that may interfere with my training/competition; I am so painful that I may not be able to train

or compete) commonly used for 'overuse' injuries in sport [21]. In addition, in order to compare the grading of injuries to that of other studies, we also reported GOIs severity in two groups of severity: a) less severe, where cyclists are still able to cycle and compete with no or minimal interference (Grade I and Grade II), and b) more severe, where the GOIs interferes with the cyclists' ability to, and even stop them from, training or competing (Grade III and Grade IV).

5. Frequency (%) of treatment modalities for GOIs were reported by a subgroup of 40,638 cyclist for 2017 to 2020 (missing information for 2016) with 1348 injuries.

Statistical analysis

All questionnaire data were entered into an Excel spreadsheet (Microsoft 2010) and analyzed using the SAS v9.4 statistical program. Only data for consented cycle race entries were used for analysis (n = 62,758) and reported on in this paper (consenting cyclists).

GOIs in the main anatomical region, specific anatomical sites, specific common GOIs, tissue and type of GOIs are described with frequencies and percentages out of all GOIs. The duration of symptoms (months) of GOIs are categorized as of 0–3 months, 4–12 months, and >12 months, and the frequency (%) is reported for each category overall, as well as by main anatomical region.

Because the questionnaire was compulsory in 2016, but not in the subsequent years 2017–2020, the demographic profile of the consenting 2016 cyclists differs from the demographic profile of the consenting 2017–2020 cyclists (Appendix I). To compensate for these differences, the data had to be weighted by sex and age category across each of the years 2017 to 2020, to align with the 2016 data. All tables therefore report weighted frequencies and percentages.

Results

Demographics of the study population

The demographics (sex and age categories) of all consenting cyclists entering the 2016–2020 CTCT is displayed in Table 1.

Table 1. Demographics of all consenting cycle race entrants (by sex and age categories) (n and % of all consenting entrants) (2016–2020).

		Number of race entrants (n = 62,758) *	% of race entrants
Male	**All**	**49,484**	78.9
	≤30	6697	10.7
	31 to ≤40	9804	15.6
	41 to ≤50	14356	22.9
	>50	18627	29.7
Female	**All**	**13274**	21.2
	≤30	2905	4.6
	31 to ≤40	2996	4.8
	41 to ≤50	3982	6.4
	>50	3391	5.4

*: Weighted totals/frequencies

The study population consisted of 62,758 consenting race entrants, the majority of which were male (78.9%) and over 50 years of age (35.1%). More females compared to males are in the younger age groups ≤40 years (45% vs 33%).

Clinical characteristics of GOIs in race entrants

Main anatomical region and specific anatomical sites of GOIs in race entrants

Among the 62758 consenting cyclists that entered the race between 2016 and 2020, 1879 reported GOIs in the previous 12 months (period prevalence = 2.95% (95%CI: 2.8.-3.09). The frequency (%) of GOIs by main anatomical region and specific anatomical sites is depicted in table 2.

Table 2. The frequency (%) of gradual onset injuries (GOIs) in cyclists by main anatomical region and specific anatomical sites (% of all GOIs) (2016–2020) (n = 1879).

Main anatomical region	Specific anatomical sites	n*	% (95% CI)
Head, Neck & Face		61	3.2 (2.4–4.0)
	Neck	52	2.8
	Head	6	0.3
	Face	2	0.1
Upper Limbs		378	20.1 (18.3–21.9)
	Shoulder	200	10.6
	Finger	83	4.4
	Wrist	48	2.6
	Elbow	40	2.1
	Forearm	5	0.3
	Upper arm	3	0.1
Trunk/Chest		21	1.1 (0.6–1.6)
	Back chest	11	0.6
	Front chest	9	0.5
Lower Back		146	7.8 (6.6–9.0)
Hip/Groin/Pelvis		188	10.0 (8.7–11.3)
	Hip/Buttock muscles	97	5.2
	Hip	76	4.0
	Groin	15	0.8
Lower Limbs		891	47.4 (45.2–49.7)
	Knee	603	32.1
	Achilles	74	3.9
	Foot	51	2.7
	Hamstring muscle	51	2.7
	Calf muscle	49	2.6
	Ankle	38	2.0
	Quadriceps muscle	17	0.9
	Shin/Lower leg	8	0.4
Other		195	10.4 (9.0–11.7)

n: number of injuries reported in the study
%: Gradual onset injuries frequency (%) of reported injuries in the study
*: Weighted totals/frequencies

The main anatomical regions most affected by GOIs (as a % of all GOIs) were the lower limb region (47.4%), followed by the upper limb (20.1%), hip/groin/pelvis (10.0%), and lower back (7.8%). Within the main anatomical regions, the four most frequently affected specific

anatomical sites for GOIs were the knee (32.1%), shoulder (10.6%), lower back (7.8%) and the hip/buttock muscles (5.2%).

Specific common GOIs in race entrants

The frequency (%) of specific common GOIs reported by race entrants are listed in Table 3.

Table 3. The frequency (%) of specific common gradual onset injuries (GOIs) (expressed as % of all GOIs) (2016–2020) (n = 1879).

Specific common gradual onset injuries (GOIs) in cyclists	n*	% (of all GOIs)
Knee – Anterior knee pain (AKP)/Patellofemoral pain (PFP)	323	17.2
Shoulder pain	200	10.6
Knee – Iliotibial band friction syndrome (ITBFS)	194	10.3
Lower back pain (LBP)	145	7.7
Hip/glutes/buttock muscle injury	82	4.4
Hip joint pain	76	4.0
Achilles tendon injury	70	3.7
Numbness in hand/fingers	69	3.7
Foot/Heel pain	56	3.0
Neck pain	52	2.8
Hamstring muscle injury	51	2.7
Calf muscle injury	49	2.6
Wrist pain	48	2.6
Elbow pain	40	2.1
Quadriceps muscle injury	17	0.9
Groin/genital numbness	15	0.8
Saddle sores	15	0.8
Other	378	20.1

n: number of injuries reported in the study
%: Gradual onset injuries frequency (%) of reported injuries in the study
*: Weighted totals/frequencies

The most frequently reported specific GOIs were anterior knee pain (AKP)/Patellofemoral pain (PFP) (17.2%), shoulder pain (10.6%), iliotibial band friction syndrome (ITBFS) (10.3%), and lower back pain (LBP) (7.7%) respectively.

GOIs by tissue type affected in race entrants

The frequency (%) of GOIs by tissue type is depicted in Table 4.

Table 4. Gradual onset injuries (GOIs) by tissue type in race entrants (expressed as % of all GOIs) (2016–2020) (n = 1879).

Gradual onset injuries (GOIs) by Tissue Type		n*	% (of all GOIs)
Soft tissue	All soft tissue	1070	57.0
	Tendon	355	18.9
	Muscle (e.g. strain)	347	18.5
	Ligament (e.g. sprain)	238	12.7
	Nerve (e.g. numbness during or after cycling)	130	6.9
Bone	Bone (e.g. bruise or stress fracture)	352	18.8
Joint	Joint (e.g. arthritis)	249	13.3
Other	Other	206	11.0

n: number of injuries reported in the study
%: Gradual onset injuries frequency (%) of reported injuries in the study
Missing data in 2 injuries
*: Weighted totals/frequencies

The majority of GOIs were to the soft tissues (tendon, muscle, ligament, and nerve) (57%), and 37.4% of GOIs were reported as musculotendinous. The specific tissue types (% of all injuries) were tendon (18.9%), followed by bone (18.8%), and muscle (18.5%).

A further analysis of the frequency (%) of GOIs by type of tissue in the main anatomical region is depicted in supplementary Table S1.

GOIs by tissue type in the main anatomical regions in race entrants

The most common tissue type affected by GOIs in the lower limb was tendon (28.7%). Bony injury was the most common tissue type affected by GOIs in the upper limb (28.5%), whilst in the lower back muscles (32.7%) and hip/groin/pelvis muscles (30.6%) was the most common tissue type affected by GOIs.

Severity of GOI in cyclists by duration of symptoms and severity grade of the GOI

GOIs by duration of symptoms category in each main anatomical region in race entrants

Race entrants reported that 44% (n = 825) of all GOIs had a symptom duration >12 months, followed by 34.2% (n = 642) with a symptom duration of 4–12 months and 21.9% (n = 411) with a symptom duration of 0–3 months).

The frequency (%) of reported GOIs by duration of symptoms category in each main anatomical region is depicted in Table 5.

Table 5. The frequency (%) of reported GOIs by duration of symptoms category in each main anatomical region (expressed as % of GOIs in the main anatomical regions) (2016–2020) (n = 1879).

	Head, Neck & Face (n* = 61)		Upper Limbs (n* = 378)		Trunk/ Chest (n* = 21)		Lower Back (n* = 146)		Hip/Groin/ Pelvis (n* = 188)		Lower Limbs (n* = 891)		Other (n* = 195)		All GOIs (n* = 1879)	
Duration of symptoms category (months)	n*	%	n*	%	n*	%	n*	%	n*	%	n*	%	n*	%	n*	%
0–3 months	13	21.1	89	23.4	12	55.7	33	22.3	30	15.9	189	21.2	47	24.0	411	21.9
4–12 months	16	25.7	139	36.7	7	32.0	28	18.9	59	31.3	326	36.6	69	35.6	642	34.2
> 12 months	32	53.2	150	39.8	3	12.4	86	58.8	99	52.9	376	42.2	79	40.5	825	43.9

n: number of injuries reported in the study
%: Gradual onset injuries frequency (column %) of reported injuries in the study
*: Weighted totals/frequencies

Of the reported GOIs by main anatomical region, 58.8% lower back, 52.9% hip/groin/pelvis, 42.2% lower limb, and 39.8% upper limb were reported as having a symptom duration of >12 months.

GOIs by severity grade in race entrants

The frequency (%) of GOIs by severity grade (grade I–IV) is depicted in Table 6.

Table 6. The frequency (%) of GOIs by severity grade (grade I–IV) in race entrants (expressed as a % of all GOIs) (2016–2020) (n = 1879).

Severity grading of injuries			n*	%
Less severe	All less severe (not affecting cycling)		1098	59.6
	Grade I	I only experience symptoms after exercise	432	23.5
	Grade II	I experience symptoms during exercise. but it does not interfere with exercise	666	36.2
More severe	All more severe (affecting cycling)		743	40.4
	Grade III	I experience symptoms during exercise that may interfere with my training/ competition	563	30.6
	Grade IV	I am so painful that I may not be able to train or compete	180	9.8

n: number of injuries reported in the study
%: Gradual onset injuries frequency (%) of reported injuries in the study
Missing data in 38 injuries
*: Weighted totals/frequencies

Of the GOIs reported, >40% were severe enough to interfere with the cyclist's ability to, and even stop them from, training or competing.

Severity of GOIs by main anatomical region in race entrants

The frequency (%) of GOIs severity (grade I–IV) by main anatomical region is depicted in supplementary Table S2 (% of reported GOIs by main anatomical region).

Of the main reported anatomical region of GOIs (as a % of all GOIs), 52.6% lower back, 44.1% lower limb, 38.3% hip/groin/pelvis, and 28.1% upper limb injuries were severe enough to interfere with the cyclist's ability to, and even stop them from, training or competing.

Treatment modalities for GOIs in recreational cyclists

The frequency (%) of the treatment modalities for GOIs is depicted in Table 7 [% of reported GOIs (n = 1348) of a subgroup of 40,638 (2017–2020 CTCT)].

Table 7. The frequency (%) of the treatment modalities for GOIs in a subgroup of40638cyclists (2017–2020) (n = 1348).

Treatment modality	n*	%
Rest	619	45.9
Physiotherapy	580	43.0
Stretches	447	33.2
Strength exercises	447	33.1
Tablets	325	24.1
Surgery	264	19.6
Bike setup	203	15.1
Other treatments	110	8.1
Cortisone injection	94	7.0
Other injections	27	2.0
New cycling shoes	22	1.7
New cycling pants	8	0.6
New cycling gloves	3	0.2

n: number of injuries reported in the study
%: Gradual onset injuries frequency (%) of reported injuries in the study
*: Weighted totals/frequencies

Multiple treatments (n = 3149) were reported for the 1348 GOIs. The four main reported treatment modalities for GOIs (as a % of the 1348 reported GOIs) were: rest (45.9%), physiotherapy (43.0%), stretches (33.2%) and strength exercises (33.1%). The use of tablets or injections as treatment was reported by 33% of cyclists and almost 20% were treated with surgery.

Discussion

The main findings are that in recreational cyclists: 1) GOIs are reported most frequently in the lower limbs (47.4%), followed by the upper limbs (20.1%), hip/groin/pelvis (10.0%), and lower back (7.8%), 2) the most affected specific anatomical sites of GOIs were the knee (32.1%), shoulder (10.6%), lower back (7.8%) and the hip/buttock muscles (5.2%), and the most frequently reported specific GOI was AKP/PFP (17.2%), 3) soft tissue injuries (muscle, tendon, ligament, and nerve) were reported in 57% of GOIs, and 4) >43% of all GOIs, and almost 42% of lower limbs GOIs were reported as having a symptom duration of >12 months, 5) >40% of GOIs were severe enough to reduce or prevent cycling (Grades III and IV), and almost 46% of lower limbs GOIs were more severe, and 6) the four main reported treatment modalities for GOIs (as a % of the 1348 reported GOIs) were rest (45.9%), physiotherapy (43.0%), stretches (33.2%), and strength exercises (33.1%).

Clinical characteristics of GOIs in cyclists has been reported in a few studies [4,14,22,23], but methodological differences make comparisons between studies challenging. These methodological differences include: differences in terminology and the definition of gradual onset injuries [9,10,22], defining and reporting the exposure [14,24], small sample sizes [9,22], low-response rates with possible selection bias [9,10], differences in the populations studied (ranging from professional cyclists to multistage cycling events) [4,14,23,25,26], and use of self-reported data with differences in timing and content of questionnaire administration [9,10,14,22]. In a recent IOC consensus statement on methods for epidemiological studies in competitive cycling [7], a standardized definitions and method of reporting injuries in cyclists was developed, and this will make the comparison of results easier for future research. In our

study, we adopted the methods classification, description, and reporting of GOIs based on the recent IOC consensus statement on methods for epidemiological studies in competitive cycling [7].

In our study, we show that the region most frequently affected by GOIs were the lower limb, followed by the upper limb, hip/groin/pelvis and the lower back. The frequency of GOIs by main anatomical region has been reported in other studies as follows: lower limb (67.9%–82.7%), lower back (13.4%–15.1%), upper limb (3.8%–10.6%), and hip/groin/pelvis (3.1%–3.8%) [23,25,26]. These differences could be associated with the little experience of recreational cyclists in our study compared with the elite cyclists in other studies [23,25,26].

The four most affected specific anatomical sites for GOIs were the knee, shoulder, lower back, and the hip/gluteal muscles. Our results are similar to other studies in recreational cyclists: knee (22%–53.8%), shoulder (13%–30%), lower back (2.7%–41%), and hip/buttock muscles (4%–36.1%) [8–10,14,22,27,28]. Knee GOIs are common and are the most likely cause of time lost due to injury in cyclists [6,12,29,30]. In our study, as in other studies [12,14,31–34], the common specific GOIs affecting the knee were AKP/PFP and the ITBFS. We did not investigate possible causes of, or mechanisms responsible for, these knee injuries, as this is a descriptive study. Multiple causes for GOIs affecting the knee in cyclists have been reported including lower limb biomechanical (e.g. anatomical malalignment or maltracking), repetitive force application, reduced range of motion (ROM), muscle imbalances, and other elements that potentially affect the responses of tissue to repetitive mechanical loading and the healing rate of microscopic tissue damage [34–37]. We recommend that causal factors need to be explored in future studies in recreational cycling.

Few cycling studies have reported the frequency of GOIs by tissue type [14,23,25,26]. In our study (57%), as in the other studies (43.4%–86%) [23,25,26], most GOIs were soft tissue injuries. During cycling, most of the force generation and force transfer takes place in the muscles, tendons, and ligaments (soft tissue), thus gradual onset bony injuries are less common as the acceleration changes and increased vertical impact forces are not usually associated with cycling. The sustained compression (e.g. sitting on the saddle) or traction (e.g. in the wrist) could possibly contribute to gradual onset nerve injuries. Due to methodological differences between studies, the direct comparison of frequencies of GOIs and types of GOIs is difficult, but in general, our findings are similar to a previous study in recreational cyclists reporting a 55% frequency of GOIs by tissue type [14].

We report that symptom duration >12 months was common (almost 45%) in cyclists with GOIs. In a previous study in recreational cyclists seeking medical treatment for GOIs, the mean symptom duration was reported as 3.7 months [9]. Another study in recreational cyclists reported the specific anatomical sites where neurological symptoms disappeared either immediately after cycling, or disappeared 1 hr after cycling, or symptoms lasted for >1 week [10]. We report the main anatomical regions where symptom duration >12 months are in the lower back, hip/groin/pelvis, lower limb, and upper limb. Our current findings are similar to a previous 1-year study in recreational cyclists [14]. As our study is a descriptive study, we could not explore the precise reason/s for the extended duration of reported symptoms. As previously mentioned, we included more severe injuries in our definition of a GOI, and this definition could be a possible reason for the extended duration. However, other factors could also account for the high % of GOIs with prolonged symptom duration including: incorrect diagnosis, cyclists that did not seek medical attention for mild symptoms with fluctuating severity, or ineffective treatment of GOI that resulting in prolonged symptoms. Another factor for chronic

symptoms of GOIs could be that after an injury, algopathic/nocipathic/nociplastic (centralization of pain) pain may develop [38]. We also note that >60% of our participants were >50 years old. In one prospective observational study, (where multivariate analysis was conducted) older age were associated with cyclists seeking medical care for GOIs [22]. We recommend that causal factors need to be explored in future studies to identify reasons for the prolonged duration of symptoms in recreational cyclists.

In cycling studies that measured the severity grading of GOIs [4,9,10,14,23,25,26], four were studies in recreational cyclists [8–10,14]. In elite cyclists, 5.7%–58.8% GOIs were classified as more severe GOIs [4,23,25,26], and in recreational cyclists 16.5%–37.3% were more severe [8–10,14]. We report a frequency of more severe GOIs (40.4%) that is similar to that of elite cyclists [4,26], and to results from a previous 1-year study in recreational cyclists [14]. Other studies showed a lower frequency of more severe GOIs in recreational cyclists [8–10]. In our study, the main anatomical regions with more severe GOIs were in the lower limb (44.1%), hip/groin/pelvis (38.3%), and upper limb (28.1%). These results are similar to other studies in recreational cyclists: lower limb (21%–52.3%), hip/groin/pelvis (14%–69.6%), and upper limb (2.0%–26.5%) [8–10]. We report more severe GOIs in the lower back (52.6%), than other studies in recreational cyclists (2.7%–26.8%) [8–10]. We recognize that a comparison of the severity of GOIs between cycling studies is limited due to the considerable differences in the definitions of 'more severe' injuries and classification of measures of severity of GOIs.

Finally, we show that the main self-reported treatment modalities for GOIs were rest and physiotherapy, and this is similar to findings in one study [22], but not another study [10] in recreational cyclists. Of clinical relevance is that almost 20% of reported GOIs needed surgical intervention and almost 35% of reported GOIs were treated with medication (tablets or injections). This is higher than previous reports in recreational cyclists, but due to methodological differences of studies, the direct comparison of treatment modalities is difficult. We acknowledge that the treatment modalities reported by cyclists could have been influenced by the expertise of health professionals in treating cycling-specific injuries, for example, knowledge of bicycle set-up.

Limitation of the study

Interpreting our results should be done with the following limitations in mind: We acknowledge that individual cyclists entering in more than one year could not be identified over the 5 year period. Therefore, the data could not be analyzed as correlated data. However, for this descriptive paper the number of several specific injuries (GOIs) were reported and not injured cyclists, that is, a cyclist could report up to 2 injuries every year they participated. Furthermore, no statistical modeling was involved, therefore no sensitivity analysis is necessary to quantify the risk. The questionnaire was voluntary 2017–2020, not all cyclist gave consent for their data to be used, and the population we studied consisted mostly of male cyclists and cyclist in the older population, which limits the generalizability of our results. There is a need for future studies in younger cyclists and female cyclists. A further limitation is that our data are self-reported. This means there is not just a potential for recall bias, but also that an accurate diagnosis of injuries, comprising the specific tissue type and the pathology involved, could not be confirmed by clinical evaluation or special investigations. However, athletes generally seek medical attention for injuries and are usually well informed about the diagnosis of their injuries, thus self-reported data collection is an acceptable and common method in large descriptive epidemiological studies on injuries in athletes [8–10]. This is also evident in numerous studies on cycling injuries [4,11,23,25]. Additional limitations of our study are that our definition of

injury leaned toward recording more severe injuries, and the maximum duration allowed for reporting injuries was restricted at '>12 months,' which was reported by more than a third of the injured cyclists. We also recognize that information on injury severity is dependent on a subjective individual assessment of pain to define the grade of severity. Although a multiple select question was used to investigate the multiple treatment modalities there is a possibility that some participants only indicted that physiotherapy was received which may have consisted of the other options provided, namely stretching, strength, or rest. The current gold standard for injury surveillance research is a prospective study design, and we suggest that this should be used for future studies.

Conclusion

This is a follow-up study from the SAFER research program in cyclists and now includes 5-year data in recreational cyclists. We showed that GOIs generally affected the knee, shoulder, hip/buttock muscles and lower back. Of these GOIs, >40% were severe enough to affect training and competition. Of some concern is that almost 45% of cyclists with GOIs reported a symptom duration of >12 months. Even though this is the largest cross-sectional study (that we are aware of) describing the clinical characteristics of GOIs in recreational cyclists preparing for a one-day cycling event, more research is needed. We propose further research focus on determining independent risk factors associated with GOIs in large populations of recreational cyclists to plan and execute effective injury prevention programs in cyclists.

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