

Andersen, C. A., Clarsen, B., Johansen, T. V., Engebretsen, L. (2013). High prevalence of overuse injury among iron-distance triathletes. *British journal of sports medicine*, 47, 857-861.

Dette er siste tekst-versjon av artikkelen, og den kan inneholde små forskjeller fra forlagets pdf-versjon. Forlagets pdf-versjon finner du på bjsm.bmj.com:
<http://dx.doi.org/10.1136/bjsports-2013-092397>

This is the final text version of the article, and it may contain minor differences from the journal's pdf version. The original publication is available at bjsm.bmj.com: <http://dx.doi.org/10.1136/bjsports-2013-092397>

HIGH PREVALENCE OF OVERUSE INJURY AMONG IRON-DISTANCE TRIATHLETES

Christian A. Andersen

Oslo Sports Trauma Research Center
Norwegian School of Sport Sciences
PB 4014 Ullevål Stadion
0806 Oslo, Norway
Tel: +4793483327
Fax: +4723262307
Email: c.a.andersen@nih.no

Ben Clarsen

Oslo Sports Trauma Research Center
Norwegian School of Sport Sciences
Oslo, Norway

Tone V. Johansen

Oslo Sports Trauma Research Center
Norwegian School of Sport Sciences
Oslo, Norway

Lars Engebretsen

Department of Orthopaedic Surgery
Oslo University Hospital and Faculty of Medicine
University of Oslo
Oslo, Norway

Short title: Injuries and illnesses among iron-distance triathletes

Key words: Triathlon, Epidemiology, Sporting injuries, Lower extremity injuries, Soft tissue injuries

ABSTRACT

Background Triathlon is an increasingly popular sport at both the elite and the recreational level. However, there have been few high-quality studies of injuries and illnesses among triathletes.

Objective To register overuse problems and acute injuries among iron-distance triathletes throughout a training season leading up to a major event.

Methods A 26-week prospective cohort study was conducted including 174 participants of the 2011 Norseman Xtreme Triathlon. Data on overuse injuries located in the shoulder, lower back, thigh, knee and lower leg were collected every second week using the OSTRC Overuse Injury Questionnaire. Illnesses, acute injuries and overuse problems affecting other anatomical areas were also recorded using standard injury surveillance methods.

Results The average prevalence of overuse problems was 56% (95% CI: 51-61) (490 cases). The average prevalence of substantial overuse problems was 20% (95 % CI: 18-21) (165 cases). The most prevalent sites of overuse problems were the knee (25%), lower leg (23%) and lower back (23%). The acute injury incidence was 0.97 injuries per 1000h of training (36 cases) and 1.02 injuries per 1000h of competition (5 cases). A majority of moderate and severe acute injuries were located at the knee, shoulder/clavicle and sternum/ribs. The predominant types of acute injuries were contusions, fractures and sprains. The incidence of illness was 5.3 per 1000 athlete-days (156 cases).

Conclusion Overuse problems constitute the majority of injury cases among iron-distance triathletes, and are far more common than acute injuries and illnesses. The most prevalent sites of injury in the present study were the knee, lower leg, lower back and shoulder. Future injury prevention studies in iron-distance triathletes should focus on these areas.

INTRODUCTION

Triathlon is a competitive sport consisting of swimming, bicycling and running. Since its incipience in the late nineteen-seventies, triathlon has grown into a popular endeavour among recreational and elite athletes, and it has been an Olympic sport since 2000. Common race distances include sprint distance (750m swim, 20km bike and 5km run), standard or “Olympic” distance (1500m swim, 40km bike and 10km run), and long distance (3000m swim, 80km bike and 20 km run). In recent years there has been a particular increase in the popularity of ultra-distance triathlons (3.8km swim, 180km bike and 42.2km run), also commonly known as “ironman” or “iron-distance” triathlons.

However, little is known about the extent to which iron-distance triathletes suffer from injury and illness. This is important information as it represents the first step in the sequence of prevention research.^{1,2} Previous studies of injuries in triathlon have been limited by a retrospective study design or by a short duration and small sample size. Inconsistent injury definitions have also been used, making it difficult to compare and interpret results.³ According to Gosling et al,³ this represents a gap in the knowledge needed to develop informed injury prevention strategies, thereby reducing the burden of triathlon related injury. To our knowledge, there have been no previous epidemiological studies of illness in triathlon. The objective of this 26-week prospective cohort study was to record the magnitude and severity of injuries and illnesses among triathletes preparing for a major iron-distance triathlon event. A new methodology for the registration of overuse injuries has been used,^{4,5} in addition to standard surveillance methods.⁶

METHODS

Inclusion

All athletes who registered for participation in the 2011 Norseman Xtreme Triathlon (n=274) were contacted by email and invited to participate in the study. Among the 274 invited subjects, 174 subjects accepted the invitation. Norseman Xtreme Triathlon is an iron-distance event held annually in Norway with participants from all over the world. Information about the study was published on the organiser’s website and in the online consent form that participants were required to complete. The study was approved by the Norwegian Data Inspectorate and reviewed by the South-Eastern Norway Regional Committee for Research Ethics.

Data collection procedure

Every second Sunday for the duration of the 26-week data collection period, online survey software (Questback V. 9692, Questback AS, Oslo, Norway) was used to send each participant an e-mail linking them to an injury questionnaire (described below). Athletes who failed to respond within five days received an automatic reminder email.

Questionnaire

The Oslo Sports Trauma Research Center (OSTRC) Overuse Injury Questionnaire was used to collect data on injuries located in the shoulder, lower back, thigh, knee and lower leg.⁵ These areas were selected for specific study as previous studies of triathlon injuries have suggested lower limb, back and shoulder to be the most common sites of injury among iron-distance triathletes.³ In addition to questions on injury, athletes were asked to register the total training volume (hours) and training volume and the average training intensity in each discipline (swim, bike, run). In order to be able to provide accurate information, athletes were encouraged to keep a daily record of their training and injuries/physical complaints. The number of days of total time loss was registered for each problem reported. Baseline data were collected in the first questionnaire. The complete questionnaire is available as an online supplement to this paper.

Severity score

A severity score of 0-100 was calculated for each anatomical area each time a questionnaire was completed.⁵ This score was monitored over the duration of the study and the average score was calculated for all reported cases.

Acute injury registration

At the end of the questionnaire, athletes were asked to record all physical complaints they had experienced in the previous two-week period, regardless of the injury's consequence or whether they had already given information on the same problem in earlier questions. The nature of onset was recorded for each complaint and those that could be linked to a specific injury event (e.g. a collision or fall) were classified as acute injuries. These injuries were reported according to the consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries.⁶ If an acute injury had been sustained in the shoulder, lower back, thigh, knee or lower leg, data corresponding to these injuries that were obtained through the overuse injury questionnaires were separated in the database.

Illness registration

Athletes were asked whether or not they had suffered from illness during the previous two-week period. Illnesses were defined as any health problems that were not related to the musculoskeletal system, for example respiratory tract infections, influenza or gastrointestinal infections. The number of days of time-loss was recorded for all cases.

Data analysis

All data were compiled in a database created with Microsoft Excel software (Microsoft Excel 2010, Microsoft Corporation, Washington, USA). At the conclusion of the study a final classification of illness and injury cases was performed based on the total information obtained from each athlete over the course of the study. The rate and severity of overuse injuries was reported for each anatomical area according to the OSTRC methodology.⁵ As previously recommended, data from the first questionnaire were removed from all injury and illness analyses.⁵ Measures included the average prevalence of all overuse problems, the average prevalence of substantial overuse problems (defined as those leading to moderate or severe reductions in training volume, *or* moderate or severe reduction in sports performance, *or* complete inability to participate in sport) and the average severity score. The number, severity and incidence of acute injuries, and overuse injuries affecting anatomical areas other than the shoulder, lower back, thigh, knee and lower leg, were reported using standard methods.⁶ Illnesses were reported using the same methodological approach, but without any system-specific classification.

RESULTS

Participant characteristics

The participant characteristics are summarised in table 1. The average male athlete had been generally active in sports for 23 years (95% CI: 21.3 – 24.7). The female athletes reported an average of 18 years (95% CI: 14.8 – 21.2) experience from active sports. Forty per cent of the female and 36% of the male athletes were training for their first iron-distance race. Within the cohort 16 athletes were classified as “elite” as they had qualified for the event through seeding. There were no female elite athletes in the study.

Table 1. Participant characteristics

Gender	Age (years)*	Height (cm)*	Weight (kg)*	Triathlon experience (years)*	Number of completed IM-distance races*
Male (n = 143)	39 (8)	182 (6)	80 (14)	5.0 (5.5)	2.4 (3.2)
Female (n = 31)	36 (9)	170 (5)	63 (6)	3.3 (2.9)	2.1 (3.2)
Total (n = 174)	38 (9)	180 (7)	77 (15)	4.7 (5.1)	2.4 (3.2)

* Values are mean (SD)

Response rate

We invited 274 athletes to participate in the study, of which 63.5% (174) accepted the invitation. Among these the average response rate to the electronic questionnaire distributed every second week throughout the course of the study was 87% (SD 4), whereas 112 (64%) completed all thirteen questionnaires. We suggest that there were no significant differences between the responders and those with missing data, except for years of triathlon experience (5 years (SD 5.3) versus 3 years (SD 3.2) respectively, $p=0.02$) and number of completed iron-distance races (2.6 (SD 3.4) versus 1.5 (SD 2.1), $p=0.02$).

Training habits

On average, athletes spent 276 hours in training during the 26-week study period (95% CI: 263-289). On average, athletes trained for 11.1 hours per week (95% CI: 10.6-11.6, range: 5.1-20.3). Of this, 1.4 hours per week was spent swimming (95% CI: 1.3-1.6, range: 0-5.2), 5.8 hours cycling (95% CI: 5.4-6.2, range: 1.1-13.2) and 2.9 hours running (95% CI: 2.7-3.2, range: 0.7-10.6). Over the course of the 26-week project, 48% of the total training time was spent on cycling, 24% on running, 12% on swimming and 16% on other training such as weight lifting, skiing or other activities.

[Figure 1 near here]

Overuse injuries

The average prevalence of overuse injury problems in any anatomical location was 56% (95% CI: 51-61). The average prevalence of substantial overuse injury problems was 20% (95 %

CI: 18-21). The average prevalence and severity score for the 5 different anatomical regions is shown in table 2.

Table 2. Average weekly prevalence of all overuse problems and of substantial problems, and average weekly severity score

	Shoulder (88 cases)	Lower back (84 cases)	Thigh (88 cases)	Knee (106 cases)	Lower leg (106 cases)
Average weekly prevalence (all problems) [#]	20 (16-23)	23 (21-25)	12 (10-14)	25 (21-29)	23 (20-26)
Average weekly prevalence (substantial problems) [#]	4 (3-5)	4 (3-5)	3 (3-4)	7 (6-8)	7 (5-8)
Average weekly severity score	27 (24-29)	26 (24-28)	28 (27-30)	30 (28-32)	32 (30-34)

Substantial problem: Overuse problem causing moderate/severe reductions in training volume or sports performance, or complete inability to participate in training or competition

[#] Values are shown as percentages with the 95% confidence interval in parentheses.

Eighty-seven per cent of the entire cohort reported some form of overuse problem at some point over the course of the study, and more than half reported substantial problems. On average, those athletes with shoulder problems reported problems 42% (95% CI: 35-49) of the time throughout the course of the study. Athletes with knee problems reported problems 44% (95% CI: 38-50) of the time. Those with lower back problems reported problems 46% (95% CI: 39-53) of the time. Athletes with lower leg problems reported problems 47% (95% CI: 40-54) of the time, whereas those with thigh problems reported problems 34% (95% CI: 27-42) of the time throughout the course of the study.

[Figure 2 near here]

Overuse problems affecting other anatomical areas than the shoulder, knee, lower back, thigh or lower leg are shown in table 3.

Table 3. Location and severity of other overuse problems

	Slight (0 days)	Minimal (1-3 days)	Mild (4-7 days)	Moderate (8-28 days)	Severe (>28 days)	Total
Neck/cervical spine	0	1	0	0	0	1
Elbow	0	0	1	0	0	1
Thoracic spine/upper back	0	1	1	0	0	2
Hip and Groin	2	0	0	2	1	5
Ankle	1	1	0	0	0	2
Foot/toe	0	1	2	2	2	7
Total	3	4	4	4	3	18

Acute injuries

Forty-one acute injuries resulting from either training or competition were registered during the study period. The acute injury incidence was 0.97 injuries per 1000h of training (36 injuries) and 1.02 injuries per 1000h of competition (5 injuries). Seventy-eight per cent of the

training related acute injuries occurred while training in primary sport (swim, bike or run), while the remaining 22 % resulted from alternative training. The predominant types of injuries were contusions (17%), fractures (10%) and sprains (10%). Location and severity of acute injuries is listed in table 4.

Table 4. Location and severity of acute injuries

	Minimal (1-3 days)	Mild (4-7 days)	Moderate (8-28 days)	Severe (>28 days)	Total
Head and Face	0	3	0	0	3
Shoulder/Clavicle	0	0	3	1	4
Elbow	0	0	1	0	1
Forearm	0	0	1	0	1
Finger	1	1	0	0	2
Sternum/ribs	0	0	4	0	4
Lumbar spine/lower back	1	0	1	0	2
Hip and groin	1	3	0	0	4
Thigh	1	1	2	0	4
Knee	2	0	5	1	8
Lower leg	1	0	2	0	3
Ankle	0	1	1	0	2
Foot/toe	1	0	1	1	3
Total	8	9	21	3	41

The inciting events of the vast majority of acute injuries, 25 injuries sustained by 12 athletes, were bike accidents, where the athlete either collided with another cyclist or motor vehicle or lost control over the bike for other reasons. Injuries sustained in bike accidents most commonly affected the knee (7), shoulder/clavicle (4), head/face (3) and sternum/ribs (3), but also injuries to the finger, forearm, elbow, hip, thigh, lower leg and ankle were reported. One third of the athletes involved in bike accidents suffered multiple injuries. None of the reported acute injuries were associated with swimming, and there were only three acute injuries associated with running; 1 ankle sprain, 1 strained thigh muscle during normal running and 1 contusion of the anterior iliac crest caused by a fall onto a rock.

Illness

There were 156 cases of illness reported during the study period, affecting 104 athletes (60% of the cohort), giving an incidence of 5.3 illnesses per 1000 athlete-days. Nine per cent of all cases did not lead to any time loss, 34% were of minimal severity (1-3 days of time loss), 36% were mild cases (4-7 days), 19% were of moderate severity (8-28 days) and 3% of all cases were of more than 28 days severity.

DISCUSSION

This is to our knowledge, the first prospective cohort study of injuries and illnesses among iron-distance triathletes. The major findings were that, at any given time during the course of the study, more than half the cohort were suffering from some form of overuse problem, and one in five had overuse injuries causing a moderate to severe reduction in training participation or sports performance, or complete inability to train (substantial overuse problems). Five specific anatomic areas were investigated in this study; the shoulder, lower back, thigh, knee, and lower leg. While overuse complaints were prevalent in all locations, the knee and lower leg were the areas with the highest prevalence of substantial problems.

A total of 87% of the entire cohort reported some form of overuse problem at some point over the course of the study, and more than half reported substantial problems. This suggests that the magnitude of overuse problems in iron-distance triathletes is high, supporting the conclusions of previous reports.⁷⁻¹⁷ However, as we have used a new method of collecting and expressing injury data, our results are not directly comparable with previous triathlon studies.

The current study has certain limitations. Firstly, no detailed baseline data except for age and gender distribution and proportion of elite athletes was obtained for those who did not accept the invitation to participate in the study. This represents a potential source of selection bias. Among the total number of athletes signed up for Norseman 2011, 13% were elite athletes, whereas 9% of the subjects included in the study were elite athletes. Thus, the elite athletes were underrepresented. It is unknown whether elite and non-elite triathletes have the same injury patterns. Nevertheless, as the proportion of elite athletes apparently is low in both the study population and our sample, we believe our results are representative. There were no differences between those who accepted the invitation and those who did not with regards to age and gender distribution. Secondly, we have collected information on the illness and injury patterns of triathletes preparing for a specific event, and the extent to which these athletes are representative of all iron-distance triathletes remains unknown. However, we are unaware of any reason for why this cohort should differ substantially from other groups of iron-distance triathletes, particularly given the diversity of nationalities represented in the event. In

addition, as we collected data on all physical complaints, a certain percentage of reported problems may have been “normal” pain associated with heavy training, for example delayed-onset muscle soreness after weight lifting. We were unable to perform a confirmatory medical examination of each reported problem and therefore lack detailed diagnostic information on each “case.” However, previous studies using these methods have found that 17% of reported problems had no consequence other than mild pain,⁵ and 30% were diagnosed with the injury type “non-specific pain” according to the Orchard Sports Injury Classification System (OSICS-10).¹⁸

In addition to the area-specific questionnaires, injuries were also registered using “standard” surveillance methods, in which a more open form of questioning was used. Using this method, only 18 overuse injuries affecting other anatomical regions than our 5 main areas of interest were identified. This may partly be due to the differences in methodology applied, as general questioning has a tendency to lead to fewer cases of overuse problems being identified compared to specific questioning on predefined anatomical areas.¹⁹ However, it seems reasonable to conclude the 5 anatomical areas we specifically studied covered a majority of the overuse injuries affecting the cohort. Ankle/foot/toe injuries have previously been reported to constitute between 9% and 35% of all injuries sustained by triathletes, thus being the second most common site of injury in the lower limb.^{11 14} We found, however, ankle/foot/toe injuries to account for only 3% of all our recorded injuries.

Acute injury data were reported consistent with current consensus methodology.^{6 20} In contrast to previous reports,³ we found a low incidence of acute injuries related to triathlon competition (1.0 injuries per 1000 h of competition). In comparison, previous studies have reported up to 17.4 injuries per 1000 hours of competition.¹⁵ The most likely explanation for this discrepancy is that previous studies have included all injuries, including exacerbations of pre-existing overuse conditions, in their incidence measures. In contrast, due to the prospective design of this study we were able to identify and eliminate pre-existing conditions from incidence calculations.

No epidemiological studies have reported illnesses among triathletes. Our findings suggest that the incidence of illnesses among iron-distance triathletes is similar to that of other individual sports,²¹⁻²³ and considerably lower than in team sports.²⁴⁻²⁸ However, our data showed a decline in illness incidence towards the main competition. This finding may be due to normal seasonal variation, but might also suggest that the incidence of illness is lower close to competition than in the training season. Previous studies reporting incidence of illnesses among athletes of individual sports have only captured data over the duration of a tournament.

CONCLUSION

The prevalence of overuse problems in iron-distance triathletes is high, whereas the acute injury incidence appears to be lower than previously reported. The incidence of acute injuries did not differ between training and competition. The findings of this study suggest that overuse problems constitute the majority of injury cases in iron-distance triathletes, with the most prevalent sites of injury being the knee, lower leg, lower back and shoulder. Future injury prevention studies in iron-distance triathletes should focus on these areas.

What are the new findings

- The majority of injury cases in iron-distance triathletes are due to overuse.
- The incidence of acute injury is low in iron-distance triathlon for both training and competition.
- The knee, lower leg, lower back and shoulder are the most prevalent sites of overuse injury in iron-distance triathletes, and future injury prevention studies should focus on these areas.

How might it impact on clinical practice in the near future

- This paper introduces a new methodology for overuse injury registration in triathlon injury surveillance, which may lead to progress in the field of triathlon injury epidemiology.
- The results from the present study shed new light on the burden of triathlon related injury, and may contribute to future informed development of injury preventive strategies.

Acknowledgements

The authors would like to thank Hardangervidda Triathlon Klubb, the organizer of Norseman Xtreme Triathlon, for their assistance in recruitment of subjects and promotion of the project. We would also like to thank the athletes for their patience and faithful reporting throughout the study period. The Oslo Sports Trauma Research Center has been established at the Norwegian School of Sport Sciences through generous grants from the Royal Norwegian Ministry of Culture, the South-Eastern Norway Regional Health Authority, the International Olympic Committee, the Norwegian Olympic Committee & Confederation of Sport, and Norsk Tipping AS.

REFERENCES

- 1 van Mechelen W, Hlobil H, Kemper HC. Incidence, severity, aetiology and prevention of sports injuries. A review of concepts. *Sports Med* 1992;**14**(2):82-99.
- 2 Finch C. A new framework for research leading to sports injury prevention. *J Sci Med Sport* 2006;**9**(1-2):3-9; discussion 10.
- 3 Gosling CM, Gabbe BJ, Forbes AB. Triathlon related musculoskeletal injuries: the status of injury prevention knowledge. *J Sci Med Sport* 2008;**11**(4):396-406.
- 4 Bahr R. No injuries, but plenty of pain? On the methodology for recording overuse symptoms in sports. *Br J Sports Med* 2009;**43**(13):966-72.
- 5 Clarsen B, Myklebust G, Bahr R. Development and validation of a new method for the registration of overuse injuries in sports injury epidemiology: the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire. *Br J Sports Med* Published Online First: 6 October 2012. doi: 10.1136/bjsports-2012-091524.
- 6 Fuller CW, Ekstrand J, Junge A, et al. Consensus statement on injury definitions and data collection procedures in studies of football (soccer) injuries. *Br J Sports Med* 2006;**40**(3):193-201.
- 7 Vleck VE, Bentley DJ, Millet GP, et al. Triathlon event distance specialization: training and injury effects. *J Strength Cond Res* 2010;**24**(1):30-6.
- 8 Main LC, Landers GJ, Grove JR, et al. Training patterns and negative health outcomes in triathlon: longitudinal observations across a full competitive season. *J Sports Med Phys Fitness* 2010;**50**(4):475-85.
- 9 Strock GA, Cottrell ER, Lohman JM. Triathlon. *Phys Med Rehabil Clin N Am* 2006;**17**(3):553-64.
- 10 Villavicencio AT, Burneikiene S, Hernandez TD, et al. Back and neck pain in triathletes. *Neurosurg Focus* 2006;**21**(4):E7.
- 11 Egermann M, Brocai D, Lill CA, et al. Analysis of injuries in long-distance triathletes. *Int J Sports Med* 2003;**24**(4):271-6.
- 12 Burns J, Keenan AM, Redmond AC. Factors associated with triathlon-related overuse injuries. *J Orthop Sports Phys Ther* 2003;**33**(4):177-84.
- 13 Vleck VE, Garbutt G. Injury and training characteristics of male Elite, Development Squad, and Club triathletes. *Int J Sports Med* 1998;**19**(1):38-42.
- 14 Manninen JS, Kallinen M. Low back pain and other overuse injuries in a group of Japanese triathletes. *Br J Sports Med* 1996;**30**(2):134-9.

- 15 Korkia PK, Tunstall-Pedoe DS, Maffulli N. An epidemiological investigation of training and injury patterns in British triathletes. *Br J Sports Med* 1994;**28**(3):191-6.
- 16 Collins K, Wagner M, Peterson K, et al. Overuse injuries in triathletes. A study of the 1986 Seafair Triathlon. *Am J Sports Med* 1989;**17**(5):675-80.
- 17 O'Toole ML, Hiller WD, Smith RA, et al. Overuse injuries in ultraendurance triathletes. *Am J Sports Med* 1989;**17**(4):514-8.
- 18 Clarsen B, Ronsen O, Myklebust G, et al. The Oslo Sports Trauma Research Center questionnaire on health problems: a new approach to prospective monitoring of illness and injury in elite athletes. *Br J Sports Med* Published Online First: 21 February 2013. doi: 10.1136/bjsports-2012-092087.
- 19 Clarsen B, Krosshaug T, Bahr R. Overuse injuries in professional road cyclists. *Am J Sports Med* 2010;**38**(12):2494-501.
- 20 Junge A, Engebretsen L, Alonso JM, et al. Injury surveillance in multi-sport events: the International Olympic Committee approach. *Br J Sports Med* 2008;**42**(6):413-21.
- 21 Alonso JM, Tscholl PM, Engebretsen L, et al. Occurrence of injuries and illnesses during the 2009 IAAF World Athletics Championships. *Br J Sports Med* 2010;**44**(15):1100-5.
- 22 Mountjoy M, Junge A, Alonso JM, et al. Sports injuries and illnesses in the 2009 FINA World Championships (Aquatics). *Br J Sports Med* 2010;**44**(7):522-7.
- 23 Engebretsen L, Steffen K, Alonso JM, et al. Sports injuries and illnesses during the Winter Olympic Games 2010. *Br J Sports Med* 2010;**44**(11):772-80.
- 24 Dvorak J, Junge A, Derman W, et al. Injuries and illnesses of football players during the 2010 FIFA World Cup. *Br J Sports Med* 2011;**45**(8):626-30.
- 25 Schwellnus M, Derman W, Page T, et al. Illness during the 2010 Super 14 Rugby Union tournament - a prospective study involving 22 676 player days. *Br J Sports Med* 2012;**46**(7):499-504.
- 26 Al-Shaqsi S, Al-Kashmiri A, Al-Risi A, et al. Sports injuries and illnesses during the second Asian Beach Games. *Br J Sports Med* 2012;**46**(11):780-7.
- 27 Derman W, Schwellnus M, Jordaan E, et al. Illness and injury in athletes during the competition period at the London 2012 Paralympic Games: development and implementation of a web-based surveillance system (WEB-IISS) for team medical staff. *Br J Sports Med* 2013;**47**(7):420-5.

28 Theron N, Schweltnus M, Derman W, et al. Illness and Injuries in Elite Football Players-A Prospective Cohort Study During the FIFA Confederations Cup 2009. *Clin J Sport Med* Published Online First: 10 May 2013. doi: 10.1097/JSM.0b013e31828b0a10.

Figure 1

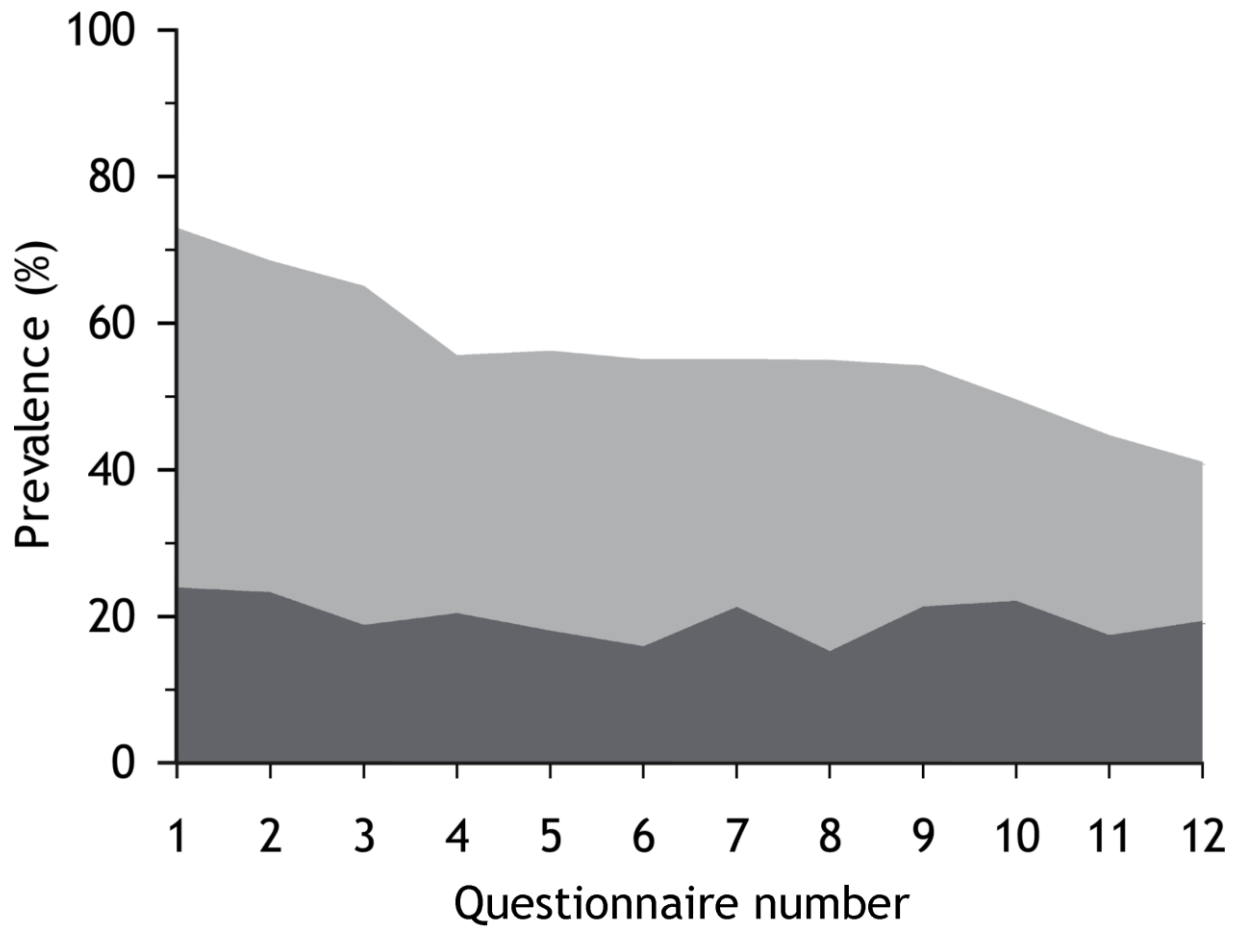


Figure 2

