

PROFILE OF INJURES PREVALENCE IN ATHLETES WHO PARTICIPATED IN SESC TRIATHLON CAIOBÁ-2011

IZABELA PICHININ BERTOLA¹, RENATO PINEDA SARTORI¹, DANIELA GALLON CORRÊA¹, TALITA GIANELLO GNOATO ZOTZ², ANNA RAQUEL SILVEIRA GOMES^{1,2}

ABSTRACT

Objective: To identify the prevalence of injuries occurred during training and/or competition in triathlon athletes at SESC Triathlon Caiobá-2011. **Methods:** One hundred and ninety athletes participated in the study (153 males and 37 females). **Results:** Athletes reported time of practice between 3 to 6 years (20%), training frequency of 5 days per week (48%), at least one injury during trainings (76%). The prevalence of injuries according to the sports category was: running (79%), cycling (16%) and swimming (5%). The most injured region during training (39%) and competition (46%) was the calf. Female athletes reported 92% of injuries during running training and 35% of those injuries were on ankle and foot. During competition only two athletes

reported injuries. Muscle injury was the most prevalent (54%) among male athletes, followed by tendon (19%), ligament (17%) and bone (9%) injuries. Among female athletes prevalent injuries were: 32% muscle, 32% bone, 32% tendon and only 4% ligament injuries. **Conclusion:** Skeletal muscle injuries were the most common lesions during running training, however, male athletes reported mostly calf injuries, while female had mostly ankle and foot injuries. **Level of Evidence III. Study of Non-Consecutive Patients; Without Consistently Applied Reference "Gold" Standard.**

Keywords: Athletic injuries. Prevalence. Bicycling. Swimming. Running.

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INTRODUCTION

Triathlon was created in the 70s in California, United States,¹ emerging in Brazil in 1982.² This sport consists of three categories: swimming, cycling and running, which are performed in three consecutive periods.²

There is a variety of distances in triathlon tests,² namely, Sprint/Short, Olympic, Long, Ironman, and Ultraman, held within a competition on the same day, with the exception of Ultraman that is accomplished in three days. The Sprint/Short modality, the most popular one, comprises 750m swimming, 20km cycling, and 5km running.³ The Olympic test consists of 1500m swimming, 40km cycling and 10km running; the Long modality the distances are 3000m, 80 km, and 20 km. Ironman consists of 3800m, 180km and 42km, and the Ultraman category consists of 10,000m swimming, 421 km cycling and 84 km running.⁴ The competition SESC Triathlon Caiobá, held in Brazil, which is a part to the national circuit of SESC Triathlon, the usual categories are Short and Olympic.

Triathlon has become popular since 2000 in Sydney, when it made its debut in Olympic Games. A total of 160,000 triathletes

participated in Triathlon Australia Season 2005-2006, and 120,000 triathletes are affiliated to the International Triathlon Union (ITU).⁵ Athletes who engage in triathlon should be polyvalent and provide versatility, so they can shift within the three sports, since triathlon training requires from the athletes physical and psychological preparation, subjecting them to thorough and grueling training, thus, making them vulnerable to muscle and joint injuries, as well as tendinopathies and abrasions.⁵

The literature shows a higher incidence of injuries in triathletes during training than in competition, with respectively 81% and 19%.⁶ However, when it was analysed the number of lesions per training or competition, these authors reported that the incidence of injuries was 6 times higher in competition than in training.⁶

Galera *et al.*⁷ also showed prevalence of injuries in 83% during practice and 16% during competitions. These authors reported that even comparing the time destined for competition with the time allocated for training, injuries rates in training are in larger number and occur mostly during running, due to the most traumatic feature of this modality.

All the authors declare that there is no potential conflict of interest referring to this article.

1. Universidade Federal do Paraná, Matinhos, PR, Brazil.

2. Universidade Federal do Paraná, Curitiba, PR, Brazil.

Work developed at Curso de Fisioterapia do Setor Litoral, Universidade Federal do Paraná, Matinhos and Programa de Pós-graduação Mestrado/Doutorado em Educação Física-Curitiba, PR, Brazil.

Correspondence: Anna Raquel Silveira Gomes. Rua Engenheiro Rômulo Gutierrez, 330, 80810-250 Curitiba, PR, Brazil. annaraquelsg@gmail.com

More prospective studies on the causes and contributing factors to the injuries that occur in triathlon athletes are needed to allow elaboration of more adequate strategies for injury prevention both in training and in competitions.

Most injuries that occur in triathlon are caused by excessive activity, prevalence ranging from 37% of lesions in a study of British triathletes to 91% in a study with participants of the Ironman triathlon in Hawaii.² The anatomical sites most affected by injuries were the lower limbs, with higher incidence in ankle, followed by foot, knee, thigh and leg. In this same review, the authors cited the work of O'Toole who studied participants of triathlon Ironman Hawaii 1986, in which 72% reported low back pain or sciatic nerve pain.²

Machado *et al.*⁸ agreed that exercise-induced injuries in triathlon athletes, are a result of intense effort. These authors found serum creatine kinase levels increased immediately and five days after the Ironman triathlon competition, is indicative of muscle damage that may have affected the sarcomeric structure. Thus, physical exercise performed exhaustively, can lead to the development of important changes in body homeostasis, with structural and biochemical alterations.

Despite the large worldwide prevalence of injuries resulting from the practice of triathlon, there are no prevalence studies on injuries in Brazilian triathletes, specifically in the state of Paraná. The objective of this study was to evaluate the prevalence profile of injuries in athletes participating at SESC Caiobá Triathlon 2011 held in the city of Matinhos, PR, Brazil.

METHODS

This is an analytical observational transversal study⁹ approved by the Ethics Research Committee from the Health Sciences Department, *Universidade Federal do Paraná* (CAAE: 0111.0.091-10) and developed during the SESC Caiobá Triathlon 2011 held in the city of Matinhos, PR, Brazil.

The regulation of SESC Triathlon Caiobá, prepared by the competition Organization, follows the official rules of Triathlon Federation - CBTri.¹⁰ The SESC Triathlon Circuit Caiobá 2011 was composed by the Short modality, comprising 750m swimming, 20km cycling and 5 km running in which only amateur athletes competed and the Olympic category, comprised by 1500m swimming, 40km cycling and 10km running in which professional athletes competed.

The day before SESC Triathlon Caiobá 2011, took place the Technical Symposium of the event, where attendees received a verbal invitation to participate in this study. At that occasion explanations were given about the objectives of the study and that participation would be voluntary. Thus, in the same location, the free and informed consent term was distributed, and only triathletes who signed the term were included in the study. Besides, a questionnaire was handed, which included questions regarding training profile and possible musculoskeletal injuries of triathletes, (Annex 1) developed by researchers of this study, which was completed by the athletes themselves. The purpose of the questionnaire was to identify qualitatively and quantitatively musculoskeletal injuries during practice or competitions in athletes who had already participated in triathlon competitions. This questionnaire had a semistructured nature and consisted of objective questions for investigation of the following aspects: time practicing triathlon; whether training

is performed with or without guidance; frequency of training; type of triathlon practiced; prevalence and type of injuries both in training and in competition by category; parts of the body where injuries occurred; prevalence of lesions in warm or cold weather; etiology of injuries; signs and symptoms after injury; whether injuries recurred.

There were included in the study athletes aged 18 years or older who participated at SESC Triathlon Caiobá 2011 competition, who agreed with and signed the consent form, which were present at the technical symposium and fully completed the questionnaire. Thus, participants were 190 athletes, 153 men and 37 women.

Sample calculation was done according to the following formula:

$$n = \frac{z^2_{\alpha/2} * N * P * (1 - P)}{\epsilon^2 * (N-1) + z^2_{\alpha/2} * (1 - P)}$$

Where:

n – number of individuals in the sample;

$z^2_{\alpha/2}$ – critical value of z, which corresponds to the degree of reliability (in this case 99%);

N – population size – N=203,429,773;

P – population proportion of individuals who belong to the category of triathletes in Brazil (0,012%);

ϵ^2 – maximum error of estimate – 0,205%.

$$n = \frac{2,58^2 * 203.429.773 * 0,00012 * (1-0,00012)}{0,00205^2 * (203.429.773-1) + 2,58^2 * 0,00012 * (1-0,00012)}$$

n= 194 athletes

The number of athletes found to the study sample was 194 (one hundred ninety-four). Since 190 subjects agreed to participate voluntarily in this study, and this represented 98% of the number of individuals needed, it can be suggested that there was no impairment of the internal validity of the study.

For statistical analysis of the results obtained from the questionnaire, a descriptive analysis of data from distribution of relative frequency through tables was performed, using Microsoft Excel®.

RESULTS

The study included 190 athletes, of which 80% were male (36 ± 9 years old) and 20% female (33 ± 9 years old). Among males, 77% competed in the Short category and 23% in the Olympic category, and among women 74% competed in the Short category and 26% in the Olympic category.

Among male athletes 18% trained for less than one year, 10% between one and two years, 18% between two to three years, 20% three to six years, 16% for six to ten years and 18% of them trained over 10 years. Among female athletes the prevalence rates were: 22% trained for less than one year, 16% for one to two years, 27% two to three years, 19% for three to six years, 11% for six to ten years and 5% trained for more than 10 years. Sixty eight percent of the athletes trained without any professional guidance, 22% of them eventually relied on professional guidance and only 10% had workouts with constant orientation. It has been observed that 48% of athletes trained five days per week, 33% seven days a week, 14% three days a week, 4% only practiced before competitions and 0.65% trained

only once a week. Among female athletes, the percentages found were: 46% trained seven days a week, 38% five days a week, 13% three times a week and 2.7% practiced only prior to competitions.

A total of 145 injuries were reported for both genders, of these, 79% occurred during training and 21% in competitions. Female athletes reported that most of their injuries (92%) occurred during practice, and among male athletes the percentage of injuries during training was 76%. Among male athletes the most injured body parts during training were calf (39%), ankle/foot (18%) and knee (18%). In competition, the most injured parts were calf (46%), thigh (15%) and the same percentage (11%) was observed for knee and ankle/foot. Women had, during practice, 35% of injuries in the ankle, 23% in calf and 18% in the knee. During competition only 2 athletes (50%) presented with lesions, one in the thoracic spine and the other in the thigh. (Table 1)

When asked in which category most athletes became injured, both male and female athletes reported that the modality in which they showed most injuries was running, with, respectively 79% and 92%. The next category where most lesions occurred was cycling, as cited by 16% for male athletes and 8% for female athletes, and finally swimming, which presented with 5% injuries to male athletes and no injury reported among female athletes. (Table 2)

Regarding the type of injury male athletes reported that 54% of injuries were of the muscle, 19% were tendinous, 17% ligamentous and 9% bone. Among women, the frequency per types of lesions showed relatively similar to each other, being 32% muscle injuries, 32% bone, 32% tendinous and only 4% ligamentous. (Table 3)

Table 1. Anatomic regions of injuries during triathlon training and competitions.

Anatomic region	Masculine		Feminine	
	T	C	T	C
Neck	0%	0%	0%	0%
Shoulder	8%	8%	0%	0%
Elbow	0%	0%	0%	0%
Wrist/hand	2%	0%	0%	0%
Thoracic spine	0%	0%	0%	50%
Lumbar spine	0%	4%	0%	0%
Hip	4%	0%	0%	0%
Knee	18%	12%	18%	0%
Thigh	6%	15%	6%	50%
Calf	40%	46%	23%	0%
Ankle/foot	18%	11%	35%	0%
Others	6%	4%	18%	0%

T: training; C: competition.

Table 2. Prevalence of injuries by category.

Category	Masculine	Feminine
Swimming	5%	0%
Cycling	16%	8%
Running	79%	92%

Table 3. Types of injuries reported by athletes.

Type of Injury	Masculine	Feminine
Bone	9%	32%
Muscle	54%	32%
Ligamentous	17%	4%
Tendinous	19%	32%

Regarding the frequency of injuries in warm or cold days, 68% of the athletes reported that their injuries were predominant in cold days and only 32% stated that their injuries occurred mostly on warm days.

Regarding the frequency of lesions in the same location or at different body parts, 56% of the athletes said their injuries occurred in the same body part, and 44% of injuries occurred in different body parts.

When asked about the cause of injuries, 70% of the athletes indicated excessive physical effort as the predominant factor. Then, the following were cited as possible mechanisms of injury: pedestrianism, 15%; falls, 10%; collision with other athletes, 4% and position on the bike 1%.

DISCUSSION

The results of this study showed that the majority of participants were male, practicing from 3 to 6 years, who trained 5 days per week, and presented higher prevalence of injury in running workouts, with most frequently calf muscle injuries.

The outcomes of this study concur with other authors who evaluated 131 Australian triathletes (70% men and 30% women) and also reported a higher prevalence (75%) of injuries during training, mostly in lower limbs, being 19% on leg, 11% on thigh, 15% on knee, 14% on foot and 16% standing on ankle.¹⁰

Tuite³ stated that race is the phase of the triathlon that causes more muscle fatigue, being highly related to injuries during practice, representing more than one third of those. However, this same study reported that the knee was the most affected part, as a result of the impact, positioning on the bike and error in the execution of the movement during race, unlike the present study, in which the calf was reported prevalent.

Engerman *et al.*⁶ evaluated 656 German athletes, through a questionnaire, during the competition Europe-2000 Ironman, and it was observed that 75% were active practitioners of triathlon and had been affected by one or more injuries while practicing triathlon. Of those, 51% had suffered one or more injuries; 33% reported muscle or tendon damage; 29% ligament or joint damage and 12% reported fractures. Among injuries, 55% occurred in the cycling training sessions and only 19%

of injuries occurred during competitions. The prevalence of injuries during cycling in Ironmen athletes may be due to the difference in amount of exercise practiced by these athletes,¹⁰ which differs from those investigated in this study. Furthermore, the term contusion may also be related to muscle injury, and in Engerman's *et al.*⁶ study contusion was differentiated from muscle injury. Thus, as in this study the term contusion was used as a synonymous to muscle injury, it is suggested that the most prevalent type of injury may be the same as Engerman's *et al.*⁶ Korkia *et al.*¹¹ in a study with 155 British triathletes, reported that most injuries occurred during running (65%), followed by cycling (16%) and swimming (11%), corroborating the present study, in which prevalence of lesions in female athletes was found during race (92%), cycling (8%), with no injuries reported on swimming. Regarding male athletes, 79% of injuries occurred at race, 16% at cycling and 5% in swimming. In a systematic review of Van Gent *et al.*¹² in which they evaluated the incidence of injuries in long distance runners, a higher incidence of lesions was found in the lower limbs (knee, leg, foot and thigh). The same study also concluded that previous injuries is already a risk factor and take longer to fully recover.

According to Collono *et al.*¹³ with the growing population of endurance athletes, there was an increase in the prevalence of injuries in the lower extremities. The prevalence of these lesions in triathlon athletes may be due to the specific performance characteristics of three types executed in the sequence, which extensively use the muscles of lower limbs.⁵

According to the official rules of triathlons, the order of the sports categories is: swimming, cycling and running. Thus, lower limbs, which are requested in the three modalities, remain in constant exercise, being increasingly required to implement cycling and running, and therefore, may lead more rapidly to high levels of fatigue in these anatomical parts than in others.⁵ This paper presents a low prevalence of lesions due to swimming, both in training and competition. These data are similar to those presented by Tuite,³ who reported that swimming is a sport category with a lower prevalence of lesions within triathlon. It should also be pointed out the quote from Strock *et al.*¹⁴ who reported that the incidence of swimming related injuries in triathlon is low, even considering the inexperience of most triathletes with pool.

Furthermore, the most prevalent injuries in this study occurred during training (79%), as found by Egermann *et al.*⁶ during the competition Europe – 2000 Ironman, with a prevalence of 81% of injuries in training, and only 19% of all injuries occurring during competitions. In another study, which also assessed the prevalence of injuries in training and competition, it has been found 83% of injuries in training and 16% of injuries in competitions, in a group of triathletes of the French league.⁷ It has been suggested that most injuries observed rather in training than in competition may be due to mistakes in training planning and not enough warming up.⁵

It has been described that anatomical regions most affected by injuries in triathlon are knees in race, lower back in cycling, and shoulder in swimming¹² Clements *et al.* cited by Tanaka *et al.*¹⁵ Corroborating these authors, Cipriani *et al.* cited by Strock *et al.*¹⁵ pointed out that knee, foot and/or ankle and leg represent 61% of injuries, mostly the knee (25%). However, in the present study we found the following prevalence on training:

male athletes, calf (39%), ankle/foot (18%), knee (18%), shoulder (8%), thigh (6%), others (6%), hip (4%) e wrist/hand (2%); for female athletes: ankle/foot (35%); calf (23%); knee (18%); others (18%); thigh (6%). The data for injuries on competitions are: male athletes, calf (46%); thigh (15%); ankle/foot (11%); knee (11%); shoulder (8%); lumbar spine (3.85%). Among female athletes only two reported injuries during competitions, being thigh (50%) and thoracic spine (50%) the injured parts.

This high prevalence of injuries in the calf could be explained because some gastrocnemius injuries usually happen during active dorsal flexion of the foot and simultaneous knee extension, in this situation active contraction and passive stretching of the gastrocnemius simultaneously occurs, in a mechanism similar to race's.¹⁶ Another possibility is due to gastrocnemius muscle being one of the most commonly shortened muscles of the lower extremities, biarticular, and that the lack of flexibility may reduce the range of motion of ankle dorsiflexion and knee extension, factors which predispose calf muscle to injuries.¹⁷

Regarding career guidance during training, it has been observed that the majority (68%) of athletes practiced without guidance of a physical education coach and only 10% had workouts with guidance. Simões¹⁷ indicates that prevention of sports injuries by minimizing its risks can and should be done through various professionals working on physical exercise. Day *et al.*¹⁸ also highlight the importance of a qualified professional during training. Therefore, the high prevalence of lesions in the group of athletes studied may be partly due to lack of proper guidance.

It was found that athletes participating at SESC Triathlon Caiobá 2011 had higher prevalence of injuries occurring on cold days (68%) than on warm days (32%). This outcome can be explained by the fact that in situations of fatigue loss of body heat to the environment can occur, particularly in cold weather, and may exceed the metabolic heat production, resulting in deterioration of neuromuscular response and exhaustion.¹⁸ Furthermore, muscle performance decreases with low muscle temperature, so it is more likely that a muscle injury occur if warming up has been inadequate.¹⁹

In the present study recurrence of injuries was found in 56% of athletes. The number of recurrences can demonstrate the need to implement a prevention program aimed to solve the problem, including mainly muscle strengthening and proprioceptive work.¹⁹

Regarding mechanisms of injury, excessive physical effort was predominantly (70%) reported by the athletes participating in this study. Korkia *et al.*¹¹ presented in their study that British athletes pointed overtraining as mechanism of injury in 41% of cases.

It was found in this study some limitations in designing the training and musculoskeletal injuries triathletes profile questionnaire, in not allowing a more complete analysis, such as: 1) it was asked the weekly frequency, on days training per week, instead of asking training hours per week; 2) it has not been asked whether the athlete withdrew from sports activity, due to any injury. Furthermore, it was not asked whether during withdrawal, or before returning to activities, any type of specific training to prevent recurrence and/or new lesions was performed. 3) Item 17 of the questionnaire: "when injured, what do you usually feel" was not included in the study results because the options given (cramping, swelling, pain, heat, redness, sting) did not allow to specify the injury, as well as the athlete could choose

one or more alternatives. Still, it is suggested for future studies analysis of the causes of injuries reported by triathletes.

The approach of this study does not allow generalizing the outcomes for the entire population practicing triathlon, since it is estimated that in Brazil there are about 25,000 triathlon athletes,¹⁰ and in this study only 0.76% of the total were investigated. Thus, the study has not external validity.

Both in male and female athletes there was a higher prevalence of muscle injury in the lower limbs during running workouts.

CONCLUSIONS

Participants of Circuit SESC Triathlon Caiobá 2011 both male and female, who agreed to participate in this study, showed a higher prevalence of muscle injury in the lower extremities during running workouts on cold days, probably due to excessive physical effort. These outcomes suggest the need for interdis-

ciplinary professionals in physical education and physical therapists, to better evaluate the training and treatment of lesions in order to hone planning, training methods and therapies, on different types and locations of injuries resulting from triathlon practice. Future studies are suggested to evaluate the effects of treatment and training strategies to minimize the prevalence of lesions in triathletes.

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Annex 1. Training profile and osteomioarticular injuries of triathlon athletes.

1. Gender	<input type="checkbox"/> feminine	<input type="checkbox"/> masculine			
2. Age	_____ (years old)				
3. For how long have you been practicing Triathlon?					
	<input type="checkbox"/> less than 1 year	<input type="checkbox"/> 4 to 6 years			
	<input type="checkbox"/> 1 year	<input type="checkbox"/> 7 to 10 years			
	<input type="checkbox"/> 2 to 3 years	<input type="checkbox"/> Over 10 years			
4. Do you train:					
	<input type="checkbox"/> Without professional guidance				
	<input type="checkbox"/> Eventually with professional guidance				
	<input type="checkbox"/> Always with professional guidance				
5. How many times a week do you train?					
	<input type="checkbox"/> Once	<input type="checkbox"/> every day			
	<input type="checkbox"/> 2 to 3 times	<input type="checkbox"/> only before competitions			
	<input type="checkbox"/> 5 times				
6. Which is your Triathlon category					
	<input type="checkbox"/> Short	<input type="checkbox"/> Olimpic			
7. Have you ever been injured during training?	<input type="checkbox"/> yes	<input type="checkbox"/> no			
8. In which part of the boby?					
	<input type="checkbox"/> Neck	<input type="checkbox"/> Thoracic spine	<input type="checkbox"/> Thigh		
	<input type="checkbox"/> Shoulder	<input type="checkbox"/> Lumbar spine	<input type="checkbox"/> Calf		
	<input type="checkbox"/> Elbow	<input type="checkbox"/> Hip	<input type="checkbox"/> Ankle/foot		
	<input type="checkbox"/> Wrist/hand	<input type="checkbox"/> Knee	<input type="checkbox"/> other		
9. Have you ever been injured during competitions?	<input type="checkbox"/> yes	<input type="checkbox"/> no			
10. In which part of the boby?					
	<input type="checkbox"/> Neck	<input type="checkbox"/> Thoracic spine	<input type="checkbox"/> Thigh		
	<input type="checkbox"/> Shoulder	<input type="checkbox"/> Lumbar spine	<input type="checkbox"/> Calf		
	<input type="checkbox"/> Elbow	<input type="checkbox"/> Hip	<input type="checkbox"/> Ankle/foot		
	<input type="checkbox"/> Wrist/hand	<input type="checkbox"/> Knee	<input type="checkbox"/> other		
11. How many injures have you already suffered?					
	<input type="checkbox"/> never been injured	<input type="checkbox"/> one	<input type="checkbox"/> two	<input type="checkbox"/> 3 to 5	<input type="checkbox"/> more than 5
12. Injuries are frequent in:	<input type="checkbox"/> training	<input type="checkbox"/> competitions			
13. Where are the injuries most prevanlent?					
	<input type="checkbox"/> swimming	<input type="checkbox"/> cycling	<input type="checkbox"/> pedestrianism		
14. Injuries occur mostly on:	<input type="checkbox"/> cold days	<input type="checkbox"/> warm days			
15. Injuries are mostly:	<input type="checkbox"/> bone	<input type="checkbox"/> muscle	<input type="checkbox"/> ligamentous	<input type="checkbox"/> tendinous	
16. Injuries occur:					
	<input type="checkbox"/> due to position on byke	<input type="checkbox"/> collision with other athlete			
	<input type="checkbox"/> sprain (pedestrianism)	<input type="checkbox"/> falls			
	<input type="checkbox"/> excess physical effort				
17. When you injure yourself, what do you normally feel?					
	<input type="checkbox"/> cramp	<input type="checkbox"/> heat			
	<input type="checkbox"/> swelling	<input type="checkbox"/> redness			
	<input type="checkbox"/> only pain	<input type="checkbox"/> "sting"			
18. Injuries occur:	<input type="checkbox"/> in the same body part	<input type="checkbox"/> in different body parts			