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Overuse injuries in triathletes

A study of the 1986 Seafair Triathlon

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ABSTRACT

A questionnaire was mailed to 600 of 657 finishers in the Seafair Triathlon (July 20, 1986); 45% of those polled returned the questionnaire. Over the preceding year, 49% of the respondents suffered a training-related injury serious enough to cause them to stop training for at least 1 day, seek medical care, or take medicine. Seventy percent of the injuries were due solely or partly to running. The knee, shoulder, and ankle were most frequently affected. Female triathletes and those more than 40 years of age showed a similar injury incidence and distribution. Elite triathletes averaged more miles per week in each sport than the athletes as a whole and showed a higher incidence of injury (60%), although this was not a significant difference. Higher weekly swimming, cycling, and running mileages did not lead to a higher incidence of injury. The likelihood of injury was independent of age, sex, body mass index, mileage per week, or other training factors evaluated in the study.

Triathlons have been increasing in popularity in recent years yet there is little information available to medical sports professionals who treat triathlon-related injuries. Only one study of overuse injuries in triathletes is currently available in the literature.[10,11]

Because of the growing athlete interest in triathlons and our observation of the potential for injury, we undertook a survey of the participants in the 1986 Seafair Triathlon, held on July 20, 1986, in Seattle, Washington. We were interested in overuse injuries suffered by triathletes and the relationship of injury to training schedules.

The Seafair Triathlon is an annual event that begins with a 1 k (0.6 mile) swim in Lake Washington, progresses to a 28 k (18 mile) bicycle race, and finishes with a 10 k (6.2 mile) run.

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MATERIALS AND METHODS

After the event, 600 of 657 finishers in the 1986 Seafair Triathlon were mailed a three-page questionnaire. The questions included demographic data (age, sex, occupation, height, weight); training data; participation in other sports; use of weights; number of previous triathlons; athletic status (elite, intermediate, or beginner); number of years in competitive swimming, cycling, and running; initial sport; mileage per week in swimming, cycling, and running; hill training; strongest leg of the triathlon; coaching in each sport; and medical history.

The triathletes also answered questions on injuries sustained during training over the past year and showed the location on traumograms of up to three injuries and described the injuries. An *injury* was defined as any musculoskeletal ailment that caused the athlete to stop training for at least 1 day, reduce mileage, take medicine, or seek medical care. Hazard encounters were excluded (e.g., collision with cars). For each injury, the respondents indicated whether the injury forced them to stop swimming, cycling, or running, and if so, how many days. They also noted whether the injury caused them to reduce mileage, take medicine, seek medical care, or do less well in the triathlon, and whether the injury was caused by swimming, cycling, or running, a combination, or an unknown cause. Finally, the triathletes indicated how long it took for complete recovery, and how long they had been training in the sport that caused the injury.

The respondents also showed the location of and described any injuries during the Triathlon itself, and indicated the following: stage during which the injury occurred (swimming, cycling, running, or transition); and whether the injury caused the athlete to leave the event, seek medical care during the event, take medicine, or seek medical care later, and if so, what the diagnosis was.

Of the 600 triathletes polled, 268 responded, a 45% return. Eleven incomplete questionnaires were eliminated. The 257 triathletes returning usable questionnaires were similar in age and sex distribution to the 657 finishers: those responding had an average age of 32 years and 20% were females; the average age of all finishers was 31.5 years and 23% were females. A second mailing of 25 letters to nonrespondents yielded 6 replies, 3 reporting injuries and 3 injury-free.

Chi square analysis was used to determine significance of demographic and training factors in relation to injury and a *t*-test was used for body mass index data. Where numbers were small, an Irwin-Fisher test was done. Z-test analysis provided a comparison with another study of triathletes.

The Sports Medicine Clinic provided volunteer medical coverage for the Triathlon, giving us the opportunity to observe the triathletes and to treat and record all injuries for which help was sought.

RESULTS

The results are based on the replies of 257 athletes with an average age of 32 years, 77% male and 23% female.

Injured versus noninjured triathletes

During the preceding year, 49% (126/257) of respondents suffered a training-related overuse injury and 51% (131/257) did not. There were 167 injuries in the 126 triathletes. Eighteen percent (23/126) of the injured triathletes reported two injuries, and 7% (9/126) reported three injuries.

Injury distribution was as follows: knee (42), shoulder (23), Achilles tendon (17), ankle (11), lower leg (11), plantar fasciitis (10), stress fracture (9), calf (9), low back (7), hip (6), iliotibial band (5), groin (4), hamstrings (3), thigh (2), and miscellaneous (8). Injury distribution in elite athletes, women, and athletes over age 40 was similar, although small numbers make comparisons difficult (Table 1).

We compared the injured and uninjured groups and noted any demographic and training differences: there were no significant differences by chi square analysis between the two groups ($P > 0.05$) (Table 2). Body mass index was compared by *t*-test (Table 3), and there were no significant differences between injured and uninjured males or between injured or uninjured females.

We looked at injury incidence in relation to weekly running mileage by category: 0 to 9, 10 to 19, 20 to 29, 30 to 39, 40 to 49, and 50+ miles per week (Table 4). There were no significant differences among categories in numbers of triathletes injured versus those not injured ($P > 0.05$). Most of the triathletes, whether injured or uninjured, reported a

TABLE 1
Number of injuries by site or type of injury

Site/type of Injury	No. injuries		No. elite triathletes		No. women		No. age 40 or older	
	No.	%	No.	%	No.	%	No.	%
Knee	42	(25)	7	(29)	9	(23)	8	(23)
Shoulder	23	(14)	1	(4)	6	(15)	4	(11)
Achilles tendon	17	(10)	3	(13)	2	(5)	8	(23)
Ankle	11	(7)	0	(0)	3	(8)	3	(9)
Lower leg	11	(7)	3	(13)	5	(13)	1	(3)
Plantar fasciitis	10	(6)	0	(0)	2	(5)	3	(9)
Stress fracture	9	(5)	2	(8)	2	(5)	2	(6)
Calf	9	(5)	2	(8)	1	(3)	3	(9)
Low back	7	(4)	1	(4)	3	(8)	0	(0)
Hip	6	(4)	1	(4)	2	(5)	2	(6)
Iliotibial band	5	(3)	3	(13)	1	(3)	0	(0)
Groin	4	(2)	0	(0)	0	(0)	0	(0)
Hamstrings	3	(2)	0	(0)	1	(3)	0	(0)
Thigh	2	(1)	0	(0)	0	(0)	0	(0)
Other	8	(5)	1	(4)	3	(8)	1	(3)
Total	167	(100)	24	(100)	40	(100)	35	(100)

TABLE 2
Injured versus uninjured triathletes

	No. triathletes ($N = 257$)	No. injured (%) ($N = 126$)	No. uninjured (%) ($N = 131$)	Chi square	*P* value
Gender					
Male	197	97 (49)	100 (51)	<1.00	>0.05
Female	60	29 (48)	31 (52)		
Age					
<40 years	199	96 (48)	103 (52)	<1.00	>0.05
≥40 years	58	30 (52)	28 (48)		
Other sports					
Yes	74	29 (39)	45 (61)	4.02	<0.05[a]
No	183	97 (53)	86 (47)		
Use of weights					
Yes	124	62 (50)	62 (50)	<1.00	>0.05
No	133	64 (47)	69 (53)		
No. previous triathlons					
0–3	130	59 (45)	71 (55)	1.41	>0.05
≥4	127	67 (53)	60 (47)		
Athletic status					
Beginning	100	47 (47)	54 (54)	1.32	>0.05
Intermediate	127	62 (49)	65 (51)		
Elite	30	18 (60)	12 (40)		
Coaching					
Swimming					
Yes	122	60 (49)	62 (51)	<1.00	>0.05
No	135	66 (49)	69 (51)		
Cycling					
Yes	27	15 (56)	12 (44)	<1.00	>0.05
No	230	111 (48)	119 (52)		
Running					
Yes	67	36 (54)	31 (46)	1.83	>0.05
No	190	90 (47)	100 (53)		
Initial sport					
Swimming	84	44 (52)	40 (48)	1.50	>0.05
Cycling	16	9 (56)	7 (44)		
Running	137	65 (47)	72 (53)		
Other	20	8 (40)	12 (60)		

[a] *P* greater than 0.05 but less than 0.10; considered not clinically meaningful.

TABLE 3
Average body mass index in relation to injury[a]

Gender	Injured		Uninjured	
	No.	Body mass index (kg/m²)	No.	Body mass index (kg/m²)
Male	97	22.9[b]	100	23.2[c]
Female	29	21.5[d]	31	20.7[e]
Total	126		131	

[a] *t*-test <1.00, $P > 0.05$.
[b] Range, 18.5–31.9.
[c] Range, 18.8–27.9.
[d] Range, 17.4–26.0.
[e] Range, 17.9–25.7.

TABLE 4
Injured versus uninjured triathletes: Running mileage per week[a]

Miles per week	No. triathletes (100%)	No. with running injury (%)	No. with other injury (%)	No. uninjured (%)
0–9	22	8 (36)	1 (4)	13 (60)
10–19	81	23 (28)	13 (16)	45 (56)
20–29	90	36 (40)	16 (18)	38 (42)
30–39	34	10 (29)	5 (15)	19 (56)
40–49[b]	21	9 (43)	1 (5)	11 (52)
50–59[b]	6	3 (50)	0	3 (50)
60+[b]	3	1 (33)	0	2 (66)

[a] Chi square 3.51, $P > 0.05$.
[b] Last three categories collapsed together for chi square analysis.

TABLE 5
Injured versus uninjured triathletes: Cycling mileage per week[a]

Miles per week	No. triathletes (100%)	No. with any injury (%)	No. with cycling injury (%)	No. with other injury (%)	No. uninjured (%)
<100	183	83 (45)	12 (7)	71 (39)	100 (55)
≥100	74	43 (58)	10 (13)	33 (45)	31 (42)

[a] Chi square 3.43, $P > 0.05$.

TABLE 6
Injured versus uninjured triathletes: Swimming mileage per week[a]

Miles per week	No. triathletes (100%)	No. with any injury (%)	No. with swimming injury (%)	No. with other injury (%)	No. uninjured (%)
<5	181	90 (50)	11 (6)	80 (44)	90 (50)
≥5	76	36 (47)	8 (11)	27 (36)	41 (54)

[a] Chi square <1.00 $p > 0.05$.

TABLE 7
Injured versus uninjured triathletes who trained most heavily[a]

Miles per week	No. triathletes (100%)	No. injured (%)	No. uninjured (%)
Swimming ≥5, Cycling ≥100, Running ≥20	24	13 (54)	11 (46)
Less than above	233	113 (48)	120 (52)

[a] Chi square <1.00, $P > 0.05$.

mileage within either the 10 to 19 miles per week or 20 to 29 miles per week categories.

Injury incidence in cycling and swimming also did not correlate with mileage in those sports ($P > 0.05$) (Tables 5-7).

Running injuries

Sixty-two percent (105/167) of overuse injuries in triathletes were caused by running, and another 8% (13/167) were due to running plus another sport, usually cycling, for a total of 70% of injuries reported solely or partly due to running (118/167) (Fig. 1). All but one of the 32 triathletes with multiple injuries sustained one or more running injuries. The injured triathletes stopped running an average of 17.3 days for each running injury reported, sought medical care for 35.5% of the running injuries, and took medication for 26% (Table 8).

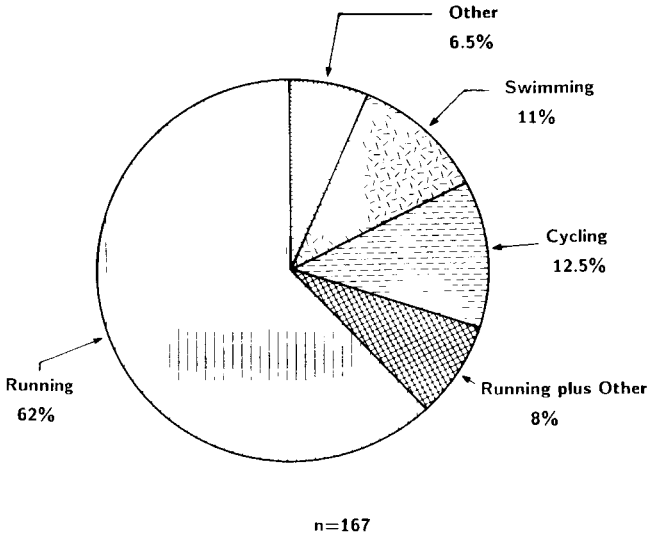

Figure 1. Cause of injury in triathletes (167 injuries in 126 athletes).

TABLE 8
Severity of injuries by cause of injury

Injury characteristic	Running	Cycling	Swimming
Mean days lost due to injury	17.3	5.1	5.0
Percent of injuries for which medical care was sought	35.5	38	31.5
Percent of injuries for which medication was taken	26	42	47.5

Triathletes reported overuse running injuries in the following distribution: knee (28), Achilles tendon (15), ankle (11), lower leg (10), plantar fasciitis (9), stress fracture (9), hip (6), calf (4), iliotibial band (4), groin (3), low back (3), hamstrings (2), and foot (1) (Table 9).

Cycling injuries

Cycling resulted in 12.5% (21/167) of the reported injuries in this study. Triathletes reporting an injury solely due to cycling stayed off their bicycles an average of 5.1 days per injury. They sought medical care for 38% and took medication for 42% of the injuries (Table 8). Cycling injuries included: knee (6), calf (3), shoulder (3), thigh (2), low back (2), Achilles tendon (2), and miscellaneous (3) (Table 9).

Swimming injuries

Swimming injuries accounted for 11% of the injuries reported. All 19 swimming-related injuries involved the shoulder (Table 9). Triathletes avoided swimming an average of 5 days per injury, sought medical care for 31.5% of the injuries, and took medication for 47% (Table 8).

Injuries with more than one cause

Seven injuries were due to a combination of running and cycling: knee (5), plantar fasciitis (1), shin splints (1). Other

TABLE 9
Site or type of injury by cause of injury ($N = 167$).

Site/type of injury	No. Injuries	Running (%)	Cycling (%)	Swimming (%)	Running + other causes (%)	Other causes (%)
Knee	42	28 (27)	6 (29)	0	5 (38)	3 (33)
Shoulder	23	0	3 (14)	19 (100)	1 (8)	0
Achilles tendon	17	15 (14)	2 (10)	0	0	0
Ankle	11	11 (10)	0	0	0	0
Lower leg	11	10 (9)	0	0	1 (8)	0
Plantar fasciitis	10	9 (8.5)	0	0	1 (8)	0
Stress fracture	9	9 (8.5)	0	0	0	0
Calf	9	4 (4)	3 (14)	0	2 (14)	0
Low back	7	3 (3)	2 (10)	0	1 (8)	1 (11)
Hip	6	6 (6)	0	0	0	0
Iliotibial band	5	4 (4)	0	0	1 (8)	0
Groin	4	3 (3)	0	0	1 (8)	0
Hamstrings	3	2 (2)	0	0	0	1 (11)
Thigh	2	0	2 (10)	0	0	0
Other	8	1 (1)	3 (14)	0	0	4 (44)
Total	167	105	21	19	13	9

combinations accounted for six injuries: calf (2), groin (1), low back (1), shoulder (1), and iliotibial band (1) (Table 9).

Multiple injuries

Thirty-two triathletes suffered more than one training-related injury; 23 reported 2 injuries and 9 reported 3 (Tables 10 and 11). Thirteen of the 32 sustained only running injuries, whereas 18 reported a running injury plus one or two injuries due to cycling, swimming, or both.

Of the 23 triathletes with two injuries, 7 sustained one or more of their injuries while cycling and 4 sustained an injury while swimming. One triathlete in this group reported only cycling injuries.

Of the nine triathletes with three injuries, six sustained one or more injuries while cycling and four sustained an injury while swimming.

Elite triathletes

Thirty triathletes (11%) designated themselves in the elite category. They were slightly younger (average age, 29.8 years), and there were fewer females in the group (3/30, 10%). Eighteen of the 30 (60%) were injured and all but one injury were due to running or to running and cycling. The 60% injury rate was not significantly different than the rate for nonelite triathletes (Table 2). The distribution of running injuries was approximately the same as that of the injured triathletes as a whole: knee (7), lower leg (3), Achilles tendon (3), iliotibial band (3), calf (2), stress fracture (2), hip (1), and low back (1). Three elite athletes sustained more than one injury (Table 1). Cycling injuries included one wrist and one shoulder.

Female triathletes

The female triathletes were evaluated separately and found to have about the same incidence of injuries (48%, 29/60) as the male triathletes (49%) (Table 2). The distribution of injuries was as follows: knee (9), shoulder (6), lower leg (5), ankle (3), low back (3), plantar fasciitis (2), Achilles tendon (2), stress fracture (2), hip (2), iliotibial band (1), hamstrings (1), hand (1), adductor (1), calf (1), and headache (1) (Table 1). Nine females reported more than one injury.

Older triathletes

Triathletes 40 years of age and older were evaluated separately and found to have a 52% injury incidence (30/58), roughly the same as triathletes younger than 40 (Table 2). The injury distribution was as follows: knee (8), Achilles tendon (8), shoulder (4), plantar fasciitis (3), ankle (3), calf (3), stress fracture (2), hip (2), lower leg (1), and toes (1) (Table 1). Five older triathletes had more than one injury.

DISCUSSION

Since the triathletes studied were fairly comparable to the Seafair Triathlon finishers as a whole, some conclusions may be drawn about triathletes who participated in this event. While we received only a 45% return on our questionnaire, we feel our findings are important for the following reasons: the age and gender distribution of respondents was about equal to that of all race finishers, an indication of a balanced sample; the actual number of replies (257) can produce a significant result; and a small repeat polling of nonrespondents yielded a 50% injury rate in those returning the second questionnaire (close to the 49% rate of injury among the original 257 respondents).

Another retrospective study of overuse injuries in triathletes, that of Levy et al.,[10,11] used the same definition of injury as our study. Ninety percent (28/31) of the triathletes studied in that report were injured during a 1 year period, a significant difference by Z-test ($P < 0.05$) from our finding. We cannot explain this difference, although we suspect it relates to the possibility that our triathletes may not be as highly competitive as the Levy group and probably fall into the category of recreational athletes. The triathletes in our

TABLE 10
Sites and causes of multiple injuries: Two injuries

Triathlete	Sites	Cause of injury		
		Swimming	Cycling	Running
1	Knee			x
	Hip			x
2	Knee			x
	Ankle			x
3	Groin			x
	Knee			x
4	Heel			x
	Hip			x
5	Groin			x
	Calf			x
6	Hamstrings			x
	Low back			x
7	Knee			x
	Calf			x
8	Heel			x
	Knee			x
9	Thigh			x
	Ankle			x
10	Knee			x
	Achilles tendon			x
11	Lower leg (shin splints)			x
	Knee			x
12	Lower leg (shin splints)			x
	Shoulder			x
13	Lower leg (tendinitis)			x
	Shoulder		x	
14	Groin			x
	Shoulder	x		
15	Knee			x
	Shoulder	x		
16	Knee			x
	Back		x	
17	Ankle			x
	Hand		x	
18	Shoulder	x		
	Lower leg (shin splints)			x
19	Knee			x
	Shoulder	x		
20	Ankle			x
	Back		x	
21	Back			x
	Achilles tendon		x	
22	Lower leg (shin splints)			x
	Neck		x	
23	Knee		x	
	Achilles tendon		x	

TABLE 11
Sites and causes of multiple injuries: Three injuries

Triathlete	Sites	Cause of injury		
		Swimming	Cycling	Running
1	Leg (tendinitis)			x
	Shoulder		x	
	Shoulder	x		
2	Hip			x
	Knee			x
	Plantar fasciitis			x
3	Knee			x
	Ankle			x
	Shoulder	x		
4	Knee			x
	Leg (muscle pull)		x	
	Achilles tendon			x
5	Knee			x
	Thigh		x	
	Calf		x	
6	Shoulder	x		
	Calf			x
	Toes			x
7	Shoulder	x		
	Lower leg (shin splints)			x
	Knee		x	
8	Calf			x
	Knee		x	
	Neck		x	
9	Iliotibial band			x
	Shoulder		x	
	Calf		x	

group ran an average of 21 miles per week during training. While Levy's study did not specify the triathletes' mileage, if they were all comparable to the runners in that study who averaged 41 miles per week, their triathletes were intensely involved in the sport. Levy et al. distributed questionnaires to members of a triathlon club, whereas we studied entrants in a recreationally oriented, but nevertheless competitive, event. We polled many people who were participating in their first triathlon; in fact, almost half had been in three or fewer. Members of a triathlon club are likely to be frequent participators and train year round, although this was not specifically stated.

Our 49% injury incidence may underestimate the actual incidence because minor injuries may be forgotten in a retrospective study. Furthermore, we studied finishers in the triathlon. Those who did not finish, or trained but did not enter, may have had a higher incidence of injuries.

Running and swimming mileages have been associated with injuries[2, 4–6, 8, 15, 17] but cycling mileage has not.[20] Cycling studies have focused on training errors other than mileage covered.[3, 7, 9] Other studies of runners have also cited training errors other than excessive mileage as being important, even in regard to stress fracture development.[1, 12–14, 18] A recent study of runners showed no age or sex differences in running injuries and did not correlate injury with training mileage.[19]

In agreement with the latter reports, our study of triathletes' injuries did not show a correlation with mileage per week in swimming, cycling, or running. The types of injuries seen in triathletes, including elite triathletes and women, paralleled that of single sport swimmers, cyclists, and runners. Whereas single sport athletes usually report only injuries related to their sport (e.g., knee in runners or shoulder in swimmers), a few triathletes (18) added a swimming or cycling injury to a running injury. However, running was by far the most likely part of the triathlete's training program to cause an injury. Other training-related factors are being assessed in relation to overuse injury.

We conclude that triathletes training for a triathlon have about a 50% likelihood of sustaining an overuse injury during a 1 year period prior to the event, and that the knee, shoulder, and ankle are most frequently affected. Running is likely to lead to the greatest number of injuries, particularly involving the knee, lower leg, ankle, and foot. Our study did not find a correlation of injuries with training mileage

or with age, sex, or other characteristics of the triathletes. The authors speculate that either training factors other than mileage or intrinsic physical characteristics may have been responsible for the incidence of injuries in triathletes. Prospective studies looking at these factors may be useful in identifying causes of overuse injury.

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