RSE
81-3-3-2

A Survey of Overuse Running Injuries

D. B. Clement, MSc, MD
J. E. Taunton, MSc, MD
G. W. Smart, BSc
K. L. McNicol

In brief: This retrospective survey of the clinical records of 1,650 patients seen from 1978 to 1980 identified 1,819 injuries. Almost 60% of the patients were men, but women under age 30 had the greatest risk of overuse running injuries. The knee was the most commonly injured site, and patellofemoral pain syndrome was the most common injury. Most patients had moderate to severe degrees of varus alignment and subsequent overpronation. Because certain injuries were more frequent in one sex or the other, the authors say future studies should differentiate injuries by sex.

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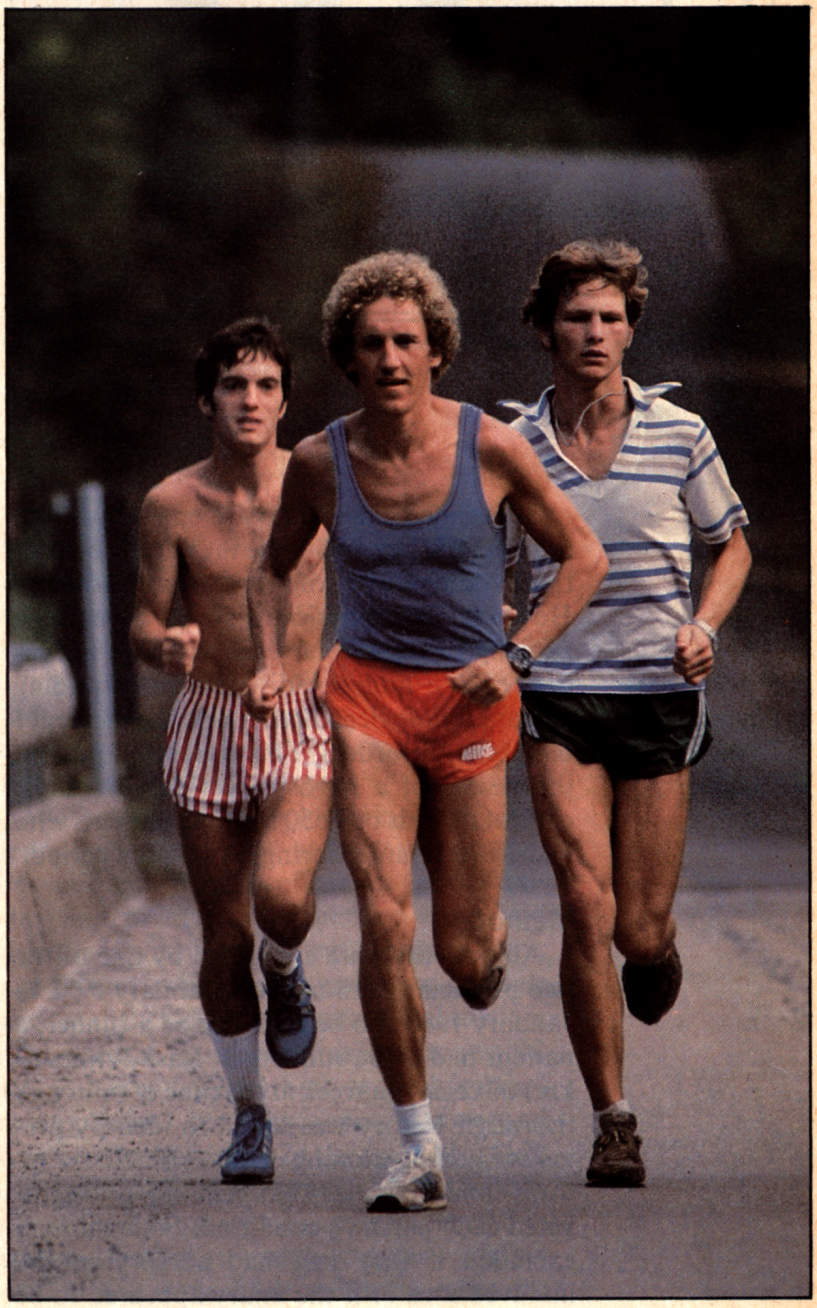

Millions of North Americans who want to improve cardiovascular fitness, relieve stress, and avoid obesity have turned to running. However, many become running addicts and attempt too much too soon, which often results in overuse injuries that force them to stop their training programs. In desperation, they seek help from their physicians.

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Dr. Clement and Dr. Taunton are codirectors and assistant professors in the division of sports medicine, department of family practice, faculty of medicine, and the school of physical education and recreation at the University of British Columbia in Vancouver. Mr. Smart is a medical student at the University of British Columbia and Mr. McNicol is assistant athletic trainer and research assistant in the department of kinesiology at Simon Fraser University in Burnaby. Dr. Clement and Dr. Taunton are fellows and Mr. Smart is a student member of the American College of Sports Medicine.

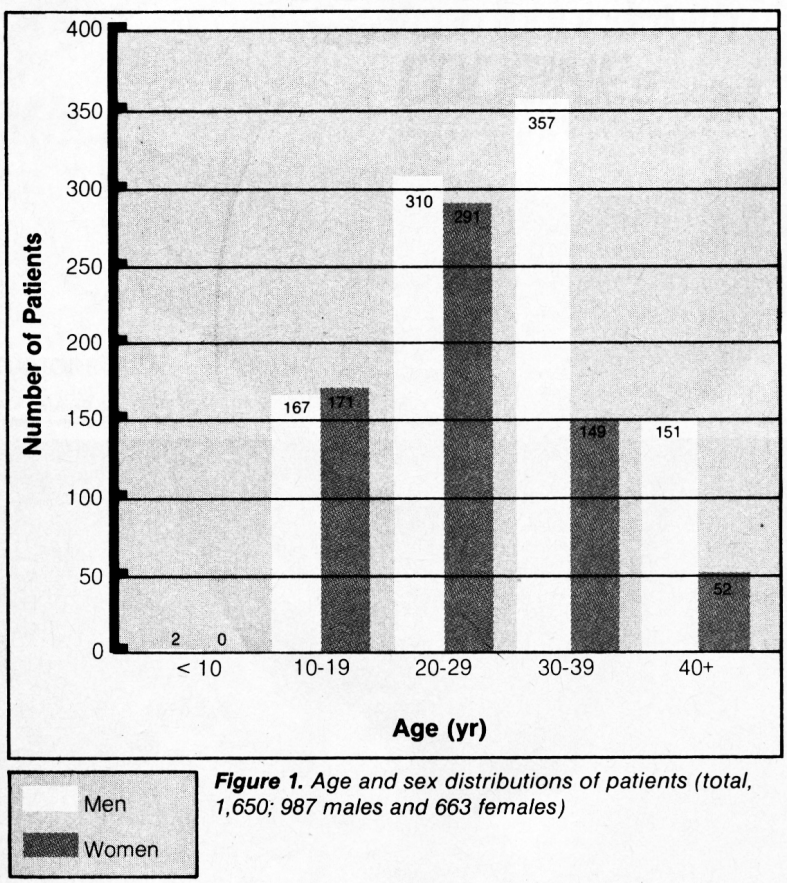

Figure 1. *Age and sex distributions of patients (total, 1,650; 987 males and 663 females)*

Sportsmedicine clinics are emerging at an exponential rate to handle the variety of injuries in competitive and recreational athletes. However, most physicians do not see enough running injuries to have an accurate indication of age and sex distributions, training mileage, etiological factors, and the incidence of specific disorders. This paper will present the results of a retrospective survey of the clinical records of 1,650 running patients who had 1,819 injuries during a two-year period.

Methods

All patients were examined by one of the two physician authors from January 1978 to January 1980. To be regarded as a runner, a patient had to be running at least 2 miles (3 km) three days a week at the time of injury. A thorough history was taken to identify previous injuries, training errors, specific symptoms, and activities that relieved or aggravated each patient's condition. Patients were excluded if they had had surgery to the involved area or if the injury appeared to be the direct result of an acute traumatic episode (ankle sprain, direct blow to the knee, etc).

Special emphasis was placed on physical examination of lower extremity structure and alignment. A detailed description of each patient was recorded. Hip alignment, extremity length, femoral neck anteversion, knee function, alignment and position of the patellae, knee configuration (genu varum, valgum, recurvatum), tibial torsion, tibial varum, ankle function, lower leg-heel alignment, heel-forefoot alignment, arch condition, toe structure and alignment, and pattern of shoe wear were among the variables studied.

Lower extremity alignment was examined in both the weight-bearing and nonweight-bearing positions. Patients were then classified as exhibiting unremarkable, mild, moderate, or severe varus alignment. We used the term varus alignment to describe a noticeable degree of tibial varum or subtalar and/or rearfoot varus in the nonweight-bearing position that produces functional overpronation during weight bearing.[1]

Results

In our survey, 1,819 injuries were identified in 1,650 patients (987 men, 59.8%; 663 women, 40.2%). One hundred twelve patients presented with two separate but simultaneous injuries, and 22 patients had three separate injuries.

The mean age of the men was 30 years (range 9 to 63) compared with 26 years (range 11 to 51) for the women. On the average, men ran 27 miles a week at the time of injury and the women ran 19 miles.

Figure 1 shows the age and sex distributions of the study group. Of the 941 patients under 30 years old (57.1% of total patients), 50.9% were men and 49.1% were women, indicating an even distribution of injury between men and women under 30 years old. Of the 709 patients (43.0% of total patients) who were 30 years or older, 71.6% were men and 28.3% were women.

Figure 2 lists the numbers and percentages of injuries to the major anatomical regions of the lower extremities. The knee was the most common site, accounting for 41.7% of all injuries. The areas least frequently injured

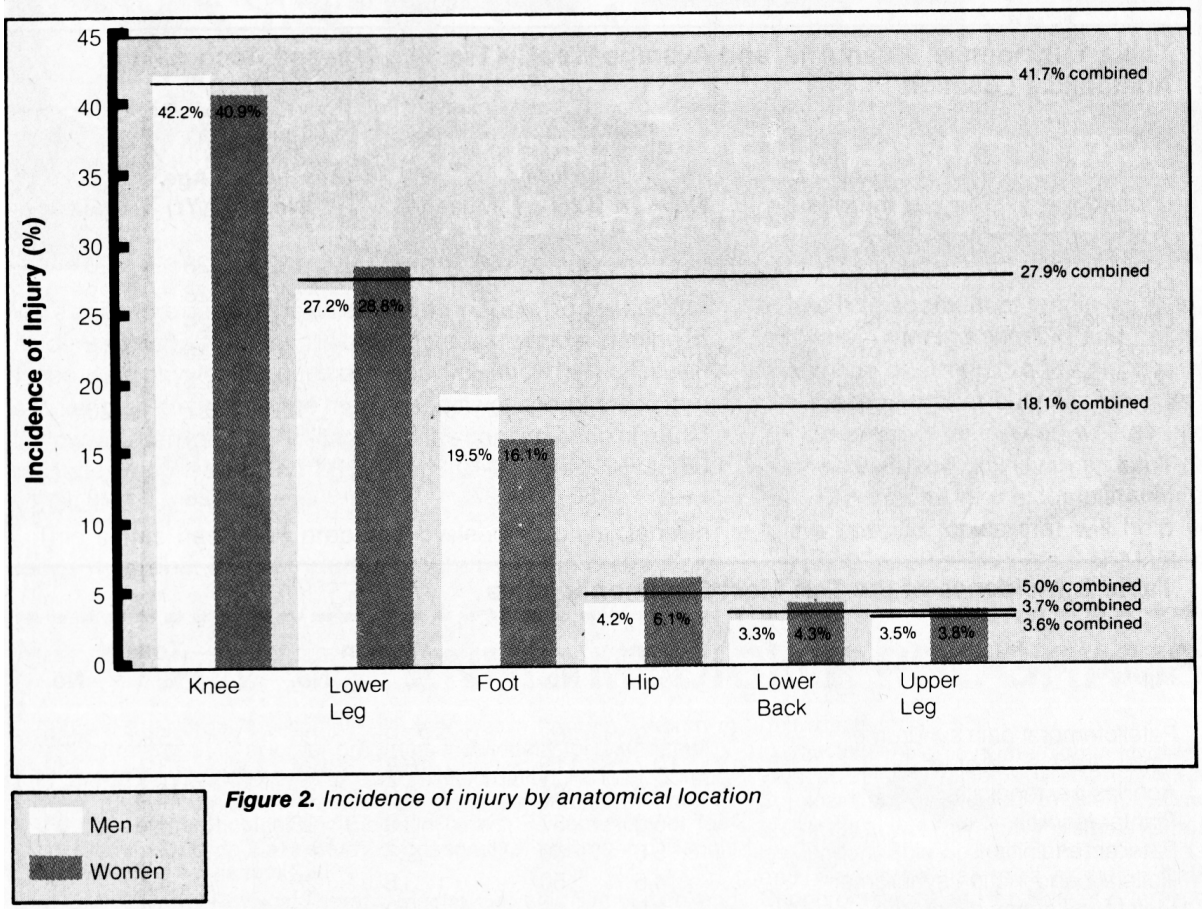

Figure 2. *Incidence of injury by anatomical location*

were the lower back and upper leg, accounting for 3.7% and 3.6% of all injuries, respectively. Table 1 shows the sex, age, and mileage of the runners according to location of injury in the lower extremities. Both sexes had an equal susceptibility to injury in all areas.

Table 2 lists the ten most common specific injuries, which accounted for 68.7% of all injuries. Patellofemoral pain syndrome was the most common disorder, being present in 468 cases (25.8% of total injuries).

A complete list of the injuries within each major anatomical region and their incidence in men and women is presented in table 3. Nineteen specific injuries of the knee, 20 of the foot, and 13 of the lower leg were identified in our survey.

Table 4 lists the prevalence of varus alignment and the most common factors directly implicated in each specific injury that occurred in 20 or more patients. Causes of injury fell into four categories, which were listed by James et al:[1] training errors, anatomical factors, running shoes, and training surfaces. Training errors included persistent high-intensity training without alternate easy days; sudden increases in training mileage and/or intensity without allowing the supporting structures of the lower extremities sufficient time to adapt to the increased work load; a single severe training or competitive session, such as a 10-km race or a marathon; and repetitive hill running.

Anatomical factors included leg-length discrepancy; femoral neck anteversion; quadriceps and hamstring insufficiency (poor flexibility and/or muscle dysfunction compared with the asymptomatic leg); genu valgum, varum, and recurvatum; excessive Q-angle (greater than 15°); patella alta; tibial torsion; tibial varum; gastrocnemius/soleus insufficiency; lower leg-heel and/or heel-forefoot malalignment; pes cavus; pes planus; and structural irregularities of the toes (Morton's foot, hallux valgus, metatarsal adductovarus, plantarflexed first toe). Factors implicated in running shoes were inadequate heel wedging; soft, loose-fitting heel counters; inflexible

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Table 1. Incidence, Mean Age, and Average Weekly Training Mileage According to Anatomical Location

Location	Total Injuries	Men No.	Men Age (Yr)	Men Mileage	Women No.	Women Age (Yr)	Women Mileage
Lower back	68	36	32	22	32	28	20
Hip	90	45	31	28	45	28	22
Upper leg	66	38	28	31	28	24	27
Knee	761	458	29	22	303	26	18
Lower leg	503	292	32	30	211	25	19
Foot	331	212	30	25	119	27	20
Total	1,819	1,081	—	—	739	—	—
Mean	—	—	30	27	—	26	19

Table 2. Incidence of the Ten Most Common Injuries

Injury	Men %	Men No.	Women %	Women No.	Total %	Total No.
Patellofemoral pain syndrome	24.3	262	27.9	206	25.8	468
Tibial stress syndrome	10.7	115	16.8	124	13.2	239
Achilles peritendinitis	7.9	85	3.2	24	6.0	109
Plantar fasciitis	5.3	57	3.9	28	4.7	85
Patellar tendinitis	5.6	60	2.8	21	4.5	81
Iliotibial band friction syndrome	4.6	50	3.8	28	4.3	78
Metatarsal stress syndrome	3.3	36	3.0	22	3.2	58
Tibial stress fracture	2.4	26	2.8	21	2.6	47
Tibialis posterior tendinitis	1.9	21	3.2	24	2.5	45
Peroneal tendinitis	2.0	22	1.6	12	1.9	34
Total	68.0	734	69.0	510	68.7	1,244

soles under the metatarsal heads; narrow toe boxes; excessive lateral heel wear; improper application of sole repair material; and the removal or breakdown of orthotics. Hard surfaces, road camber, and uneven terrain were also occasional etiological factors.

Discussion

We compared the age and sex distribution of our runners with that of local fun runners. In the fun runs with 5,419 runners, 69.9% of the participants were men and 30.1% were women. In another fun run, 64.7% of the 1,716 participants were under 30 years old. Of these, 64.0% were men and 36.0% were women. In the fun runners over 30 years old, 76.5% were men and 23.5% were women. Because a relatively high percentage of women runners (40.2%) were seen in our clinic, we believe that these data suggest that women runners under age 30 are more susceptible to injury than men. This difference apparently disappears after age 30. However, we cannot assume that the ratio of participants in these or other similar competitive situations accurately indicates the sex distribution of the total running population.

The incidence of injury by anatomical location (figure 2) indicates that 41.7% of all injuries occurred in or about the knee. To our knowledge, this is the highest incidence of running knee disorders reported to date. Values of 29%[1] and 25%[2] have been documented previously.

The higher incidence of knee injuries in our study may reflect an increase in the ratio of

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Table 3. Incidence of Specific Injuries by Anatomical Location

Location	Men	Women	Total
Lower back	**36**	**32**	**68**
Nonspecific lower back pain	27	27	54
Sciatica	7	3	10
Spondylolysis	2	1	3
Spondylolisthesis	—	1	1
Hip	**45**	**45**	**90**
Nonspecific hip pain	21	27	48
Greater trochanter bursitis	9	5	14
Gluteal strain/tendinitis	4	8	12
Avulsion of anterior superior iliac spine	3	2	5
Femoral stress syndrome	3	1	4
Femoral stress fracture	3	1	4
Myositis ossificans	1	1	2
Iliac crest apophysitis	1	—	1
Upper leg	**38**	**28**	**66**
Semimembranous/semitendinous tendinitis	15	9	24
Biceps femoris/semimembranous/semitendinous strain	11	5	16
Quadriceps strain	5	10	15
Adductor strain	5	1	6
Biceps femoris tendinitis	2	3	5
Knee	**458**	**303**	**761**
Patellofemoral pain syndrome	262	206	468
Patellar tendinitis	60	21	81
Iliotibial band friction syndrome	50	28	78
Osgood-Schlatter disease	19	5	24
Chondromalacia patellae	10	12	22
Lateral-collateral ligament strain	16	6	22
Synovitis	13	8	21
Popliteal tendinitis	10	5	15
Medial-collateral ligament strain	6	—	6
Osteoarthritis	—	4	4
Subluxing patella	—	4	4
Lateral patellar compression syndrome	2	1	3
Tibial plateau stress fracture	3	—	3
Partial medial meniscal tear	2	—	2
Baker's cyst	1	1	2
Popliteal tear	1	1	2
Avulsion of tibial tubercle	2	—	2
Tibial plateau stress syndrome	—	1	1
Osteochondritis dissecans	1	—	1

recreational (noncompetitive) to competitive runners in today's running population. The average weekly mileage for the all-male group studied by James et al[1] was 49 miles, compared with 27 miles for the men in our survey. This implies that James's patients were more competitive and perhaps better suited biomechanically and dynamically to tolerate the repetitive stresses of distance running. Many of our patients had never engaged in regular physical activity, or they had resumed running after long periods of relative inactivity. Therefore, we believe they had a greater risk of injury—particularly in or about the knee—than their running peers, due to either an imbalance or insufficiency in the knee extensor-flexor mechanism or lower extremity malalignment with subsequent abnormal patellofemoral tracking. Although these factors may be insignificant in sedentary or nonrepetitive

Location	Men	Women	Total
Lower leg	**292**	**211**	**503**
Tibial stress syndrome	115	124	239
Achilles peritendinitis	85	24	109
Tibial stress fracture	26	21	47
Tibialis posterior tendinitis	21	24	45
Gastrocnemius/soleus strain	24	8	32
Fibular stress fracture	5	3	8
Tibialis anterior tendinitis	2	3	5
Rupture of soleus	4	1	5
Fibular stress syndrome	3	1	4
Anterior tibial compartment syndrome	2	1	3
Extensor digitorum longus tendinitis	2	—	2
Posterior tibial compartmental syndrome	2	1	3
Rupture of gastrocnemius	1	—	1
Foot	**212**	**119**	**331**
Plantar fasciitis	57	28	85
Metatarsal stress syndrome	36	22	58
Nonspecific foot pain	34	11	45
Peroneal tendinitis	22	12	34
Sever's disease	15	5	20
Metatarsal stress fracture	8	10	18
Anterior talofibular ligament strain	10	6	16
Morton's neuroma	4	4	8
Longitudinal arch strain	7	1	8
Calcaneal stress syndrome	3	4	7
Tarsal tunnel syndrome	4	2	6
Navicular stress syndrome	2	3	5
Calcaneal bursitis	2	2	4
Callus	2	2	4
Navicular stress fracture	2	1	3
Subungual hematoma	2	1	3
Sesamoid stress syndrome	—	2	2
Exostosis	1	—	1
Calcaneal stress fracture	—	1	1
Cuboid stress fracture	1	—	1
Cuneiform stress fracture	—	1	1
Sesamoid stress fracture	—	1	1
Total	**1,081**	**738**	**1,819**

activities, they may precipitate injury when novice runners attempt heavy training schedules.

Achilles peritendinitis accounted for only 6.0% (table 2) of all injuries, which is significantly lower than the incidences reported by James et al (11%)[1] and Krissoff and Ferris (18%).[2] We speculate that this downward trend is a result of the general increased awareness of the importance of gastrocnemius/soleus flexibility and the wide selection of running shoes now available with good rearfoot stability, a flexible sole under the metatarsal heads, and adequate heel wedging (greater than 10 mm).

Although both sexes were equally susceptible to injury in all major anatomical locations (figure 2), certain conditions were observed more frequently in one sex or the other (table 2). These included Achilles peritendinitis

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Table 4. Degree of Varus Alignment and Etiological Factors in Injuries Occurring More Than 20 Times

Injury	No.	Degree of Varus Alignment			Most Prevalent Etiological Factors
		Mild	Moderate	Severe	
Patellofemoral pain syndrome	468	125	229	81	Sudden increase in mileage (57) Quadriceps insufficiency (52) Squinting patellae (40) Poor shoes (40) Training surface (31) Single severe session (30)
Tibial stress syndrome	239	78	108	44	Gastrocnemius/soleus insufficiency (66) Sudden increase in mileage (27) Training surface (26) Squinting patellae (13)
Achilles peritendinitis	109	35	49	12	Gastrocnemius/soleus insufficiency (41) Sudden increase in mileage (13) Single severe session (11) Poor shoes (11) Cavus foot (6)
Plantar fasciitis	105	30	37	11	Gastrocnemius/soleus insufficiency (14) Sudden increase in mileage (12) Cavus foot (11)
Patellar tendinitis	81	23	48	6	Single severe session (12) Quadriceps insufficiency (16)
Iliotibial band friction syndrome	78	27	37	5	Single severe session (23) Sudden increase in mileage (21) Leg-length discrepancy (12)
Metatarsal stress syndrome	58	17	27	10	Sudden increase in mileage (10) Increase in training intensity (8) Gastrocnemius/soleus insufficiency (7) Hallux valgus (7) Morton's foot (7)
Nonspecific back pain	54	12	27	1	Leg-length discrepancy (32) Poor hamstring flexibility (10) Poor back flexibility (7)

(7.9% in men and 3.2% in women), tibial stress syndrome (10.7% in men and 16.8% in women), patellar tendinitis (5.6% in men and 2.8% in women), gastrocnemius/soleus strain (2.2% in men and 1.1% in women), Osgood-Schlatter disease (1.8% in men and 0.7% in women), and Sever's disease (1.4% in men and 0.7% in women). These results should prompt future authors to differentiate incidence of injury by sex.

We believe that a runner's predisposition to injury increases with his degree of functional overpronation. We have observed that persons with mild to severe varus alignment compensate by excessively pronating the ankle and subtalar joints during the support phase of gait. Due to the hypermobility within the ankle-subtalar-midtarsal complex, few patients exhibit moderate to severe functional overpronation in the absence of a significant varus alignment. Therefore, it is essential to examine each patient for compensatory motions during full weight bearing.

Treatment consisted of combinations of modified rest (symptomatic reduction in training volume and intensity supplemented by weight training, swimming, and cycling), ice massage, local physiotherapy, anti-inflamma-

Injury	No.	Degree of Varus Alignment Mild	Moderate	Severe	Most Prevalent Etiological Factors
Nonspecific hip pain	48	13	20	8	Leg-length discrepancy (26) Sudden increase in mileage (8)
Tibial stress fracture	47	13	21	11	Gastrocnemius/soleus insufficiency (19) Increase in training intensity (14) Sudden increase in mileage (12) Leg-length discrepancy (6)
Tibialis posterior tendinitis	45	12	26	7	Gastrocnemius/soleus insufficiency (12) Poor shoes (10)
Peroneal tendinitis	34	13	11	5	Gastrocnemius/soleus insufficiency (8) Single severe session (7) Sudden increase in mileage (6)
Gastrocnemius/soleus strain	32	5	16	4	Gastrocnemius/soleus insufficiency (10)
Semimembranous/semitendinous tendinitis	24	4	13	2	Poor hamstring flexibility (12) Single severe session (6)
Lateral-collateral ligament strain	24	7	7	4	Single severe session (3)
Osgood-Schlatter disease	24	4	9	4	Quadriceps insufficiency (3) Sudden increase in mileage (2)
Chondromalacia patellae	22	6	13	0	Subluxing patella (4) Quadriceps insufficiency (3) Hamstring insufficiency (2)
Synovitis of knee	21	9	10	0	Sudden increase in mileage (5) Quadriceps insufficiency (5) Squinting patellae (4) Single severe session (4)
Sever's disease	20	11	5	2	Gastrocnemius/soleus insufficiency (4) Sudden increase in mileage (3)

tory medication, soft and rigid orthotics, modification or change of shoe, and where indicated, surgery.

Often running had to be stopped until symptoms disappeared or the injury healed. The runner usually could continue cardiovascular training by swimming or cycling.

Every running-induced injury produces compensatory movement patterns that cause disuse atrophy in the muscles around the pain. Early rehabilitation to the involved muscle groups is essential and should emphasize balancing the strength and endurance in the injured muscles to the contralateral group. Naproxen (250 mg) twice daily often helps control inflammation and pain and facilitates the early introduction of alternate local and general nonweight-bearing exercise.

For injured runners who exhibited significant varus alignment features, we prescribed a soft orthotic made from plastazote and 1/8-in. orthopedic felt to produce a medial rearfoot and/or forefoot wedge, or we recommended a Scholl's runner's wedge or Spenco orthotic arch support. A nonweight-bearing cast of the feet was made and a semirigid orthotic was constructed by a commercial laboratory for runners with extreme biome-

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chanical malalignment or those who were not sufficiently controlled with soft orthotic devices. Most responded in two to six weeks and were able to resume running and increase training volumes without recurrent injury.

Summary

A review of the clinical records of two sports physicians identified 1,819 injuries in 1,650 running patients during a two-year period. Men comprised 59.8% of the total patients, and women under age 30 appeared to have the greatest risk of overuse running injuries.

The knee was the most common site of complaint, accounting for 41.7% of all injuries. The least frequently involved areas were the lower back (3.7%) and upper leg (3.6% of total injuries). All anatomical regions were equally susceptible to injury in both sexes.

Patellofemoral pain syndrome was the most frequent disorder, accounting for 25.8% of all injuries. Most patients had moderate to severe varus alignment and subsequent functional overpronation. Certain injuries were more frequent in one sex or the other, so we believe that our results should prompt other authors to differentiate incidence of injuries by sex in the future.

Address correspondence to D. B. Clement, MD, Division of Sports Medicine, Department of Family Practice, Faculty of Medicine, Mather Bldg, University of British Columbia, Vancouver, V6T 1W5.

References

1. James SL, Bates BT, Osternig LR: Injuries to runners. Am J Sports Med 6:40-50, March-April 1978
2. Krissoff WB, Ferris WD: Runners' injuries. Phys Sportsmed 7:55-64, December 1979

Correction

A bracket was omitted from the beta-2 agonists in the "memory jogger" that appeared in the article "Physical Activity and the Asthmatic" by Alan R. Morton, EdD, on page 57 of the March issue. The corrected version appears below.

memory jogger

Drugs Used for Treating Asthmatic Attacks Induced by Exercise: Effectiveness and Legal Status for Competition*

Drug	Route of Administration	Effectiveness	Legal or Banned
Ephedrine	Oral	Uncertain	Banned
Isoproterenol	Oral	Slight	Banned
	Aerosol	Fair	Banned
Metaproterenol	Oral	Fair	Banned
	Aerosol	Good	Banned
Atropine	Aerosol	Slight	Legal
Glucocorticosteroids	Oral	Uncertain	Legal
	Aerosol	Uncertain	Legal
Theophylline	Oral	Good	Legal
Cromolyn sodium	Aerosol	Good	Legal
Beta-2 agonists			
Salbutamol†	Oral	Good	Legal
Terbutaline	Aerosol	Excellent	Legal
Fenoterol†			

*According to the Medical Commission of the International Olympic Committee
†Fenoterol is not currently available for use in the United States; salbutamol is available in aerosol form.