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Injuries in the Sport of Racewalking

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Objective: To examine the nature and incidence of injuries suffered by racewalkers.

Design and Setting: A total of 682 questionnaires were distributed to racewalkers in the San Diego/Long Beach, CA area, participants in a national qualifying race held in Washington, DC, and subscribers to *The Ohio Racewalker*.

Subjects: Four hundred questionnaires were returned to the investigators, for a return rate of 58.7%.

Measurements: Questions addressed demographics, exercise patterns, competitive history, walking surfaces, types of footwear normally used for training and competition, and injuries suffered during racewalking. Questionnaire results were tabulated and chi-square analyses were used to test for interrelationships. A stepwise discriminant analysis was used to develop a model for the prediction of injury in racewalking.

Results: Racewalking participation peaks in the 30- to 39-year-old age group, while the proportion of injured participants is greatest in those under 30. Most injuries involved the lower extremity, but the "average" racewalker suffered only one serious injury every 51.7 years. Those participants who trained six or seven times per week were most likely to be injured; those who trained three or fewer times per week were least likely to be injured. The percentage of injured participants increased progressively with weekly training mileage. A model based on the data from this investigation correctly predicted membership in either the injured or uninjured group in only 64.1% of cases and is, therefore, of limited use to the researcher or clinician.

Conclusions: Although the rate of injuries in racewalkers is low, more systematic research is necessary before sports medicine professionals can confidently recommend consistently effective injury prevention procedures.

Key Words: walking surfaces, footwear, training, injury prediction

The popularity of racewalking has increased steadily ever since the sport was first included in the Olympic Games in 1908. International competitors have been drawn from countries all over the world, but the two Olympic events (20 km and 50 km) are currently dominated by athletes from Mexico, Italy, and countries that were formerly part of the Soviet Union. Racewalking has not yet attracted large numbers of participants in North America, but there appear to be indications that the sport is growing in popularity. Racewalking events of 5 and 10 km are becoming increasingly popular for casual athletes, and successes in these relatively short events have encouraged some newcomers to attempt progressively longer races.

A number of walking enthusiasts have attributed the rising popularity of racewalking to a decline in the popularity of jogging and a concomitant increase in the number of people who are taking part in exercise walking programs. It is presumed[1–3] that this trend has been influenced by the widespread belief that racewalking is a sport providing opportunities for competition, as well as valuable health and fitness benefits, without significant risk of injury.

A review of the literature revealed that little has been documented about injuries associated with racewalking. Palamarchuk[4] questioned 31 racewalkers and concluded that the individuals in his small sample were prone to the same kinds of injuries as runners. The primary complaint was blisters of the heels and toes. Hamstring injuries were the next most common, followed in decreasing order of incidence by medial knee pain, nonspecific hip pain, plantar fasciitis, shin splints, stress fractures, and groin strains. In view of the increasing popularity of racewalking, we reasoned that a survey of a larger group of participants would provide additional objective data that would be useful to the athletic training and coaching communities.

METHODS

A detailed questionnaire was designed, field tested, and modified before being administered to subjects used in the investigation. In addition to questions of a demographic nature, the instrument elicited responses about exercise patterns (including racewalking and any other physical activities), competitive history, and the walking surfaces and types of footwear normally used for training and competition. Finally, questions were asked about injuries suffered during participation in racewalking. A distinction was made between injuries that respondents believed to have been the direct result of participation in racewalking and injuries that were assumed to have been associated with prior orthopaedic history.

In an effort to establish a means of communicating with a broad representative sample of the racewalking population, an informal survey was carried out before the present investigation. The survey revealed that there was considerable variability in the available estimates of the size of the population of racewalkers in the United States, especially with respect to the number of casual athletes involved in the sport. For example, estimates of the size of the total racewalking population provided by various individuals associated with the United

States Olympic Committee and the Athletic Congress varied from 2,000 to 6,000 participants. Preliminary inquiries also indicated that the racewalking population is widely distributed throughout the nation.

Therefore, two different methods were used in an attempt to obtain a representative sample from this sparse and widely distributed population.

One of the investigators (N.M.R.) met personally with potential subjects at competitions held at two widely separated geographic locations. Seventy prestamped and preaddressed questionnaires were distributed to competitors in the San Diego/Long Beach area in California. An additional 100 questionnaires were randomly distributed at a national qualifying race held in Washington, DC. Finally, in an effort to contact participants in other areas of the United States, a mailing list was obtained from the editors of a racewalking newsletter (*The Ohio Racewalker*), and questionnaires were distributed to all 512 individual subscribers. Thus, the total number of potential subjects was 682.

RESULTS

Data analysis was carried out when a total of 400 completed questionnaires were received by the investigators, which represented a return of 58.7%. On the basis of available estimates, the present investigation was based upon a sample of approximately 7% to 20% of the entire population of racewalkers in the United States. All data were coded and analyzed so as to obtain descriptive and inferential statistics.

Demographic Information

The sample consisted of 294 males and 106 females whose ages ranged from 12 to 88 years (mean = 44 years). History of participation in the sport for the individuals in the sample ranged from 3 months to 62 years (mean = 8.04 years). The sample included participants from all but five states. About one third of the subjects (34.6%) indicated that they began racewalking after being injured in another sport. Of these subjects, 89% indicated that running was the activity responsible for the earlier injuries. The remaining subjects indicated that they had suffered injuries while taking part in a variety of other activities, of which football, bicycling, and soccer were reported most frequently.

Exercise Habits

Most respondents (357 = 89.3%) indicated that they took part in competitive walking events ranging in distance from 1 mile to the marathon, but it was apparent that the level of participation varied greatly. Figure 1 summarizes the average frequency, duration, and weekly mileage of the racewalking exercise of the subjects. The variability clearly indicates that the sample included participants who ranged from casual racewalkers to serious competitors.

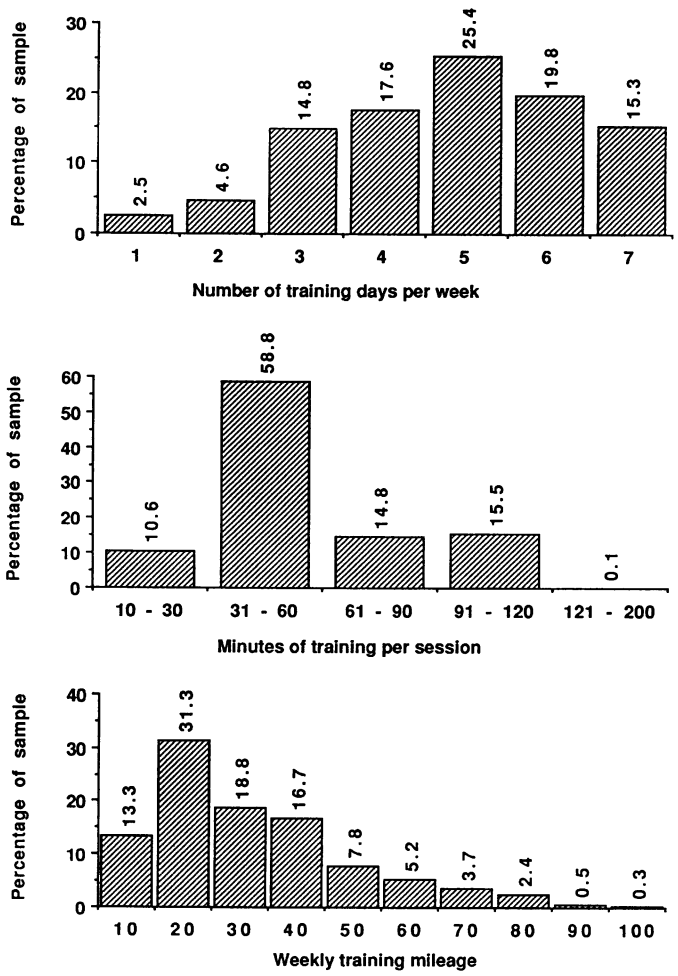

Fig 1. Frequency and duration of training sessions and average weekly mileage of 400 racewalkers.

Most participants reported that they were concurrently participating in other athletic activities, of which running, bicycling, swimming, and weight training were the most common. The great majority of participants (83%) indicated that they took part in some form of stretching program in conjunction with their racewalking programs. Almost two thirds of the subjects (213 = 63.2%) reported that they stretched both before and after exercise.

Footwear and Walking Surfaces

A little more than one third (150 = 37.5%) reported that they normally used shoes designed for racewalking during training and competition. However, more than half of the respondents (239 = 59.8%) wore shoes that were designed for running. The remainder reported that they normally wore a variety of types of footwear, including shoes designed for court and racquet sports.

Most respondents (61%) indicated that they exercised almost exclusively on a single type of ground surface. Almost half of these individuals (195 = 48.8%) performed on concrete for the

majority of time, while 156 (39%) did most of their walking on asphalt. Other individuals reported that they trained on a combination of surfaces, including various indoor and outdoor tracks (all-weather, cinder, dirt, wood, grass) and treadmills.

Injuries

Incidence of Injuries. About two thirds of all respondents (257 = 64.2%) reported that they had suffered one or more injuries during their racewalking careers. The incidence of such injuries was remarkably similar for females (69 = 65.1%) and males (188 = 63.5%). The 400 respondents in the investigation reported a total of 502 injuries, which, based on the mean length of participation of 8.04 years, represents 0.156 injuries per year per person. Put in other terms, the "average" racewalker suffers one injury for every 6.4 years of participation. On the basis of this observation alone, it would appear that the widely held belief that racewalking is a relatively safe sport is justified.

Types and Locations of Injuries. During the planning stages of this investigation, we assumed that some racewalkers would be able to provide specific medical diagnoses of injuries that they had suffered. Conversely, we assumed that other injured individuals would be unable to provide such information for a variety of reasons, including the inability to recall precise medical terminology or the fact that they had not received any form of medical attention. Therefore, subjects who were able to do so were given the opportunity to provide the precise medical terms used to describe each of the injuries they had suffered. In addition, all subjects were asked to identify the anatomic location of injuries that they had suffered.

About half of all reported injuries (247 = 49.2%) were identified with specific diagnoses (Table 1). In apparent agreement with the observations of Palamarchuk,[4] we found that many of these injuries are similar to those suffered by runners. The most common injuries reported by runners appear to be patellofemoral pain syndrome, tibial stress syndrome, Achilles peritendinitis, plantar fasciitis, and patellar tendinitis.[5,6] However, the most commonly reported injury in our investigation was hamstring strain. A number of subjects indicated verbally that they frequently suffered from blisters of the heels and toes, but only six cases were reported in response to the questionnaire. Many racewalkers appear to regard a blister as an inconvenience rather than an injury.

Table 2 lists the anatomic locations and frequency of occurrence of all the injuries counted in this investigation. It has been reported that the knee is the site most commonly associated with injury in runners.[6–9] However, the foot and knee were almost equally affected by injury among the racewalkers in our investigation. During informal discussions, several competitors stated that racewalkers rarely if ever suffer knee injuries. However, this contention was not supported by our data. Even though hamstring strain was the most frequently reported specific injury, the knee, shin, hip, and back were more commonly affected by a variety of nonspecific injuries than was the hamstring musculature.

Table 1. Specific Diagnoses of Injuries Reported by Subjects

Injury	Frequency
Hamstring strain	24
Shin splints	19
General ligament sprains	17
Other muscle strains	17
Tendinitis, foot	16
Spinal injuries	10
Tendinitis, knee	9
Iliotibial band syndrome	8
Sciatica	8
Plantar fasciitis	8
Chondromalacia patella	7
Groin pull/strain	6
Anterior tibial tendinitis	6
Arthritis, knee	6
Ligament strain, knee	6
Stress fracture, foot	6
Blisters, foot	6
Arthritis, other locations	6
Stress fractures, other locations	5
General tendinitis	5
Sesamoiditis	5
Nonspecific pain	5
Bursitis	5
Anterior compartment syndrome	4
Muscle spasm	2
Other conditions	31
Total	247

Table 2. Locations of Injuries Reported by 400 Racewalkers

Location	Frequency	Percentage of All Injuries at This Location With No Prior Orthopedic History
Knee	107 (21.3%)	66.0%
Foot	104 (20.7%)	75.0%
Shin	64 (12.7%)	94.2%
Hip	58 (11.6%)	74.5%
Back	46 (9.2%)	41.5%
Hamstring	41 (8.2%)	81.1%
Ankle	37 (7.4%)	84.6%
Groin	13 (2.6%)	
Thigh	9 (1.8%)	
Shoulder	6 (1.2%)	
Neck	4 (0.8%)	
Abdomen	2 (0.4%)	
Iliotibial band	1 (0.2%)	
Pelvis	1 (0.2%)	
Other	9 (1.8%)	
Total	502 (100.1%)	

* Total (100.1%) due to rounding all percentages to one decimal place.

Initial Occurrence of Injuries. For each injury reported, subjects were asked to indicate whether they believed that the injury had occurred as a direct result of participation in racewalking or whether the injury had occurred as a result of some other activity and had been aggravated or reinjured by subsequent participation in racewalking. Table 2 shows the percentage of injuries at each anatomic site that were not

associated with prior orthopaedic history: that is, injuries respondents assumed to have been a direct result of participation in racewalking. Our analysis has been restricted to those sites that include at least 5% of all reported injuries. Data generated from subsets that included only a handful of cases appear to be of dubious value.

In total, about four fifths of all injuries reported at the seven most commonly injured sites were not associated with prior orthopaedic history, but a closer examination of the data reveals some interesting trends. For example, more than half of the injuries involving the back (58.5%) had been associated with prior orthopaedic history. However, most injuries to the shin (94.2%), ankle (84.6%), and hamstring (81.1%) were not associated with prior orthopaedic history. On the basis of these observations, we inferred that many back pain sufferers "bring their injuries to the sport," but there appear to be cause-and-effect relationships between racewalking and many injuries to the shin, ankle, and hamstring.

Severity of Injuries. Subjects were asked to designate the level of severity of each of the injuries that they had suffered, based upon the following scale:

- Level 1. Pain only after exercise.
- Level 2. Pain during and after exercise, but little change in exercise patterns or daily activities.
- Level 3. Pain resulting in changes in exercise patterns and affecting some daily activities.
- Level 4. Pain all the time, eliminating all exercise and affecting many daily activities.

Only 15.5% of respondents reported more than two injuries, and in most instances where more than two injuries were reported, the additional injuries were classified by respondents as Level 1 (pain only after exercise). Therefore, we limited subsequent analysis to the most serious injury and the second most serious injury for subjects who reported two or more injuries (Fig 2). About half of all the injuries (49.5%) can be regarded as relatively trivial, since they created few or no changes in exercise patterns or daily activities. Of the remainder, only 12.4% were classified by respondents as Level 4 injuries, which had a significant effect on exercise and daily life. These observations reinforce the contention that racewalking is a relatively safe activity. As indicated earlier, the racewalkers in our sample suffered an average of 0.156 injuries per year. If only 12.4% of all injuries are Level 4, the average racewalker will suffer one serious (Level 4) injury every 51.7 years!

Relative Severity of Injury at Each Anatomic Site. Analysis of the severity of those injuries that subjects assumed to have been sustained as the result of racewalking revealed some interesting trends. Figure 3 shows the distribution of injury severity at the four anatomic sites where such injuries were most frequently reported. Subjects indicated that most injuries to the shins had little or no effect on exercise patterns or daily activities and that only 6.3% were serious (Level 4). Conversely, over half the injuries to the knees, ankles, and feet resulted in changes to exercise patterns and daily activities (65.3% of knee injuries, 65.2% of the ankle injuries, and 60% of foot injuries were classified as Levels 3 or 4).

Medical Attention. A further insight into the relative seriousness of injuries can be inferred from the fact that almost one third of injured subjects (30.6%) did not seek any form of medical treatment even for their most serious injury. Of those

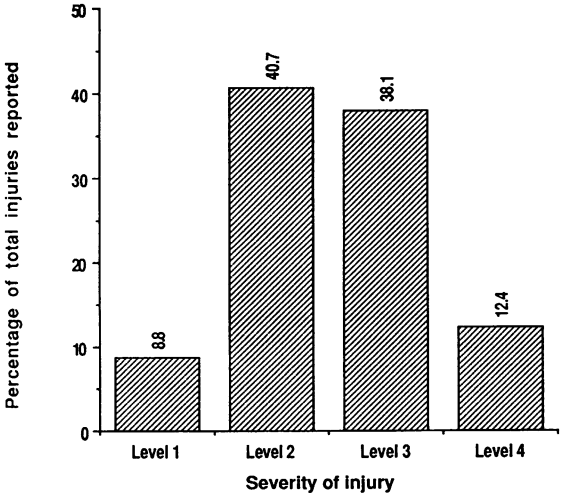

Fig 2. Distribution of severity of all reported injuries.

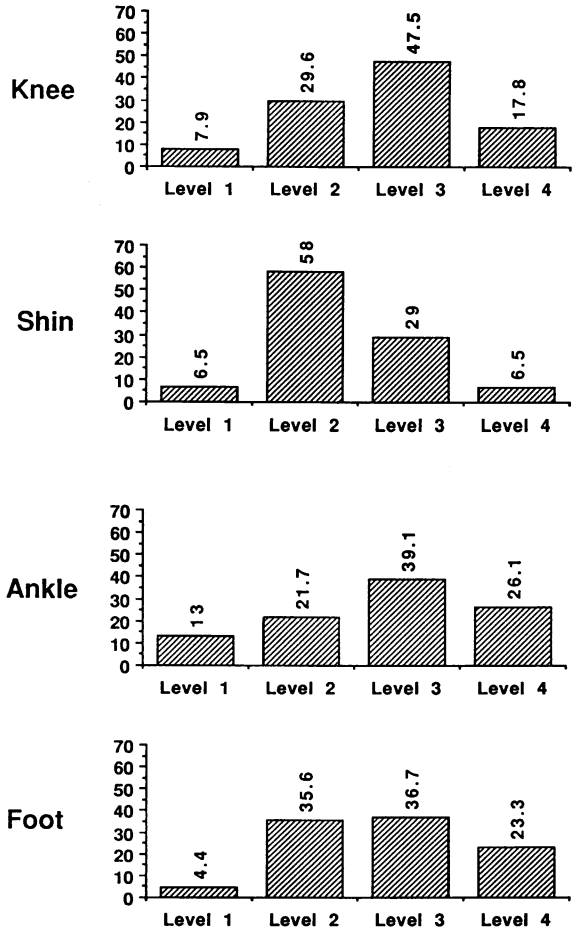

Fig 3. Relative severity of injuries reported at four anatomic sites.

subjects who did seek treatment, some subjects sought medical advice from more than one source. In all, 343 sought medical consultations (Table 3). The specific treatments recommended are listed in Table 4. It is apparent that only a limited number of subjects sought attention from athletic trainers (6.4%), which we assume is due to a lack of opportunities for racewalkers in the high school and collegiate settings. However, we suggest that athletic trainers who have an interest in racewalking injuries should make local physicians aware of their willingness to accept referrals of injured athletes.

Perceived Causes of Injuries. Subjects were given the opportunity to attempt to explain the causes of their injuries. These data must be regarded with some reservations. However, in the absence of information about the precise circumstances associated with each of the injuries reported, it can be argued that the subjects' perceptions might provide better insights than the researcher's or clinician's speculations.

For 225 of the 502 reported injuries (44.8%), subjects believed that they could identify the cause of their injuries. Almost two thirds of all of these "accountable" injuries (146 = 64.9%) were attributed to either a significant increase in the amount of exercise that was done (97 = 43.1%) or postural or anatomic deficiencies (49 = 21.8%). Improper technique (29 = 12.9%), improper shoes (19 = 8.4%), and improper surface (17 = 7.6%) were also reported. One or more subjects also attributed the cause of injuries to running on hills, insufficient stretching or warm-up, poor coaching, and pushing too hard during a race.

Cross-Tabulation Of Variables

We made an effort to establish a relationship between injury status and the variables examined in our investigation. Analyses were restricted to those injuries that were not associated with a prior orthopaedic history. That is, injuries that had been sustained before participation in racewalking and had subsequently been aggravated or reinjured by participation in racewalking were excluded from the remainder of the analyses.

Table 3. Medical Consultations Reported by 400 Racewalkers

Practitioner	Frequency
Orthopaedist	105 (30.6%)
Podiatrist	82 (23.9%)
Chiropractor	57 (16.6%)
General practitioner	44 (12.8%)
Athletic trainer	22 (6.4%)
Physical therapist	18 (5.2%)
Massage therapist	3 (0.9%)
Sports medicine MD	2 (0.6%)
Military physician	2 (0.6%)
Sports medicine clinic	2 (0.6%)
Coach	1 (0.3%)
Kinesiologist	1 (0.3%)
Internist	1 (0.3%)
Rheumatologist	1 (0.3%)
Osteopath	1 (0.3%)
Neurosurgeon	1 (0.3%)
Total	343 (100%)

Table 4. Treatments Prescribed as the Result of Consultations Listed in Table 3

Recommended Treatment	Frequency
Reduced activity	83 (24.2%)
Physical therapy	68 (19.8%)
Medication	55 (16.0%)
Complete rest	45 (13.1%)
Surgery	45 (7.3%)
Other treatments	63 (18.4%)
No treatment	4 (1.1%)
Total	343 (99.9%)*

* Total (99.9%) due to rounding all percentages to one decimal place.

Results of a chi-square analysis indicated significant relationships between injury status and three of the variables examined. These were age of subjects ($P = .0001$), the number of training sessions in a typical week ($P = .009$), and the weekly training mileage ($P = .02$). Table 5 shows the means and standard deviations for each of these three variables for both injured and noninjured subjects.

Age and Injury. Figure 4A shows the distribution of ages of subjects in this investigation. Participation peaks in the range of 30 to 39 years of age and declines steadily thereafter. Figure 4B shows the percentage of individuals in each of the age groups who reported injuries. The greatest proportion of injuries was reported by individuals under the age of 30 (42 injured out of 57 subjects = 73.7%), and the proportion of injured participants tends to decline thereafter.

Interpretation of this observation is open to some speculation. However, on the basis of the mean ages of injured and noninjured participants (40.7 and 48.2 years of age, respectively), it might be argued that those participants who are prone to discomfort and injuries are more likely to give up the sport earlier than those who are injury free. In this sense, older participants can be regarded as having "survived" by virtue of genetic factors such as mechanically sound biomechanics and by behavioral factors such as prudent training practices. This hypothesis could be tested by examining the injury history of a sample of retired racewalkers.

Frequency of Training. Figure 5 shows the proportion of injured participants grouped on the basis of the number of training sessions in a typical week. Less than half the group who trained three or fewer times per week had suffered injuries, while about two thirds of the individuals who trained six or seven times per week had been injured. These observa-

Table 5. Means (± Standard Deviation) of Age, Training Frequency, and Average Weekly Mileage for Noninjured Racewalkers and Racewalkers Who Suffered Injuries With No Prior Orthopedic History

	Age (y)	Training (sessions/wk)	Average (weekly mileage)
Injured ($n = 200$)	40.7 ± 13.2	5.1 ± 1.4	32.3 ± 17.9
Noninjured ($n = 143$)	48.2 ± 15.3	4.7 ± 1.6	26.7 ± 18.4

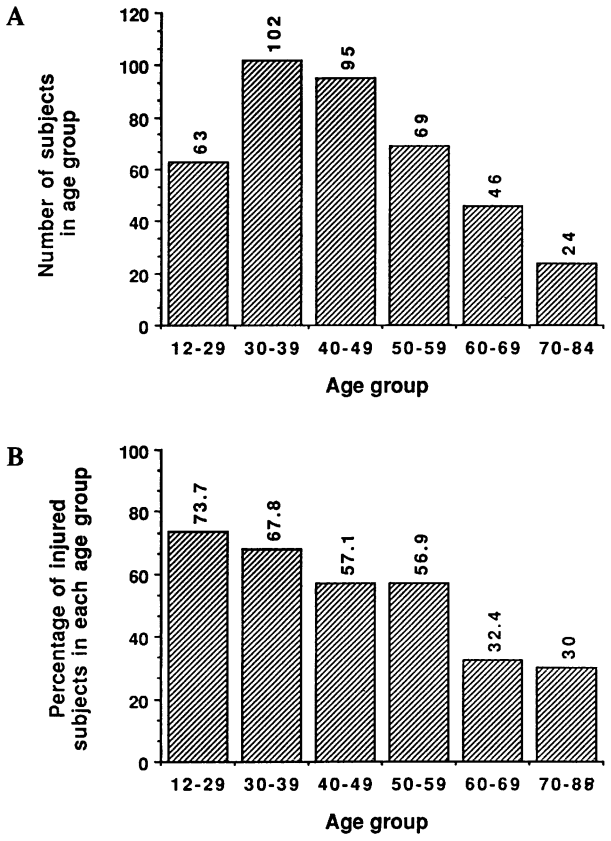

Fig 4. A, Age distribution of 40 racewalkers. B, Percentage of injured racewalkers in each of the age groups shown in A.

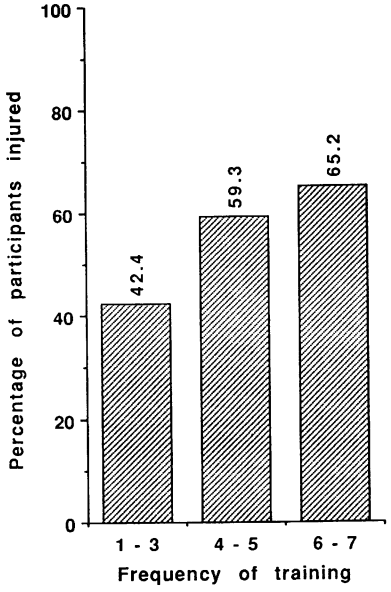

Fig 5. Number of training days each week and corresponding number of injured participants.

tions appear to reflect cumulative stress disorders. It is widely believed that the potentially injurious effects of mechanical stress are cumulative, but that days of rest will allow physiologic processes to repair microtrauma to the musculoskeletal system.

Weekly Training Mileage. The average weekly training mileage reported by injured subjects (32.3 miles) was greater than the mileage reported by uninjured subjects (26.7 miles). Figure 6 indicates that the greatest proportion of injured individuals occurred among the group whose members accrued more than 50 miles each week, and the smallest proportion of injured individuals occurred among those who restrict weekly training to 15 miles or less. This observation is consistent with the conclusion of Powell et al,[10] who reviewed three epidemiologic studies of running injuries and reported, "Of all the possible causes of injury, the number of miles run per week is most clearly associated with the incidence of running injuries."

Discriminant Analysis of Variables Related to Injury

We used a stepwise discriminant analysis to determine which linear combination of variables examined would best discriminate between injured and uninjured racewalkers. Results indicated that years of participation in racewalking (Y), the duration of the average training session (D), the frequency of training sessions in a typical week (F), and age (A) were significant ($P < .05$). A model for the prediction of injury in racewalking was established: $D = 0.28(Y) + 0.27(D) + 0.34(F) - 0.83(A)$

However, indicators of practical significance, including the canonical correlation coefficient (0.32) and Wilks lambda (0.90), demonstrated little utility for the model. In fact, the above relationship would correctly predict membership in either the injured group or uninjured group in only 64.1% of cases. In practical terms, such a model is not a great deal more effective than prediction based upon coin tossing, which would correctly predict group membership in 50% of cases. The current model is therefore of limited value to the researcher or clinician.

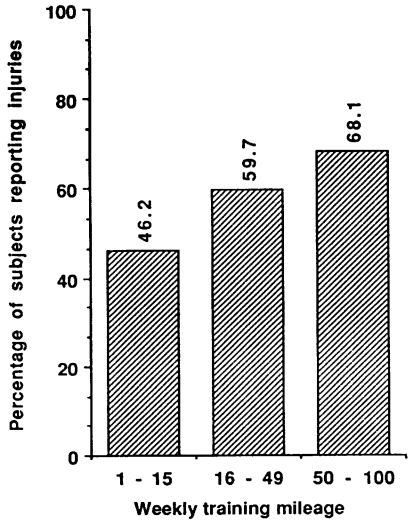

Fig 6. Percentage of racewalkers reporting injuries in each of three groups based on weekly training mileage.

DISCUSSION

Our investigation provided demographic data that are of interest to the athletic training community. Specifically, overall participation peaks among the 30- to 39-year-old age group. This finding is likely to reflect the passage of the "age wave" of baby boomers in our society, but the total number of participants under the age of 20 years (16, 4%) revealed that racewalking appears to have limited appeal to younger individuals. In a study conducted on behalf of the Athletic Footwear Association,[11] Ewing and Seefeldt questioned more than 8,000 young people and found that there was a steady decline in interest in track sports between the ages of 10 and 18 years. Subjects indicated that the mean reason for participation was "having fun." In commenting on the sociologic implications of Ewing and Seefeldt's observations, Danish[11] stated, "What is enjoyable for individuals will change with age. Even though boredom or anxiety may produce a drop-out, the individuals may well turn to the same or another sport later on, especially if they can find something important about themselves in the activity."

On the basis of our data, it would appear that racewalking has exemplified this state of affairs. The cross-training habits of many participants are clearly appropriate for goals other than success in competition, and long-term commitment to the sport is common. The widespread use of footwear that was designed for activities other than racewalking may be indicative of the limited selection of racewalking shoes available. However, this observation could also indicate that many participants have a relatively informal attitude to the activity when compared with many dedicated runners and dance-exercise enthusiasts, who tend to be fiercely loyal to specific models of activity-specific shoes.

Participants appear to be well informed about current sports medicine practices. The injury-prevention benefits of stretching have not been objectively demonstrated, but stretching, on the basis of anecdotal evidence, is widely advocated by sports medicine professionals and practiced by most racewalkers. Most medical consultations appear to have been sought within the framework of credible medical resources. Racewalkers' perceptions of the causes of their injuries are also consistent with the conclusions of researchers who have studied injuries to runners and dance-exercise participants and instructors.[7,8,12,13]

The injury rate in the sport is low by any standards, and the nature and location of injuries to the lower extremity are somewhat consistent with the biomechanics of the activity. Fenton[5] found that the mediolateral forces on the feet of racewalkers were significantly higher than for a normal walking gait. Payne[14] attributed these relatively large mediolateral forces in racewalking to the straightening of the supporting leg and the compensatory lowering of the opposite hip and ipsilateral shoulder in order to maintain a linear progression of the center of mass. Corrallo et al (V. Corrallo, L. Downes, K. Hogan, T. King, K. Larsen, J. O'Dwyer, and A. Peck, unpublished data, 1983) found that, unlike normal walking gait, there was no knee flexion during midstance.

The characteristic rolling gait of racewalking is mandated by the rules, which specify that at least one foot should be in contact with the ground at all times and that the knee should be extended when the corresponding foot makes first contact with the ground. Although a significant change in the first of these rules would predictably reduce some mechanical stress on the lower extremities, it is likely that such a fundamental change would radically alter this traditional competitive activity. In actual fact, high-speed cinematographic analysis has shown that many racewalkers do incorporate an unsupported phase during competition,[15] but that the practice cannot be detected using only the visual acuity of judges. Furthermore, on the basis of the incidence of injury indicated by the current investigation, there is little compelling rationale for advocating such an extreme change in the rules. However, some writers have recommended that changes should be made in the rule governing knee extension during initial impact with the ground.[16]

Finally, even with the relatively large sample of subjects that was used in our investigation, we were unable to generate a model that would provide good prediction of injury status on the basis of the variables examined. Such a conclusion is consistent with similar attempts to objectively identify factors that cause injuries to runners.[10]

In an attempt to provide a systematic approach to the identification of factors that contribute to injuries, Nigg et al[17] proposed a system that classifies the sources of potentially injurious mechanical stresses into a number of categories and subcategories. These include external factors, (such as the various characteristics of shoes, surfaces, and the environment), internal factors (such as pre-existing orthopaedic status and various aspects of psychological status), technique (including the influence of history of instruction and experience), and training habits. However, the authors indicated that even with a systematic approach, there may be additional factors involved, and it is likely that there are complex interactions between the various factors. On the basis of research involving running injuries, Powell et al[10] concluded that a number of the factors widely believed to be causative of such injuries have not been objectively demonstrated to be strongly related to injury status. Furthermore, human populations cannot be readily subjected to experimental controls, and so it is inevitably either impractical or impossible to account for all potentially causative factors. A great deal more systematic research must be completed before the athletic training community can confidently recommend consistently effective injury prevention procedures in sport in general and racewalking in particular.

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