The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature

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ABSTRACT

THACKER, S. B., J. GILCHRIST, D. F. STROUP, and C. D. KIMSEY, JR. The Impact of Stretching on Sports Injury Risk: A Systematic Review of the Literature. *Med. Sci. Sports Exerc.*, Vol. 36, No. 3, pp. 371–378, 2004. **Purpose:** We conducted a systematic review to assess the evidence for the effectiveness of stretching as a tool to prevent injuries in sports and to make recommendations for research and prevention. **Methods:** Without language limitations, we searched electronic data bases, including MEDLINE (1966–2002), Current Contents (1997–2002), Biomedical Collection (1993–1999), the Cochrane Library, and SPORTDiscus, and then identified citations from papers retrieved and contacted experts in the field. Meta-analysis was limited to randomized trials or cohort studies for interventions that included stretching. Studies were excluded that lacked controls, in which stretching could not be assessed independently, or where studies did not include subjects in sporting or fitness activities. All articles were screened initially by one author. Six of 361 identified articles compared stretching with other methods to prevent injury. Data were abstracted by one author and then reviewed independently by three others. Data quality was assessed independently by three authors using a previously standardized instrument, and reviewers met to reconcile substantive differences in interpretation. We calculated weighted pooled odds ratios based on an intention-to-treat analysis as well as subgroup analyses by quality score and study design. **Results:** Stretching was not significantly associated with a reduction in total injuries (OR = 0.93, CI 0.78–1.11) and similar findings were seen in the subgroup analyses. **Conclusion:** There is not sufficient evidence to endorse or discontinue routine stretching before or after exercise to prevent injury among competitive or recreational athletes. Further research, especially well-conducted randomized controlled trials, is urgently needed to determine the proper role of stretching in sports. **Key Words:** ATHLETES, CONDITIONING, META-ANALYSIS, SYNTHESIS

Stretching before participation in athletic activities is standard practice for all levels of sports, competitive or recreational. Athletes, coaches, trainers, physiotherapists, and physicians recommend stretching in an effort to both prevent injury and enhance performance; numerous journal articles and textbooks are devoted to the topic, providing a variety of approaches directed to different parts of the body and for specific sporting activities (1). As more people participate in sports and other recreational activities through social changes (e.g., Title IX) and increased recognition that physical activity is part of a healthy lifestyle, injury prevention becomes more important. However, some investigators have questioned the routine practice of stretching and contend that there is little evidence that stretching pre- or postparticipation prevents injury and that it might affect performance negatively (82,93). In particular, a recent systematic review (35) concluded that the best available evidence indicates that stretching before or after exercise does not prevent muscle soreness or injury and that there is insufficient evidence to assess effect on performance.

We developed a logic model to illustrate the relations among stretching, flexibility, performance, and injury (Fig. 1). *Flexibility* is an intrinsic property of the body tissues that determines the range of motion achievable without injury at a joint or group of joints (40). There are several methods of stretching to increase flexibility including passive, static, isometric, ballistic, and proprioceptive neuromuscular facilitation (PNF) (Table 1). Although static stretching is the easiest and most frequently used stretching method, each approach has advocates (1). Both passive and PNF techniques require a second person with specific skills, and there is some concern that PNF techniques might increase the risk of injury because of the resulting increase in stretch tolerance (i.e., the ability to increase the range of stretching

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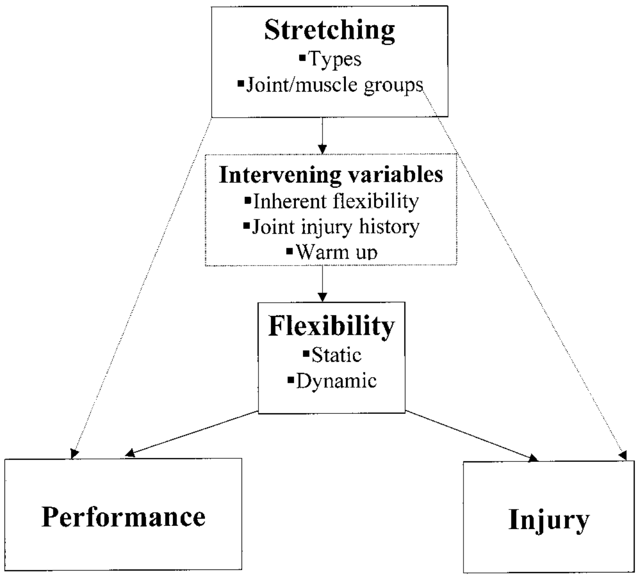

FIGURE 1—Logic model for relations among stretching, flexibility, performance, and injury.

without pain). Concerns about connective tissue trauma have caused the practice of ballistic stretching to fall from favor (18).

Flexibility is dependent on the viscoelasticity of muscle, ligaments, and other connective tissue. Flexibility is assessed with tools such as goniometers to measure joint angles, fleximeters to measure the degree of bending, and arthrometers to measure joints. These tools are generally used to measure *static flexibility* (i.e., the measured range of motion about a joint or series of joints in an immobile subject), and the relationship of these measures to *dynamic flexibility* (i.e., the measure of resistance to active motion about a joint or series of joints) is not clear (19). Although some persons are described as loose-jointed, a general body measure of flexibility has not been demonstrated, and there is little agreement on the definition and limits of normal flexibility (39). The improvement in short-term flexibility that results from stretching has been documented (44).

As with stretching, little evidence exists that documents a relation between increased flexibility and reduced incidence of injury (54,55,88). Indeed, injury may be related to too much or too little flexibility or, in some instances, increasing flexibility may actually increase the rate of injury (49). The lack of flexibility does not account for many muscle injuries that occur within a normal range of motion (96). However, an imbalance in flexibility in individual athletes might predispose to injury (54). Although stretching before activity might improve performance for some sports that require an increased range of motion (e.g., gymnastics or swimming), increased flexibility might compromise muscle performance for up to 1 h (56,57).

TABLE 1. Stretching methods.

Method	Description
Passive	Slow, sustained muscle lengthening with a partner
Static	Slow, sustained muscle lengthening held by subject for 15–60 s
Isometric	Static stretching against an immobile force
Ballistic	Rapid lengthening of the muscle by use of jerking or bouncing movements
PNF*	Passive muscle lengthening with a partner after an antagonistic muscle is contracted

* Proprioceptive neuromuscular facilitation.

Literature reviews (87) and analytic studies (48,62,88) concerning injury enumerate many risk factors such as age, extremes in body mass index, decreased fitness, inexperience, short stature in women, increased body fat in men, strength imbalance between flexor and extensor muscle groups, history of previous injury, increased weekly running mileage, increased duration and frequency of endurance training, weight training, smoking, and competitive motivation. Yet, the studies have methodological problems, often complicated by both ascertainment and information biases, lacking sufficient statistical power and having inadequate control of potential confounding variables such as warm-up. In addition, most of the comparative analytic data on injuries come from studies of runners. Close examination of these studies, however, finds that stretching has not been shown to prevent injury (61,87). Instead, use of stretching as a prevention tool against sports injury has been based on intuition and unsystematic observation rather than scientific evidence. Indeed, risk factors are not often demonstrated conclusively to predict injury because there is usually insufficient epidemiologic evidence to make a judgment. Of the few comparative studies in the literature, only a small number address multiple potential risk factors and potential confounding variables (49,62). Similarly, little research has addressed stretching as an injury prevention strategy.

In this paper, we first conduct a systematic review of the literature to summarize the research on flexibility and its relation to stretching and sports injuries in the context of other risk and protective factors. Second, we assess the evidence for the effectiveness of stretching as a tool to prevent injuries in sports. To do this, we first assess the evidence that stretching improves flexibility as well as the adverse effects of stretching on flexibility. We then examine the effect on injury prevention of warm-up, a critical intervening or independent variable, as well as other risk factors for injury. Finally, we make recommendations for a systematic approach to future research and prevention.

METHODS

Using OVID version 2, we searched electronic data bases: MEDLINE, 1966 through August 2002; Current Contents, 1997 to August 2002; Biomedical Collection, 1993 to 1999; and Dissertation Abstracts (in all languages) using MDConsult and the following search terms: "stretching," "flexibility," "injury," and "sports injury." We searched without language limitations. We limited this search using the terms "epidemiology" and "injury prevention." Using the same strategy, we searched the Cochrane Library and SPORTDiscus. We then identified additional citations from the reference sections of papers retrieved and contacted experts in the field to locate additional unpublished studies. We performed a formal meta-analysis using only randomized trials (RCT) or cohort studies for interventions that included

Variables	Score
Experimental design:	
Statement of research question (prior hypothesis)	4
Source of Sample	5
Inclusion/exclusion criteria	6
Randomization	10
Examiner/analyst blinding	4
Selection bias addressed	2
Information bias addressed	2
Description of intervention	7
Comparison of participants to eligible decliners	3
Comparison of participants to dropouts	3
Independent validation of data	1
Power calculations (sample size requirements)	3
Clear methods to evaluate outcome variable defined	3
Appropriateness of method	3
Addressed possible confounders	1.5 pt. each
Age	
Gender	
Race	
Flexibility	
Warm-up prior to stretching	
Prior physical activity/sports participation	
Prior lower extremity injury	
Current type and amount training	
Appropriateness of method of adjustment	4
Data presentation and statistical analysis:	
Description of tests	6
Use of relative risk of odds ratio	2
Use of confidence intervals or p values	3
Multivariate techniques	4
Regression coefficients (if multivariate technique used)	3
Demographic data	2
Confounders	2
Comparability groups	2
Collinearity	2
Addressed issues of multiple testing	2
Total	(Possible 100)

FIGURE 2—Quality scoring form.

stretching. We excluded studies that lacked controls, those in which stretching could not be assessed independently of other interventions, and those that did not include subjects in sporting or fitness activities. All articles were screened by one author (SBT). We identified 361 articles reporting about flexibility (its underlying physiology and its relation to stretching), risk factors for injury and methods for prevention, alternative approaches to stretching, the effects of stretching on performance and injury prevention, and adverse effects of stretching and flexibility. Of these, six reports compared stretching with other methods to prevent injury.

We modified a scoring instrument previously used to evaluate the methodological quality of cohort studies and RCT (Fig. 2) (86). Reviewers were blinded to the primary authors' names and affiliations but not to the study results. Each citation was then evaluated independently for quality by three reviewers. After independent evaluation, the reviewers met to reconcile substantive differences in interpretation.

We calculated pooled odds ratios based on an intention-to-treat analysis using Epi Info Version 6 (31). We weighted each study result by total study size and calculated both crude and adjusted odds ratios (50). We conducted subgroup analyses according to quality score (low vs high), nature of intervention (single vs multiple muscle stretching), and study design (RCT vs other). We calculated 95% confidence intervals using the Mantel-Haenzel procedure. Because no significant differences were found, we did not perform a formal test for publication bias. However, given the nature of our search, we are comfortable that no large comparative study which shows a protective effect of stretching has been completed. Heterogeneity was measured using the Q statistic (34).

RESULTS

Stretching to improve flexibility. The literature on flexibility includes both studies of the effects of stretching on specific joints and muscles, and studies of the effectiveness of alternative methods of stretching and the extent and duration of the effect (Table 2). Alternative methods of stretching, including passive stretching, static stretching, ballistic stretching, isometric contractions, and PNF, have been compared for their effects on flexibility (6,11,23). By whatever method used to measure flexibility, in 27 reports published since 1962, stretching was demonstrated to increase joint flexibility about the knee (including hamstring/quadriceps muscles) hip, trunk, and shoulder and ankle joints (soleus/gastrocnemius muscles) (references available from authors on request). Although there is evidence that PNF stretching is more effective in improving flexibility (2,22,41,74,89), this has not been demonstrated consistently (10,29,33,60), and the apparent result might be related to other factors such as posture during stretching (85). A 15-s or 30-s passive stretch is more effective than shorter duration stretches (75,90) and as effective as stretches of longer duration (4,63). Passive stretching is more effective than dynamic stretching of the hamstring (5), although no difference was found in active versus passive stretching of the hip joint (42). Various protocols have also been tested for effectiveness such as timing of rest periods (9), placement within a workout schedule (12), a stance phase stretch versus a forward swing phase stretch (78), and repeated passive stretching (30). The duration of increased flexibility after stretching is from 6 to 90 min (17,68), although an extensive program of several weeks duration has produced increased flexibility that persists for several weeks (65,98).

Adverse effects of stretching/flexibility. There is some evidence of unintended adverse effects of stretching and/or increased flexibility. Stretching has been associated with a temporary strength deficit (up to 1 h) (24,57) and increased arterial blood pressure (13). Recent studies of passive stretching shows significant adverse effects on jump performance (14) and plantar flexion (65). Increased flexibility decreases running economy (15,27) and peak performance (77), but these findings are not consistent (28,58,70), and there is some evidence that increased flexibility enhances performance (60).

Warm-up to prevent injury. Preparation for athletic activity often includes both stretching and warm-up, making it difficult to assess their independent effects on injury

TABLE 2. Results of field studies to determine the effectiveness of stretching in the prevention of injuries.

Senior Author (Country)	Year	Study Design	Population	Study Groups	Outcomes	Median Quality Score
Andrish et al. (US) (3)	1974	Randomized trial	2777 male navy midshipmen in 8 wk basic training	1) foam heel pad 2) heel stretching 3) heel pad and heel stretching 4) graduated running 5) control	97 with shin splints 1) 15/344 (4.4%) 2) 12/300 (4.0%) 3) 14/463 (3.0%) 4) 13/217 (6.0%) 5) 43/1,453 (3.0%)	31
Bixler and Jones (US) (7)	1992	Prospective cohort study	5 Pennsylvania high school football teams: 28 games	1) 3-min half-time warm-up/ stretch (3 teams) 2) controls (2 teams)	27 with shin splints or tibial stress reaction 1) 3rd quarter a) total injuries 7 (0.3 per game) b) sprains/strains 1 (0.04 per game) 2) a) total injuries 22 (0.8 per game) b) sprains/strains 13 (0.46 per game)	32
Pope et al. (Australia) (72)	1998	Randomized trial	1093 Army recruits in 26 platoons in 12-wk basic training	1) 2, 20-s stretches of calf before rigorous exercise (549 recruits in 13 platoons) 2) 2, 20-s stretches of wrist and triceps before rigorous, exercise (544 recruits in 13 platoons)	1) 23 lower-extremity injuries 2) 25 lower-extremity injuries	61
Cross and Worrell (US) (16)	1999	Retrospective cross-sectional series	195 college football players, 1994 and 1995 seasons	1) 1995 season—static stretching program—prior to conditioning training 2) 1994 season-no stretching program	1) a) 153 injuries b) 21 lower-extremity injuries 2) a) 155 injuries b) 43 lower-extremity injuries	29
Hartig and Henderson (US) (32)	1999	Prospective cohort study	298 army recruits in two companies	1) 148 recruits—static hamstring stretch, 3 times daily 2) 148 recruit controls—no stretching program	1) 25 lower-extremity overuse injuries (17%) 2) 43 lower-extremity overuse injuries (29%)	34
Pope et al. (Australia) (73)	2000	Randomized trial	1538 army recruits in 39 platoons in 12-wk basic training	1) 735 recruits in 19 platoons, 20 second supervised stretches of 6 major leg muscle groups before each physical training session 2) 803 recruits in 20 platoons—no stretching Program	1) 158 lower-limb injuries (21%) 2) 175 lower-limb injuries (22%)	60

prevention. Warm-up together with stretching increases the flexibility of the ankle, hip, and knee joints (46,94) but has not been shown to prevent muscle soreness (37). At least one report demonstrates that static stretching and warm-up by cycling increase flexibility equally for at least 15 min (46), although the effects of combined intervention are not consistent (76). Several programs that combine warm-up, strength, and balance training with stretching have demonstrated effectiveness in the prevention of knee and ankle injuries (21,36,92), but the independent effects of warm-up and stretching were not determined.

Since 1945, 32 published reports have addressed the effect of warm-up on performance (references available from authors on request). A summary of 22 clinical studies in the 1950s and 1960s found that flexibility and performance (especially strength and speed) in a number of sporting activities improved after warm-up, especially when stretching was vigorous, sustained, and related to the activity to be undertaken (71), and subsequent studies found similar results. Passive methods to increase body temperature (hot baths, moist heat) also tended to increase performance but to a lesser degree (69), whereas the effect of massage on performance was not consistent (67). In this literature, the detrimental effects on performance of fatigue from vigorous activities suggests that there might be optimal levels of warm-up, and that might, in turn, be related to the fitness of the persons involved. A positive attitude toward warm-up was associated with a significant improvement in performance (84).

Risk factors for injury. Two different approaches appear in the literature to determine whether the lack of flexibility puts athletes at risk for injury or whether stretching prevents injury. One approach is to examine flexibility or stretching specifically to determine whether they are associated with injury. A second approach uses cohort or case-control methods, and flexibility and/or stretching are among several risk or protective factors included in a multivariate analysis.

Questionnaire surveys and/or personal logs of groups of runners and other athletes have asked about stretching and have shown either no association with injury (62,91), no protective effect (95), or no increased injury rates (43). Stretching after wrist hyperextension against weight decreased muscle soreness in college volunteers (18), but in other studies, stretching before or after exercise had no effect in the prevention of postexercise pain (47). Studies of

TABLE 3. Combined data from five prospective studies of the effectiveness of stretching to reduce injury.

Study	OR (with CI)
Andrish et al. (3)	1.37 (0.67, 2.72)
Pope et al. (72)	0.91 (0.49, 1.68)
Cross and Worrell (16)	0.97 (0.70, 1.36)
Hartig and Henderson (32)	0.50 (0.27, 0.90)
Pope et al. (73)	0.88 (0.77, 1.26)
Pooled Weighted OR	0.93 (0.78, 1.11) $P = 0.43$

flexibility or joint laxity have often shown no association with injury (51,53), although the lack of flexibility (i.e., tightness) has been found to be associated with specific injuries (20,66). A 1999 study of 303 male military trainees found that the most flexible and the least flexible men were at significantly increased risk of injury in a multivariate analysis (48).

Intervention studies. Six controlled studies have been published that specifically address the role of stretching in the prevention of injury (Table 2). Three of these studies focused on stretching of specific muscle groups, either heel/calf (3,72) or hamstring (32); the other three assessed programs that addressed multiple muscle groups (7,16,72). Although two studies targeted the prevention of shin splints (3) or shin splints and tibial stress reaction (7), the other four studies examined all lower extremity injuries.

Pooled analysis of five of these studies found that stretching was not significantly associated with a reduction in total injuries (OR = 0.93, CI 0.78–1.11) (Table 3). (We were unable to pool one study (7) because of the authors' choice of denominators for the rates (games rather than players).) Although crude odds ratios were higher for low (2.36) versus high quality studies (0.95), this difference did not persist when adjusted odds ratios were calculated (0.88, CI 0.67–1.15 vs 0.97, CI 0.77–1.22). Weighted odds ratios were also not significant for studies in which stretching focused on specific muscles (0.80, CI 0.54–1.14) or multiple muscle groups (0.96, CI 0.71–1.28). Further, odds ratios for RCT (1.00, CI 0.81–1.25) and non-RCT (0.81, CI 0.61–1.09) were similar. Tests for heterogeneity were not significant on any of these reported analyses.

Quality of reported studies. Quality scores for the RCT ranged from 26 to 65 (of a possible 100) for the individual rater scores; the median scores for the six studies ranged from 29 to 61 (Table 2).

DISCUSSION

This review of the available evidence clearly demonstrates that stretching of most if not all muscle groups that are important to athletic performance will increase muscle and joint flexibility, usually measured as short-term static flexibility. Studies also suggest that extremes of inflexibility and hyperflexibility increase the risk of injury. However, the importance of these results for injury prevention within the limits of normal flexibility is not documented in the literature. Because dynamic range of motion is generally greater than static range of motion due to enhanced tissue elasticity and reciprocal inhibition leading to relaxation of opposing muscles during physical activity, the relevance of static flexibility to dynamic performance is an unresolved issue (25,39).

Qualitative flexibility is clearly important in sports such as gymnastics, diving, ice skating, and dance. Also, flexibility might improve performance under specific conditions in other sports. At the same time, it is not clear whether there is a flexibility threshold for optimal performance or that additional flexibility in already flexible athletes is necessary or desirable (49). Certainly, joint integrity should not be compromised simply to increase range of motion. Although some laboratory and clinical evidence suggests that increased flexibility might improve athletic performance, little population-based evidence addresses this issue. The best available data indicate that performance might be lowered at the extremes of flexibility and that, at least for some muscle/joint groups, there might be optimal levels of flexibility that would enhance performance. However, these benefits are likely to be highly specific to a sport or even to a specific body movement.

Recently, the President's Council for Physical Fitness and Sports reported that stretching not only might not prevent injuries but also might compromise performance (56). Animal studies also suggest that stretching does not protect against acute injury (8). Muscle strain injuries occur during eccentric exercise when muscles develop tension while lengthening; fatigue and weakness make muscle more susceptible to injury (26). Several theories explain how performance could be compromised or the rate of injury could be unaffected or even increased because of stretching (82). These theories include decrease in joint stability making joint movement less efficient, increased tissue compliance with a decrease in the ability of tendon and muscle tissue to absorb energy leading to injury, creation of body positions with dangerous loading effects that could stretch ligaments too far, decreased strength before the recovery phase of training, and increased pain tolerance leading to cytoskeletal and tissue damage. Finally, because most injuries occur during eccentric contractions within the normal range of joint motion, it is not clear how increasing the range of motion through stretching will decrease injury risk (82).

The limited epidemiological evidence more clearly addresses the question of injury prevention than its effects on performance. The three RCT in this study that address stretching and injuries fail to demonstrate a protective effect of supervised stretching (3,72,73). The three cohort studies (7,16,32) that find that stretching might prevent injury are small and are of lower methodological quality than the two recent RCT (72,73). Even pooling data from these studies demonstrated no significant protective effect. At the same time, the evidence is not of sufficient strength, quality, and generalizability to recommend altering or eliminating preexercise stretching. Further, no studies have examined subpopulations that might be at higher risk for injury (e.g., "tight" athletes) and thus might benefit from stretching. Finally, none of the studies address the comparative severity of injury in experimental and control groups that could lead to an economic reason for stretching if the injuries are less serious, as was found for a workplace flexibility program (38).

Stronger evidence demonstrates that various approaches to conditioning that include warm-up and stretching along with other techniques such as strength training, plyometrics, and proprioception training both enhance performance and prevent certain kinds of injury (52,64,83,94). This suggests that strength training, conditioning, and warm-up play an important role in injury prevention. In addition, stretching of specific muscles and joints for specific activities might enhance the effectiveness of these other preexercise activities, an approach consistent with a multifactorial model for prevention (97). At the same time, there might also be a risk of injury and impaired performance associated with stretching without adequate conditioning and/or warm-up. Further research on various stretching techniques targeting specific joints and muscles is urgently required that will allow physicians, physical therapists, athletic trainers, coaches, and personal trainers to make appropriate recommendations to athletes. Too little is known to make evidence based recommendations.

Some have argued that warm-up is more important than stretching in the prevention of injuries in sports (79). Warm-up increases blood flow to muscles, speed of nerve impulses, oxygen and energy substrate delivery to working muscle while removing waste products, and oxygen release from hemoglobin and myoglobin; warm-up decreases both the activation energy for cellular reactions and muscle viscosity (59,81). These changes prepare the body for vigorous exercise by accelerating metabolism in muscle fibers and decreasing intramuscular resistance, thus increasing both mechanical efficiency and range of motion (i.e., flexibility), as well as the speed and force of muscle contraction. Animal studies suggest that warm-up increases muscle elasticity, which decreases the likelihood of muscle tearing (80).

Based on this review, we can recommend neither the endorsement nor the discontinuation of stretching, which has been a basic tenet of preparation for athletic participation. The evidence demonstrates that stretching clearly increases flexibility and, to the degree that flexibility might benefit performance or decrease the risk of injury, stretching might be desirable. It is also evident that strength training, conditioning, and warm-up have an important role in injury prevention, and we suggest that when stretching is done, it should be conducted in the context of adequate conditioning and appropriate warm-up.

We recommend that several research questions be addressed in RCT. First, does preexercise stretching reduce the occurrence of injury in well-conditioned competitive athletes? Such studies should be done in a variety of sports/activities and in both youth and adults of both sexes. Second, does preexercise stretching reduce the occurrence of injury in well-conditioned recreational athletes? Such studies should be done first in the most popular recreational activities recommended currently for general better health such as walking, running, swimming, and aerobics. Because it might not be ethical to conduct RCT of this question among poorly conditioned recreational athletes, one can undertake cohort or other analytic studies in such populations to make recommendations for this potentially large population at risk. In any of these studies, injury severity and preparticipation conditioning and flexibility should be measured and reported. Particular attention should be paid to subjects with the least flexibility to determine whether they might benefit most from stretching. Finally, because athletes do not use injury prevention measures consistently, the inherent behavioral aspects of sports injuries and issues such as compliance and motivation warrant careful study (45).

Several methodologic issues are important in future research. Blinded allocation of subjects and blinded data analysis for the original studies are necessary to minimize bias, particularly in an area such as stretching where beliefs are strongly ingrained. In RCT and cohort studies, subjects in both intervention and control groups should be subject to uniform, consistent, and ongoing monitoring of injuries and performance. In calculating rates of injury, consideration must be given to the choice of denominators (e.g., hours of participation and number of participants vs numbers of games), as well as baseline risk (e.g., fitness and previous injury). Similarly, assessment of performance should examine the possibility of thresholds and optimal levels of flexibility. More scrupulous attention to issues of bias (e.g., different baseline abilities of companies of military recruits) and confounding (e.g., fitness and variable durations of exercise) are critical to understanding the effect of stretching where so many other factors might play a part. Finally, rigorous statistical methods are essential.

In conclusion, there is not sufficient evidence to endorse or discontinue routine pre- or postevent stretching to prevent injury among competitive or recreational athletes. Better research is needed to determine the proper role of stretching in sports, especially as there are increasing numbers of athletes and growing recognition that all people need to increase their physical activity to improve their health and quality of life.

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