Editorial

Multi-faceted exercise programs versus strength training to prevent sports injuries

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Exercise and sports participation are important for children and adolescents development, quality of life, and prevention of metabolic diseases (1). Adverse effects, in form of sports injuries, render injury prevention a necessary and relevant subject for both researchers and lay persons (2,3). Treatment of sports injuries can be troublesome, time-consuming, and expensive. Indeed, effective prevention of injuries would potentially benefit the whole spectrum of individuals involved in any kind of sport or exercise. Efforts to prevent sports injuries, also in adolescents, have been pursued and several internal and external risk factors have been targeted for intervention (4). Within these, proper exercise training has been identified as a useful intervention to treat these risk factors.

Risk factors internal to an individual, such as body composition, general health, physical fitness, skill level, and, perhaps, psychological factors are all hypothesized to be modifiable by exercise. Summarizing developments within the field of prophylactic exercise to prevent sports injuries releases a list of keywords, including muscle strength, joint stability, postural stability, joint range of motion, proprioception, coordination, and sport specific technique. Intuitively, prevention programs should target all these factors and several sports injury prevention trials have, in fact, analyzed multi-faceted programs during the last decade. These typically comprise exercise modalities such as strength training, proprioception/coordination exercises, and stretching together with varying elements of specific technique training, agility exercises, running and/or unspecific warm-up.

Soomro *et al*. recently analyzed the effect of ten multifaceted training programs to prevent adolescent sports injuries in team sports (5). They found that multi-faceted programs were effective in preventing sport injuries with a 32% decrease in injuries. The review was based on a thorough search and included a meta-analysis, which was adjusted for publication bias. However, the analysis exhibited substantial heterogeneity and results should be interpreted with a caution. In response, authors classified and analyzed eight different study characteristics in an attempt to account for the statistically diverse studies. These parameters were sex, sport type (soccer *vs*. baseball/basketball), type of comparison group (sham intervention *vs*. control), type of injury prevention program (FIFA *vs*. non-FIFA interventions), wobble board use (yes/no), intervention duration (<8 *vs*. >8 months), participant compliance (<70% *vs*. >70%), and study quality. None of the subgroups were found to explain the variation in study outcomes. It is worth noting, as the FIFA11+ interventions comprised half of the studies, non-FIFA studies had a tendency towards being more effective. Surprisingly, no relationship between compliance and effect size was found and studies with higher assessed study quality had lower effect estimates.

With the included ten studies covering 2008 sports injuries in 8,513 adolescent soccer, handball, and basketball

athletes, we consider the primary analysis as appropriately powered. However, the subgroup analysis suffered from the limited number of studies and injuries available for each group. As a result, these analyses needed quite large differences between groups in order to reach significance. Given the low power for sub-groups, it was unfortunate that the authors decided to exclude articles on multi-faceted intervention on the basis of lack of exposure time reporting. A different decisions would have added studies such as van Beijsterveldt *et al.* (6), Gilchrist *et al.* (7), Heidt *et al.* (8), Holmich *et al.* (9), LaBella *et al.* (10), and Pasanen *et al.* (11)—each of which would contribute data relevant to this review and meta-analysis.

The choice of calculating injury rates relative to exposure time versus an absolute measure of injuries remains a complex matter. Approaches to control group instructions are greatly diverse in sports injury prevention studies. In the ten studies included by Soomro *et al.* none of the control groups performed activities equal to intervention groups in duration. Seven control groups practiced as usual and three control groups performed sham interventions, however in all cases the durations for these controls were lesser than their corresponding intervention groups. This creates an analytical problem when time spent on the content of the intervention is included as exposure time. Mathematically, this results in a beneficial relative risk estimate, even in the event that the intervention in reality was ineffective—as the intervention group will have their number of injuries divided by a larger exposure time in the calculation of an injury rate than will the control group. We also consider it debatable to equate all exposures as they often differ significantly in character. Specifically, the risk of injuries during controlled and gradually progressive exercise programs has been shown to be substantially less compared to full training sessions and especially for intensive match exposure. In a study including 4,564 individuals performing a neuromuscular warm-up, Waldén *et al.* remarkably observed no injuries during the intervention (12). We believe absolute analyses of sports injuries, omission of intervention time from exposure hours, or performing sensitivity analyses would provide less biased results. We also consider exclusion of an unknown number of studies merely on the basis of lack of exposure time measures to be controversial.

Adding to the complexity of the discussion regarding precise intervention effects is the tendency towards beneficial injury duration and severity in intervention groups in comparison to control groups (8,13). Soomro *et al.* did to extract data regarding injury characteristics. Reporting and analysis of complete injury details remain highly relevant as muscle sprains/mild overuse injuries and Achilles/ACL ruptures have categorically dissimilar long-term consequences. Reporting of available injury characteristics would, in case incomplete data hinder statistical analysis, enable both qualitative discussion and sensitivity analyses.

Soomro *et al.* concluded that a 32% decrease in injury risk in adolescent team sport is a significant and clinically meaningful reduction. While this holds true, we believe that providing the larger context could add value to the clinical implications of these findings. By design, multi-faceted interventions embody an—"a little bit of everything"—approach to sports injury etiology and mechanisms, based upon varying amounts of training modalities that are effective to different degrees. One challenge to these interventions is that time spent on injury prevention is often restricted by the interest of practicing the sport itself. As such, we consider efficacy of programs equally important to effectiveness. In other words, because less time is spent on each individual component, multi-faceted prevention programs are at risk of diluting the most effective types of training. In a meta-analysis by Lauersen *et al.* (14), three separate exercise modalities—strength training, proprioception exercises, and stretching —were compared to multi-faceted programs. Stretching interventions were unable to significantly reduce the relative risk of sports injuries, while proprioceptive training programs (45% reduction) had a slightly better effect than multi-faceted programs (34% reduction). Strength training programs displayed an impressive injury reduction of just above two thirds (68% reduction) consistently across four studies, which was a statistically significant improvement over multi-faceted intervention studies. Further, strength training programs showed no heterogeneity (I^2=0%). This means that the different strength training programs were equally effective, valid to compare, and able to prevent both acute and overuse injuries.

Referring to *Figure 1*, multi-faceted programs are hypothesized to affect more risk factors than strength training. However, as strength training studies consistently achieved superior relative risk estimates, it can be inferred that the listed risk factors are not equally important and that strength training affects the more important risk factors to a larger degree than multi-faceted studies. Since

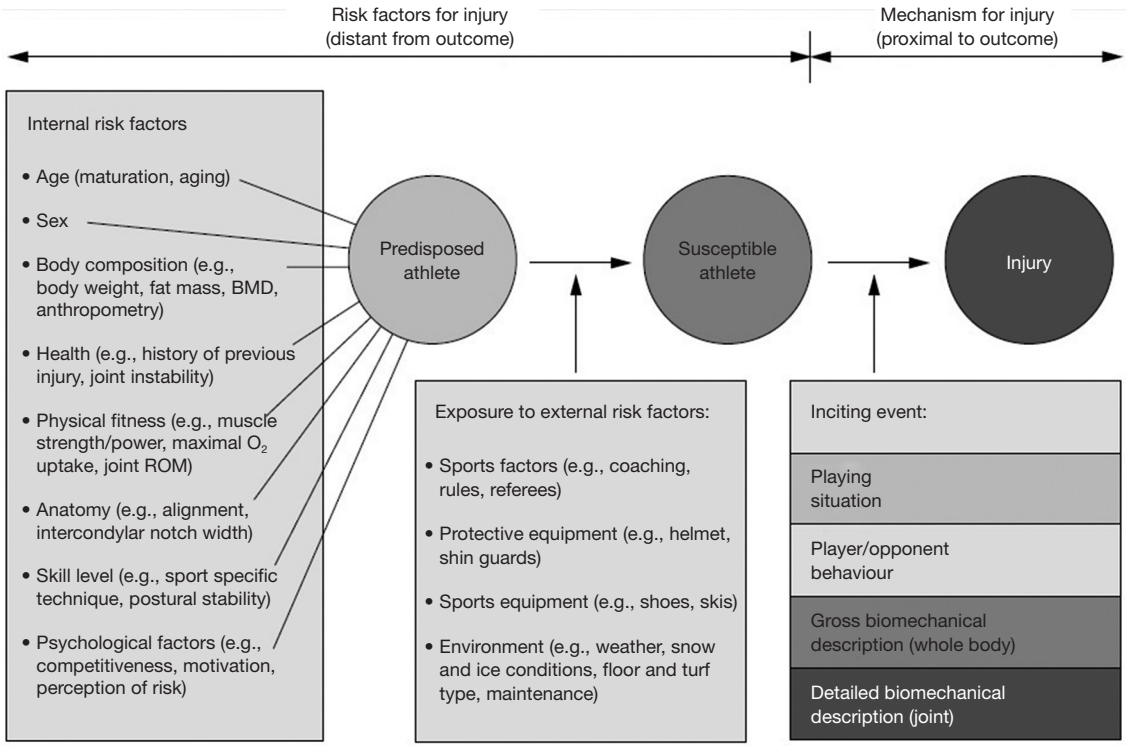

Figure 1 Comprehensive model for injury causation from Bahr and Krosshaug 2005. BMD, body mass density; ROM, range of motion [Reprinted with permission (4)].

the meta-analysis of Lauersen *et al.* two further strength training prevention programs have been published by van der Horst *et al.* (15) and Zouita *et al.* (16) Both have results in line with the previous four articles. van der Horst *et al.* included 648 amateur male soccer players and performed a 13-week Nordic hamstring program that reduced injury risk by 43%. Zouita included 54 youth elite players in an individual randomized study. Participants were living at the soccer center with the injury prevention program as part of a planned and structured training regimen. They presented what is perhaps the most refined strength training intervention, which managed to include: individualized training programs, preceding technique-familiarization, progressive program phases, relative load-calculations, program variation to avoid monotony and performance plateaus, recovery weeks, forced repetitions (completion of all sets even if assistance was required), and periodization. The program was supervised by a physiotherapist and a reduction of injuries by 69% was found. However, the high quality of this study also raises a question regarding the application of strength training versus multi-faceted programs. While strength training may be markedly more effective than multi-faceted interventions, it also often carries greater demands for technique, motivation, rest-periods, and exertion—each of which are more difficult to implement. Multi-faceted programs may have a place for amateur coaches and teams wishing for a quick and easily implemented prevention method.

In summary

The study of Soomro *et al.* (5) is a methodically well conducted systematic review and meta-analysis, which includes a sophisticated method to adjust for publication bias. Soomro *et al.* showed a clinically important reduction in injuries in multi-faceted studies, which have been the main trend during the last decade. That said, injury prevention results and research still carry potential for further improvements. Within recent years several studies on strength training for injury prevention have emerged and focus has, in our view, appropriately shifted towards analyzing the separate training modalities and

implementation methods more specifically. On the basis of these developments, together with the Lauersen *et al.* (14) review and meta-analysis, we strongly advocate strength training to be the cornerstone in most, if not all, injury prevention programs. However, we agree to add the favorable facets of proprioception and coordination exercises, depending on sport and individual, together with other training modalities that are able to stand the test of separate scrutiny.

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