

How Fundamental Knowledge Aids Implementation: Ankle Sprains as an Example



O Contributo do Conhecimento Fundamental na Prevenção e Tratamento de Lesões: o Exemplo das Entorses do Tornozelo

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ABSTRACT

Over the years a number of high quality studies has established the effectiveness of external measures (tape, brace) and neuromuscular training for the prevention of ankle sprains. The general conclusion derived from these studies is that recurrent ankle sprains can be effectively prevented using any of these measures, and that measures are cost-beneficial. Nevertheless, despite the commonness of this type of injury and the availability of effective measures, implementation of prevention in clinical practice is lagging behind. In addition, although proven effective, a link between biomechanical and neurophysiological adaptations as a function of preventive measures, leading to clinical and functional improvements and ultimately ankle sprain recurrence prevention, has never been fully made. The current evidence on ankle sprains and their prevention provides ample opportunities to pursue a translational approach through which fundamental knowledge will provide guidance to specify the effective preventive program to its bare essentials and decrease user-burden while retaining full effectiveness.

Keywords: Ankle Injuries; Sprains and Strains.

RESUMO

Ao longo dos últimos anos, um conjunto de estudos de elevada qualidade demonstrou a eficácia de medidas como suportes externos (ligaduras funcionais e estabilizadores) e treinamento muscular na prevenção de lesões da tibiotalar. Estes resultados sugerem que a recorrência de entorses do tornozelo pode ser prevenida de um modo eficaz através do uso destas medidas, as quais apresentam uma relação custo-benefício favorável. Contudo, embora estas lesões sejam muito comuns e exista uma disponibilidade de medidas eficazes, verifica-se que a implementação de estratégias de prevenção na prática clínica tem sido algo desprezada. Além disso, nunca foi implementada uma relação entre as adaptações biomecânicas e neurofisiológicas enquanto medida preventiva, embora existam evidências que comprovam a sua eficácia na melhoria clínica e funcional e, em último caso, na prevenção da recorrência de entorses do tornozelo. A evidência atual sobre esta lesão e sua prevenção oferece amplas oportunidades para fomentar uma abordagem translacional através da qual o conhecimento fundamental providenciará orientações para especificar programas de prevenção eficazes e acessíveis.

Palavras-chave: Lesões do Tornozelo; Entorses e Distensões

INTRODUCTION

Ankle sprains are the most common sports and physical activity (PA) related injury.¹⁻⁴ It has been estimated that about 25% of all injuries across all sports are ankle injuries. Of all ankle injuries 85% involve the lateral ankle ligaments, i.e. acute lateral ankle sprains. Previous cost-effectiveness data⁵ have shown that, disregarding the requirement of medical treatment, the mean total (direct and indirect) cost of one ankle sprain is approximately €360. In addition, there is extensive evidence that there is an up to twofold increased risk for ankle re-injury during the first year post-injury.⁶⁻⁹ In about 50% of all cases recurrences may result in disability and can lead to chronic pain or instability, requiring prolonged medical care.¹⁰

Research has shown that both externally applied supports (i.e. taping or bracing of the ankle), as well as neuromuscular training (NT) programs are very successful in preventing recurrent cases of ankle sprain, both from an effectiveness, as well as cost perspective.¹¹⁻¹⁵ About half of all recurrent sprains can be prevented.¹²

However, despite our vast knowledge on the effectiveness (i.e. the preventive potential) of preventive measures,

we are lacking crucial translational insight into the working mechanisms of these measures.¹⁶ Moreover, despite ankle sprains being the single most common athletic injury and despite an active approach in implementing our epidemiological knowledge on cost-effectiveness, large-scale community uptake of preventive measures, and thus actual prevention of ankle sprains, is lagging well behind.

From problem to solution

Tugwell et al¹⁷ postulated a research cycle that describes the full pathway from problem statement to effective prevention in practice, including implementation (Fig. 1). In general this cycle states that effective prevention of injuries is the result from a sequence of seven translational steps, ranging in content from fundamental to practical. The first step is identifying the burden of disease and the seventh is evaluating a program that provides, by implementation, health benefits in the real world. If one substitutes 'disease' with 'ankle sprains', gaps arise in this translational research cycle. With regards to ankle sprains there is an abundance of knowledge of step 1 (burden of disease)¹⁻⁴ and a vast

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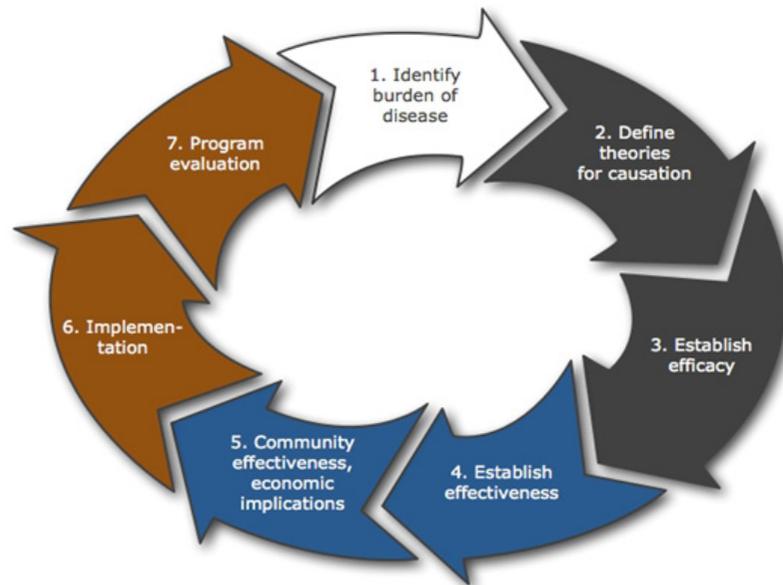


Figure 1 - The research cycle of Tugwell et al.¹⁷ In this model, there are seven distinct steps. The first is identifying the burden of disease and the seventh is evaluating the implementation of a program that provides health benefits in the real world (e.g. a prevention program for ankle sprains).

knowledge base on steps 4 (effectiveness) and 5 (cost-effectiveness).¹¹⁻¹⁵ However, etiological (causation) and efficacy evidence is lagging behind, and implementation knowledge and program evaluation is completely lacking.

With a lack of efficacious evidence, preventive measures against ankle sprains target a broad range of causal theories and cannot be optimized to the end-users needs and possibilities, hampering successful implementation of (cost) effective measures.

Proprioception?!

As stated before, it has been well documented that athletes who experience an ankle sprain have a higher risk of re-injury within 1 year post-injury.⁶⁻⁹ This increased injury risk after an initial ankle sprain is generally thought to be caused by a proprioceptive impairment in the ankle due to trauma to mechanoreceptors of the ankle ligaments after an ankle sprain.¹⁸ Partly based on this rationale, NT is widely used for rehabilitation after an ankle sprain, and is thought to improve proprioception by re-establishing and strengthening the protective reflexes of the ankle.^{19,20}

In a variety of sports, multiple studies have looked at the effectiveness of NT for the prevention of ankle sprains.¹² A common finding in these studies is that NT reduces the increased injury risk for ankle sprains in athletes with a previous injury to the same level as athletes without any history of ankle sprains.^{21,22} Athletes without a previous injury do not seem to benefit from such a training²³. Thereby, these studies provide indirect evidence that NT indeed improves ankle proprioception after an initial ankle sprain. However, a 'true' effect on ankle proprioception due to NT can only be established through biomechanical and neurophysiological analyses, looking at the pathway of morphological (i.e. changes in ankle form and structure) and neurophysiologi-

cal changes (i.e. changes in neuromotor system function) of the ankle, leading to clinical and functional effects (i.e. changes in physiological activity of the ankle, e.g. postural sway).

External prophylactics

In addition, compared to NT, external prophylactic measures (bracing or taping) are arguably equally effective in reducing ankle-sprain recurrence risk.¹² However, such external measures have a seemingly different pathway through which they achieve this secondary preventive effect. External measures for the ankle joint have initially been designed with the aim of mechanically restricting the abnormal ankle range of motion. Given the etiology of ankle injuries, it is believed, historically, that the support system that provides the best mechanical restriction is also the system that is superior in preventing ankle injuries. However, the superior mechanical properties of braces as opposed to ankle taping do not in epidemiological studies translate to differences in preventive effects.^{24,25} Based on outcomes from clinical and mechanical studies, it is more likely that external measures act primarily by supporting the impaired neuromuscular function after an ankle sprain rather than by mechanically restricting ankle range of motion; for instance through stimulation of skin receptors, thereby providing an alternative neural pathway that compensates for impaired ligament proprioception. Again, such a suspected mechanism can only be established through biomechanical and neurophysiological analyses.

Laboratory versus the field

In contrast to the epidemiological studies on the preventive effect of NT and external measures, which are characterized by large cohorts and prospective study design with

a long follow-up, most biomechanical and neurophysiological studies rely on small sample sizes, mixed study designs and single outcome measures. Therefore, it is not surprising that the number of these studies reporting changes in ankle functioning due to a preventive measure matches the number of studies failing to show such changes.^{16,26} Additionally, a common critique on the more 'fundamental' studies that do provide positive outcomes is that the studied measure or program has not been linked to an effectiveness outcome. A link between biomechanical and neurophysiological adaptations, leading to clinical and functional improvements, and ultimately ankle sprain recurrence prevention has never been fully made.

Added to this 'etiological' knowledge gap, true prevention of ankle sprain recurrences by wide-scale implementation of cost-effective intervention measures under real life conditions proves to be an ongoing 'other' challenge. This challenge can be derived, for instance, from the Dutch injury rates registered by the Dutch Consumer Safety Institute,⁴ indicating that ankle sprain rates are level over the years. This is despite the availability of easy to use, cheap and effective preventive measures. Multiple efforts to implement ankle sprain preventive measures in Dutch sports have been undertaken, with mixed success. A general critique is that results of efficacy and effectiveness studies are translated literally from the respective efficacy and effectiveness studies to the field of practice. Although efficacy and effectiveness research is a necessary first step before implementation questions can be answered the controlled nature of efficacy and effectiveness research hampers generalization of thus attained results to a practical, real life setting.²⁷ Positive results are seldom fully adopted by a target population, indicating that in order to truly impact the active individual's health, more (implementation) research effort should be placed on translating efficacious preventive methods to practice.

The latter has been recognized by multiple authors, calling for a more behavioral approach towards sports injury

prevention.²⁸⁻³¹ Despite this, the role of behavior in sports injury prevention remains under-researched.^{28,29,32} Combining the meager literature on this topic with knowledge from injury prevention in general, health promotion and common sense, it is possible to get some notion of the types of relationships that can exist between behavior and injury risk, and of the different pathways through which behavior may affect injury risk.^{28,33,34}

The way forward

To push preventive in practice forward we require a more integrated and translational approach to bridge the gaps between on the one side effective preventive measures and the underlying working mechanisms, and on the other side between effective preventive measures and true injury prevention in every day practice (Fig. 2). In regards to ankle sprains, our group recently finished the 2BFit study, a randomized controlled trial on the effectiveness of an 8 week unsupervised NT program for the prevention of recurrent ankle sprains.^{14,15} This particular program was a further elaboration from a previous study we conducted.^{5,11} In these two studies this NT program has now been proven (cost) effective for the prevention of ankle sprain recurrences. As such, we now have an epidemiologically sound effective preventive NT program that can be used to unravel preventive pathways as well as effective prevention in practice.

We know that this NT program reduces injury risk in recently injured athletes. Therefore, in a laboratory setting we can specifically study changes induced by the program in recently injured athletes, as compared to healthy athletes. This will provide information on which etiological factors are positively affected, which specific exercises of the program induce this effect, and the required frequency and duration of exercises for the NT program to be effective. The latter is required as the current effective NT program is a container of different exercises targeting strength, proprioception and agility in an 8 week program prescribing 3 exercise sets

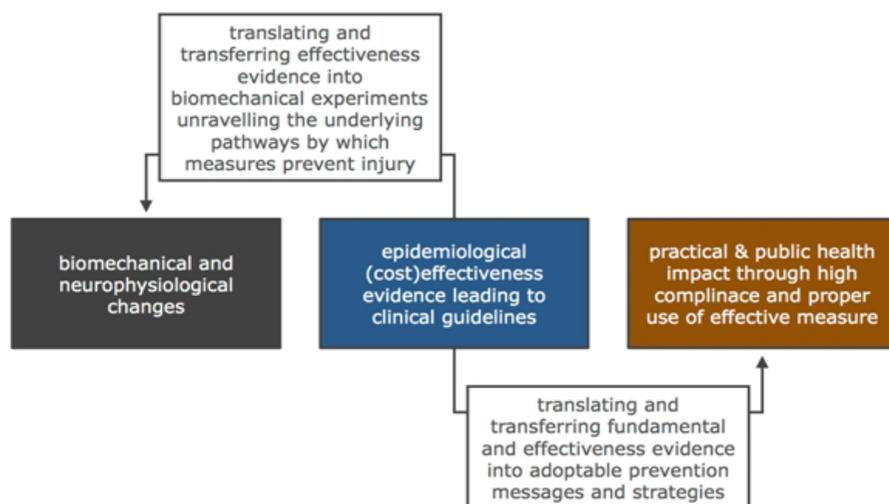


Figure 2 - A schematic description of the proposed translational approach with a (cost) effective preventive measure as the starting point of fundamental and implementation goals.

per week. Not surprisingly full compliance to prescribed program was low, even in controlled studies. Through this approach, fundamental knowledge will provide guidance to specify the NT program to its bare essentials and decrease user-burden while retaining full effectiveness. This will give us an effective and useable intervention message to be implemented.

Such a translational approach will complete the gaps in the Tugwell research cycle,¹⁷ from problem statement to practical solution, providing the first ever full research cycle for sports and physical activity related injury prevention. The current evidence on ankle sprains and their prevention pro-

vides ample opportunities to pursue this approach and to provide an example for a broader range of topics within the field of injury prevention in physical activity and sports.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest in concern to this article.

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