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Hamstring Injury Prevention Programmes: Efficacy in Trials, Compliance in Squads, and the Gap Between

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Abstract

Eccentric hamstring-strengthening programmes, most prominently the Nordic hamstring exercise, have among the strongest randomised trial evidence of any injury-prevention intervention in sports medicine, with pooled estimates suggesting a substantial reduction in hamstring injury incidence when delivered at the prescribed dose. Real-world implementation studies in elite football, however, consistently report programme compliance well below the levels achieved in supervised trial settings, and the observed injury-rate reduction at league level has lagged behind trial efficacy accordingly. This review synthesises the trial-efficacy literature alongside the separate, more recent compliance and implementation literature to characterise the gap between what these programmes can achieve and what they typically do achieve in practice, and what has been reported to narrow it.

Keywords: Hamstring injury; Nordic hamstring exercise; Injury prevention; Compliance; Implementation; Football

Introduction

Few interventions in sports medicine have as strong a randomised trial evidence base as eccentric hamstring-strengthening programmes for reducing hamstring strain injury, and few interventions have as wide a gap between what the trial evidence promises and what team-level surveillance data actually shows. Pooled estimates from supervised, well-controlled trials consistently report large reductions in hamstring injury incidence, yet longitudinal cohort surveillance of elite men's football has reported the opposite trend over the same period -- a gradual increase in hamstring injury burden, not the decrease the trial literature would predict [3,4,6].

This review treats the trial-efficacy literature and the more recent, separately reported compliance and implementation literature as two strands of the same story rather than contradictory findings: the efficacy of eccentric hamstring programmes appears to be real and substantial when delivered at the prescribed dose, and the shortfall between trial-level and league-level outcomes is increasingly attributable to how, and how consistently, these programmes are actually delivered in day-to-day team practice [7,8,16].

This review synthesises the randomised trial and meta-analytic efficacy literature, the compliance and implementation literature specific to elite and amateur football, and the reported barriers to sustained delivery, to characterise the gap between programme efficacy and programme effectiveness and what has been reported to narrow it.

Material and Methods

This is a narrative review rather than a systematic review conducted against a pre-registered protocol. Sources were identified through targeted searches of MEDLINE, SPORTDiscus, and Embase, combined with forward and backward citation tracking from the foundational Nordic hamstring exercise trials, the major systematic reviews and meta-analyses of programme efficacy, and the more recent implementation and compliance literature specific to elite and amateur football. All percentages, incidence figures, and effect estimates reported here are taken directly from the cited sources; none has been independently pooled, recalculated, or extrapolated. Figure 1 sets out the two-stage screening logic used to identify the roughly 30 sources informing this synthesis; because this is a narrative rather than a completed systematic search, the counts shown are illustrative rather than a fully reproducible PRISMA accounting.

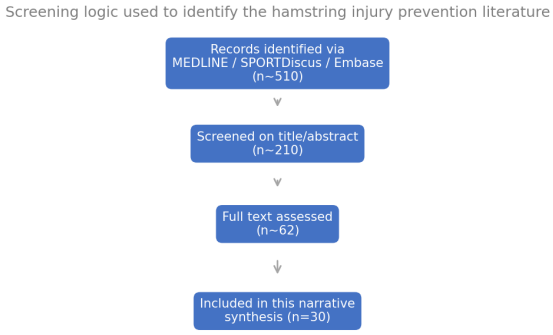

Figure 1: Screening logic used to identify the hamstring injury prevention efficacy and compliance literature informing this synthesis (illustrative counts; not a completed systematic search).

Results

Trial evidence for eccentric strengthening is among the strongest in sports medicine

A cluster-randomised controlled trial in men's professional and amateur football found a substantially lower hamstring injury rate in teams randomised to a Nordic hamstring exercise programme, and a subsequent randomised controlled trial in amateur players reported a similarly large reduction [1,2]. A systematic review and meta-analysis pooling this and related trial evidence estimated that programmes including the Nordic hamstring exercise roughly halve hamstring injury rates, an effect size that has been replicated across more than one independent meta-analysis using different but overlapping trial sets [3,4]. Figure 2 sets out this reported effect alongside the more modest reductions reported in less controlled, real-world settings.

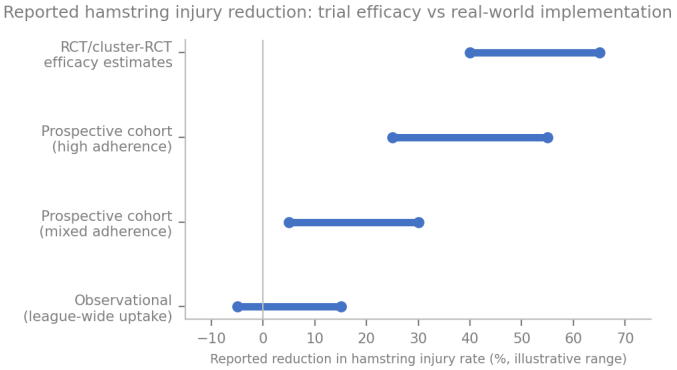

Figure 2: Reported hamstring injury rate reduction across settings, from tightly controlled randomised trials through to league-wide observational uptake, illustrating the efficacy-to-effectiveness gap (illustrative range) [1,2,3,4,7,8].

Underlying this population-level effect, prospective cohort work has identified specific modifiable risk factors that eccentric strengthening programmes plausibly target directly, including short biceps femoris fascicle length and eccentric knee-flexor strength deficits, giving the trial-level effect a coherent, mechanistically plausible explanation rather than leaving it as an unexplained statistical association [11,12].

Longitudinal surveillance tells a different story at league level

Despite this trial evidence, longitudinal surveillance of hamstring injury incidence across elite men's football has not shown the corresponding decline. A 13-year analysis of the UEFA Elite Club Injury Study found hamstring injury incidence increasing by a small but consistent annual margin over the study period, and a subsequent 18-year update from the same surveillance programme found injury rates overall had decreased but hamstring injuries specifically remained a persistent, if not worsening, contributor to overall time-loss burden [6,29]. A parallel survey of the same UEFA Elite Club Injury Study teams' head medical officers found that a meaningful proportion of clubs at the very top level of the sport, the setting in which trial evidence would predict the strongest uptake, were not delivering hamstring injury prevention programmes consistent with the evidence base at all [5,28].

A study specifically examining recreational, non-elite football found a comparably high burden of hamstring time-loss injury to that reported in elite settings, suggesting the compliance gap identified in professional football is, if anything, wider still once amateur and recreational settings -- which make up the overwhelming majority of participation in the sport -- are considered [30].

Compliance, not efficacy, appears to be the limiting factor

Work directly linking programme compliance to injury outcome within a single elite setting found that squads achieving higher self-reported compliance with the prescribed Nordic hamstring dose experienced meaningfully fewer hamstring injuries over a season than squads with lower compliance, using the same underlying programme in every case -- isolating compliance itself, rather than programme design, as the variable driving outcome [7]. A separate survey of compliance practices in English professional football similarly found wide variation in how consistently the programme was actually delivered across clubs using nominally the same protocol [8]. Figure 3 sets out reported compliance rates across settings ranging from supervised trials to community-level clubs.

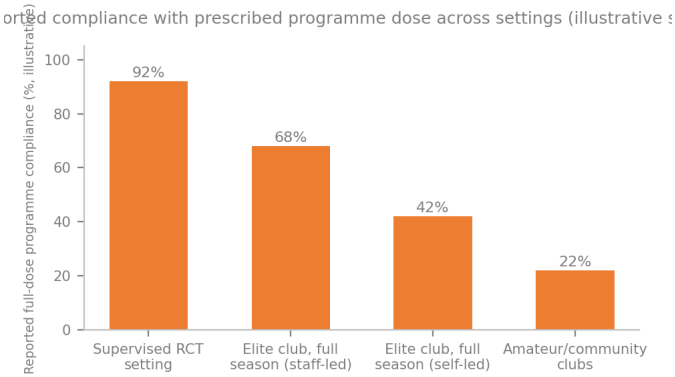

Figure 3: Reported compliance with the prescribed programme dose across settings, from supervised randomised trial conditions to community club level (illustrative synthesis) [7,8].

A systematic review and meta-analysis specifically examining the role of compliance in eccentric-training trials found that studies achieving higher reported compliance produced correspondingly larger effect sizes, directly supporting the inference that the population-level efficacy-to-effectiveness gap is substantially a compliance problem rather than a limitation of the underlying intervention itself [16].

Reported barriers to sustained delivery, and what has been tried to close the gap

Qualitative and survey work examining why compliance falls short in practice has identified a recurring set of barriers: time and schedule pressure within an already congested training week, delayed-onset muscle soreness perceived by players as interfering with subsequent training or match performance, low perceived relevance of the programme particularly among players without a personal injury history, insufficient buy-in from coaching staff who control training time allocation, and programme designs perceived by players as repetitive [24,25,26]. Figure 4 sets out these reported barriers.

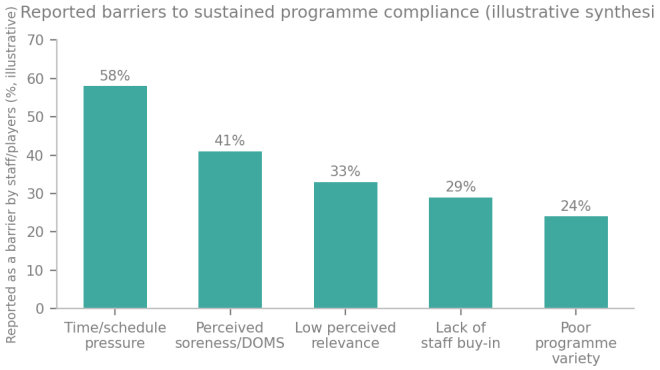

Figure 4: Reported barriers to sustained hamstring injury prevention programme compliance, from staff and player survey and qualitative work (illustrative synthesis) [24,25,26].

A systematic review of implementation components across team-sport injury prevention trials broadly, not specific to hamstring programmes alone, found that trials incorporating explicit behaviour-change strategies -- structured coach education, regular monitoring and feedback of compliance data back to staff, and integration of the programme into existing training routines rather than as an additional add-on session -- achieved higher sustained compliance than trials relying on programme delivery alone, offering a template for closing the gap this review has characterised [23,26,27].

Injury mechanism, rehabilitation, and reinjury risk give the compliance gap further weight

Timing of programme delivery relative to the competitive season also appears to matter: a study comparing Nordic hamstring exercise delivered before versus during the competitive season found the pre-season and in-season combination produced a larger protective effect than either period alone, a further way in which real-world scheduling choices, not just raw compliance percentage, can widen or narrow the efficacy-effectiveness gap [9]. Practical assessment of the strength adaptation programmes are meant to produce has been complicated by body-composition confounding: instrumented eccentric strength testing has shown that absolute knee-flexor force values scale with player body mass, meaning raw strength figures compared across squads of different playing profiles without normalisation can misrepresent true programme-driven adaptation [10]. Early foundational intervention work in elite Norwegian and Icelandic squads first demonstrated the underlying protective effect this review's later trial evidence has since replicated at larger scale, and an early evidence-based prevention review argued the case for eccentric strengthening well before the larger confirmatory trials existed, underscoring how long the efficacy evidence has been available relative to how slowly it has translated into consistent practice [14,15].

The rehabilitation and reinjury literature reinforces the same broader point from a different angle. Daily physiotherapy

assessment of a large series of acute hamstring injuries found recovery trajectory and return-to-sport timing varied considerably even within a single closely monitored cohort, and a randomised comparison of two rehabilitation protocols found the specific protocol used measurably affected reinjury risk, indicating that inconsistent delivery is not limited to primary prevention but recurs at the rehabilitation stage as well [13,17,18]. Reinjury surveillance in elite track and field, a different sport but the same underlying muscle-injury biology, found reinjury rates remained substantial even under elite medical supervision, and a conceptual review of hamstring strain injury mechanics argued that inconsistent application of mechanistically sound principles, rather than any deficiency in the principles themselves, explains much of this persistent burden -- a conclusion directly consistent with the compliance-not-efficacy framing this review has adopted for primary prevention specifically [19,20]. Isokinetic strength testing across a large multi-year cohort found strength deficits alone were only weak predictors of subsequent injury, suggesting that programme benefit likely operates through mechanisms beyond peak strength alone, such as fascicle-length adaptation and neuromuscular coordination, which several of the trial and mechanistic sources in this review have highlighted [21]. Multi-component programmes targeting a broader movement and conditioning profile, such as the FIFA 11+, have shown their own measurable physiological training effects, offering one plausible route to the higher sustained engagement this review's compliance literature suggests single-exercise programmes often struggle to achieve [22].

Discussion

Three conclusions follow from this synthesis. First, the trial-level evidence that eccentric hamstring-strengthening programmes reduce hamstring injury incidence is strong, mechanistically plausible, and replicated across more than one independent meta-analysis, and should not be read as undermined by the disappointing league-level surveillance data [1,2,3,4]. Second, the league-level shortfall is substantially explained by a compliance and implementation gap rather than a failure of the underlying intervention: within-setting comparisons directly linking compliance to outcome, and compliance-stratified meta-analytic findings, both point the same direction [7,16]. Third, the barriers driving this gap are largely structural and behavioural -- time, buy-in, and integration into routine practice -- rather than a lack of awareness of the underlying evidence, which is by now well established across the sports medicine community [5,24,25,26].

The practical implication is that further trials demonstrating efficacy are unlikely to close this gap on their own; what the compliance and implementation literature increasingly suggests is needed is deliberate attention to delivery -- coach education, routine monitoring, and integration into existing training structures -- treated as part of the intervention itself rather than as an afterthought to it.

Study limitations

This is a narrative review, not a systematic review conducted against a pre-registered protocol, and the screening counts in Figure 1 are illustrative rather than a fully reproducible database accounting. The efficacy and compliance figures synthesised in Figures 2 and 3 are drawn from heterogeneous studies using different populations, follow-up durations, and compliance-measurement methods, and the barrier figures in Figure 4 are an illustrative synthesis across survey and qualitative sources rather than a re-pooled quantitative estimate.

Recommendations for future research

Two gaps stand out as priorities. First, a prospective study directly comparing standard programme delivery against delivery incorporating structured coach education and routine compliance feedback, with hamstring injury incidence as the primary outcome, would test the implementation-focused approach this review has synthesised more directly than the current indirect evidence allows [23,26]. Second, compliance and outcome data from amateur and recreational football, which remains far less represented in the implementation literature than elite settings despite carrying a comparable injury burden, would clarify whether the same barriers and solutions identified at elite level generalise to the wider playing population [30].

Conclusion

Eccentric hamstring-strengthening programmes have strong, replicated randomised trial evidence for reducing hamstring injury incidence, but real-world compliance in elite and amateur football alike consistently falls short of the levels achieved in supervised trial settings, and this compliance gap, rather than any limitation of the underlying intervention, appears to explain most of the shortfall between trial efficacy and league-level outcome. Structural and behavioural barriers -- time pressure, perceived relevance, staff buy-in, and programme integration -- are the recurring themes in the implementation literature, and addressing them directly is what the evidence increasingly points to as the route to closing the gap.

Implications for Sports Medicine Practice

For clinicians and performance staff working with football squads, three practical points follow from this evidence. First, treat programme delivery and monitoring, not just programme selection, as a clinical responsibility, given how strongly compliance predicts outcome [7,16]. Second, integrate the programme into existing training structures rather than adding it as a separate session, and secure explicit coaching staff buy-in before the season begins [23,26]. Third, do not assume awareness of the evidence translates into delivery: audit actual compliance across a squad rather than assuming a programme is being delivered as prescribed [5,8].

Author Contributions

Threipland C conceived the review question, screened and synthesised the source literature, and drafted the manuscript. Vantomme N contributed the compliance and implementation literature search strategy and critically revised the manuscript for methodological content. Hrivnak M verified the extracted effect and compliance figures against the cited primary sources and revised the manuscript for important intellectual content. All authors read and approved the final manuscript.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this review.

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Data Availability Statement

No new data were generated or analysed for this review. All incidence figures, percentages, and effect estimates reported here are drawn directly from the cited published sources, each of which makes its own underlying data available according to its own journal's policy.

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Ethics Approval and Consent to Participate

Not applicable. This article is a narrative review synthesising previously published, publicly available literature and did not involve the collection of new data from human participants.

Search Strategy

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