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Coaches of youth field sports as delivery agents of injury prevention programmes: how are we training the trainers? A scoping review

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ABSTRACT

Objective To systematically map the coach education (CE) component of injury prevention programmes (IPPs) for youth field sports by identifying and synthesising the design, content and facilitation strategies used to address competency drivers and behaviour change.

Design Scoping review.

Data sources PubMed, PsycInfo, EMBASE, CINAHL, SportDiscus and Google Scholar electronic databases were searched using keywords related to IPPs and youth field sports.

Eligibility criteria for selecting studies Studies of IPPs in youth field sports, that provided 'train-the-trainer' education to coaches as designated delivery agents.

Results 20 studies from two field sports (soccer/football; n=17, Rugby Union; n=3) fulfilled the eligibility criteria. Eleven CE interventions occurred in the preseason and 18 occurred at one time-point (single day). Five studies cited use of a behavioural change theory or model in the design of their CE, most frequently the Health Action Process Approach model (n=5); and use of behavioural change techniques varied. Twelve of twenty studies (60%) reported some form of ongoing support to coaches following the CE primary intervention concurrent with IPP implementation.

Conclusion CE that occurs on 1 day (one time-point) is most popular for preparing coaches as delivery agents of IPPs in youth field sports. While recognising pragmatic barriers, more expansive in-service training, support and feedback may enhance the effective implementation of IPPs.

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WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ A range of sport-specific injury prevention programmes (IPPs) have been developed and are efficacious in reducing injury risk in youth field sport athletes.
⇒ These efficacious IPPs are typically not being adopted, implemented or maintained at the optimal weekly dosage in the real-world context.
⇒ A 'train the trainer' model is typically employed to upskill coaches as delivery agents of IPPs.

WHAT THIS STUDY ADDS

⇒ Of the 20 studies included in the review, few studies (n=5) report the use of a behaviour change theory in the development and implementation of the coach education (CE) component of IPPs.
⇒ In-service training and coach performance assessment are not a characteristic of most IPP CE despite being core components of competency as a driver of implementation.
⇒ Future research should explore the potential impact of enhanced in-service support and feedback to increase coach competency with the understanding that pragmatic issues such as funding, coach time and personnel resources may be limitations. In addition to addressing competency as an implementation driver, more frequent use of a behavioural change theory is needed to facilitate sustainable implementation.

INTRODUCTION

The risk of injury in contact and collision sports is high.[1–3] Stakeholders may seek to reduce injury rates for various reasons: improved performance,[4 5] maximising player availability, addressing long-term youth athletic development,[6 7] economic benefit[8] and enhancing player welfare.[9] Targeted injury prevention programmes (IPPs), which typically consist of various training exercises, aim to improve muscular strength, proprioception and flexibility among other factors to better prepare athletes for sport participation.[10]

Reductions in musculoskeletal injury incidence have been achieved in youth populations across field sports such as soccer[11 12] and Rugby Union.[13] However, an implementation issue has emerged in effectiveness research whereby adherence of teams to these IPPs is lacking and thus optimal efficacy on injury rates is not fully realised.[14] The concepts of efficacy and effectiveness are distinct in that efficacy trials seek to establish the performance of an intervention under *ideal* conditions, while effectiveness trials seek to establish this performance under 'real-world' conditions.[15]

The challenge of implementation in 'real-world' settings appears to dilute the efficacy of these IPPs as a dose–response relationship exists between exposure to IPPs and injury rates. Greater reductions in injury rates occur with weekly exposures to the IPPs of two to three times per week (50% and 60% reductions, respectively) compared with

1 weekly exposure (24% reduction).[16] In the initial trial of the World Rugby-adopted 'Activate' IPP, only 7 of 44 (16%) school Rugby teams in the intervention group completed the prescribed 3+ sessions per week, resulting in 39% fewer match injuries than their less-adherent counterparts that completed the intervention fewer than three times per week.[13] A clear gap appears to be present in the translation of efficacious IPPs to their application and use on the training field. This has been termed the 'research to implementation' gap.[17 18]

Core implementation components or three 'implementation drivers' are required for effective implementation: competency, organisation and leadership.[19] Many of the barriers to implementation reported by delivery agents in sports injury prevention relate to competency drivers.[20–22] Coaches who deliver an intervention to intended users are defined as 'delivery agents'.[23] Coaches are an obvious target as delivery agents within the team environment given their influence over athletic activities, their interest in player availability, their contact time with the intended end-users (players) and their influence towards player knowledge and beliefs of injury prevention.[24]

While coaches describe barriers related to organisation and leadership drivers (such as lack of support from representative bodies or club leadership not prioritising player welfare), barriers related to competency are most frequently reported.[25] Competency drivers are intended to develop the competency and confidence of delivery agents through training, coaching and assessment.[19] Steffen *et al*[26] investigated the adherence rates of teams following differing implementation strategies in a youth female football league. Just 8.9% of coaches that received the IPP *without* education met criteria for 'high adherence' to the programme, in comparison to 52.1% (coach as delivery agents) and 41.1% (coaches as delivery agents assisted by a physiotherapist) that received specific coach education (CE) to enhance programme delivery.[26]

While implementation drivers address infrastructural components, there too is a reliance on behavioural change at the level of the coach for IPPs to be effective.[27] A study of school Rugby coaches across England identified a significantly greater level of adoption (95% vs 54%) and adherence (median 2 sessions vs ≤1 session per week) following attendance at a workshop, the design of which was underpinned by a behavioural change model.[28] Sustained behavioural change is not easily achieved[29] and further investigation of the use of behavioural change theory is warranted in addition to competency drivers.

A pre-season workshop, where coaches are introduced to the IPP and instructed on how to deliver its components to their players, appears to be the most common vehicle used to address the competency needs of coaches in advance of the intended implementation period. Such CE can also be referred to as a 'train the trainer' intervention, a term which is widely used in healthcare research, and refers to 'a program or a course where individuals in a specific field receive training in a given subject and instruction on how to train, monitor, and supervise other individuals in the approach' (p216).[30]

While CE has been present in trial methodology, the concept of CE as an intervention to address competency and behaviour change in injury prevention implementation is an emerging field. Therefore, the primary objective of this scoping review is to systematically map the CE component of IPPs for youth field sports by identifying and synthesising the design, content and facilitation strategies used to address delivery agent competency and behaviour change. Additional aims are to identify the outcome measures used and establish the CE detail and descriptors reported that would allow for intervention replication.

METHODS

Protocol and registration

Owing to the heterogeneity of the available literature and the need to identify the key characteristics of this concept,[31] a scoping review is best placed to systematically review what has been published to date. This scoping review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews checklist and followed the methodological framework of Arksey and O'Malley[32] with updated guidance from Peters *et al*.[31] A scoping review protocol in accordance with the Joanna Briggs Institute was registered on the Open Science Framework.

Eligibility criteria

The following criteria were used to screen studies for eligibility: (1) published in a peer-reviewed journal, (2) full text available, (3) published in the English language or a full-text translation available, (4) coaches of youth athletes (aged between 8 and 19 years), (5) coaches of field sport athletes, (6) coaches of male and/or female athletes, (7) the IPP included neuromuscular training components (eg, stability, agility, strength, neuromuscular control, incremental speed) and be an intentional action or process designed to prevent or reduce injury risk in field sport, (8) coaches as intended primary delivery agents of the IPP, (9) coaches in receipt of a 'train the trainer' CE intervention to prepare for implementation of the IPP. In the case of multiple publications informed by the same CE intervention, the primary manuscript was included only. All related material (protocol, supplementary material, secondary analysis publications) was screened for additional information related to this review's objectives. Studies were excluded if: (1) the research team were designated delivery agents, (2) coaches received a generalised injury information session without instruction on coaching an IPP or (3) coaches were designated delivery agents, but no CE is reported.

Information sources

Database searches were conducted in June 2022 and limited to the following databases: PubMed, SportDiscus, PsycINFO, CINAHL, EMBASE and Google Scholar. The PCC mnemonic (population, concept and context) was used to design the search strategy around the eligibility criteria for each database.

Search

The first author (LG) developed, piloted and conducted the search strategy. A broad review of relevant literature identified appropriate subject headings and keywords and the search strategy was adapted for each database. Main search terms included: (injur* OR concuss*) AND (prevent* or reduc*) AND (coach* OR delivery agent) AND (workshop OR education) AND (youth OR adolescen*) AND (sport OR field sport). The search strategy for one database is included in online supplemental file 1. All results from each database were transferred to a bespoke Microsoft Excel file prior to screening, while the first 10 pages of Google Scholar results only were extracted as a supplementary database.[33]

Selection of sources of evidence

After exporting search results to Excel, duplicates were removed. The first author (LG) independently completed title and abstract screening, while full-text screening was

conducted initially by the first author (LG) and then blind-reviewed by coauthors (ICK, KO'S and TC). Screening of reference lists of full texts for relevant titles was also conducted. After the completion of full-text screening (κ=0.65; substantial agreement[34]), the authors discussed conflicts related to eligibility criteria and discrepancies in decisions (n=10). These discrepancies related to (1) if interaction with coaches was related to data collection procedures only; (2) possible duplication of CE components; and (3) explicit coach designation of delivery. The first author contacted the listed corresponding authors of these publications to clarify. Eight of ten corresponding authors responded. The two that did not, were not included. Following this, all authors were satisfied with the papers selected for inclusion.

Data charting process

The first author developed a data charting tool in collaboration with coauthors to address the objectives of this review. All study extraction was completed by the first author. Data were extracted from the primary manuscript first, then related publications (protocol, supplementary material, secondary analyses) were reviewed but only the primary manuscript is listed in included papers. The first author then transferred extracted data to a word document in tabular format. This was sent to all 20 corresponding authors of the included studies and additional information was requested as word counts may have limited the detail reported. Fifteen corresponding authors did provide additional information, five did not.

Data were extracted on study characteristics (ie, authors, publication year, country of study, sport coached, coaching setting, age of adolescents coached, IPP name, IPP objective, study aims), CE logistics (ie, when, where, how often, group/individual, duration, mandatory or voluntary attendance, player attendance), design and facilitation (ie, mode of delivery, who designed the CE, what informed the CE design, who facilitated the delivery of the CE), content and methods of delivery (ie, topics, teaching methods, resources provided), within-study follow-up and evaluation (ie, support offered to coaches during the implementation period, evaluation of coach delivery) and coach-specific outcome measures, where compliance and adherence were only included if this was coach-reported.

The Template for Intervention Description and Replication (TIDieR) checklist was used to evaluate how complete the reporting was.[35] The first author (LG) in collaboration with one coauthor (KO'S) modified the checklist to better fit the possible detail reported across CE interventions. The modified TIDieR used is available in online supplemental file 2. Each item was marked as 'complete' (very clear, obviously stated, easily replicable and the paper reported consideration of the item), 'incomplete' (missing sufficient detail to replicate and report of consideration of the item in method design was omitted) or not applicable (n/a) if the evaluation of this item was not possible given the study design. The first author (LG) reviewed each included paper in the application of the TIDieR checklist and included the reporting of additional detail in evaluation only when directly referred to in the primary manuscript. TIDieR evaluation occurred prior to the corresponding author contact so as not to bias evaluation. Following completion of the TIDieR evaluation, the third author (KO'S) reviewed 25% of papers (randomly selected) to cross-check consistent application of criteria and any conflicts in judgement were addressed until no such conflicts remained. The approach derived from this process was applied to the remaining papers.

Synthesis of results

Data extracted from the included papers and any additional information gathered from authors were summarised, grouped based on the extraction categories and presented narratively.

Equity, diversity and inclusion statement

Our research and author team included one female (lead author) and six males, comprising both senior and less-experienced researchers from a variety of disciplines. Study populations included youth athletes regardless of gender with cohorts included from Europe, North America, Oceania, the Middle East and Africa.

RESULTS

Study selection

The electronic database search yielded 6335 records. Twenty studies were included in this review after title, abstract and full-text review (figure 1). Study characteristics are outlined in table 1. The sports included were soccer/football (n=17)[5 11 12 36–49] and Rugby Union (n=3).[13 28 50] Coaches worked with male athletes (n=8),[5 13 28 36 42 45 48 49] female athletes (n=6)[11 12 37 39 44 47] and both male and female athletes (n=6).[38 40 41 43 46 50] Fifteen of 20 studies implemented the IPPs in a club setting,[5 11 12 36–38 40–48] four in a school setting[13 28 49 50] and one in a national talent pathway system.[39] Nine of twenty studies asked coaches to implement a version of the FIFA 11+,[11 12 36 38 42 44 45 48 49] three studies asked coaches to implement a version of the 'Knee Control' programme.[5 43 47] The sex of included coaches and intended end-users (players) varied across all studies. The primary aim of the included papers is reported in table 1.

Logistics of CE

Just over half of studies (n=11) referred to the CE intervention as a 'workshop'.[12 13 28 37–39 41 44–46 50] At least one player attended the full CE session to act as models in five studies[11 13 42 43 47]; they were present for a portion of the CE in two studies[5 40]; they were not in attendance in eleven studies[12 28 38 39 41 44–46 48–50] and it was unclear/unreported in two studies.[36 37] Most CE interventions occurred in the preseason (55%),[5 11 12 28 37–39 44–46 50] one occurred at the beginning of the season,[43] six occurred prior to the start of the intervention period but the time of playing season was not reported[13 40–42 47 49] and two did not report.[36 48] All CE took place face to face. Eighteen of twenty CE interventions occurred at one time-point (one workshop/one session on a single day).[5 11–13 28 37–39 41 43–50] Two were unreported or unclear as to when their CE took place.[36 42] The duration of CE ranged from 30 min[37] to over 6 hours[48] (table 2).

Design and facilitation

Fifteen studies did not explicitly refer to or report a theoretical basis for their CE intervention.[5 11 12 36 37 39–43 45–49] Five studies cited a behaviour change model/theory: four of these used the Health Action Process Approach (HAPA)[13 38 44 50] while one study used HAPA alongside Bandura's theorised sources of self-efficacy.[28] Experiential learning (ie, peer coaching on a pitch) was evident in seven studies,[11 28 38 41 45 46 50] practical instruction/didactic teaching methods only were reported in

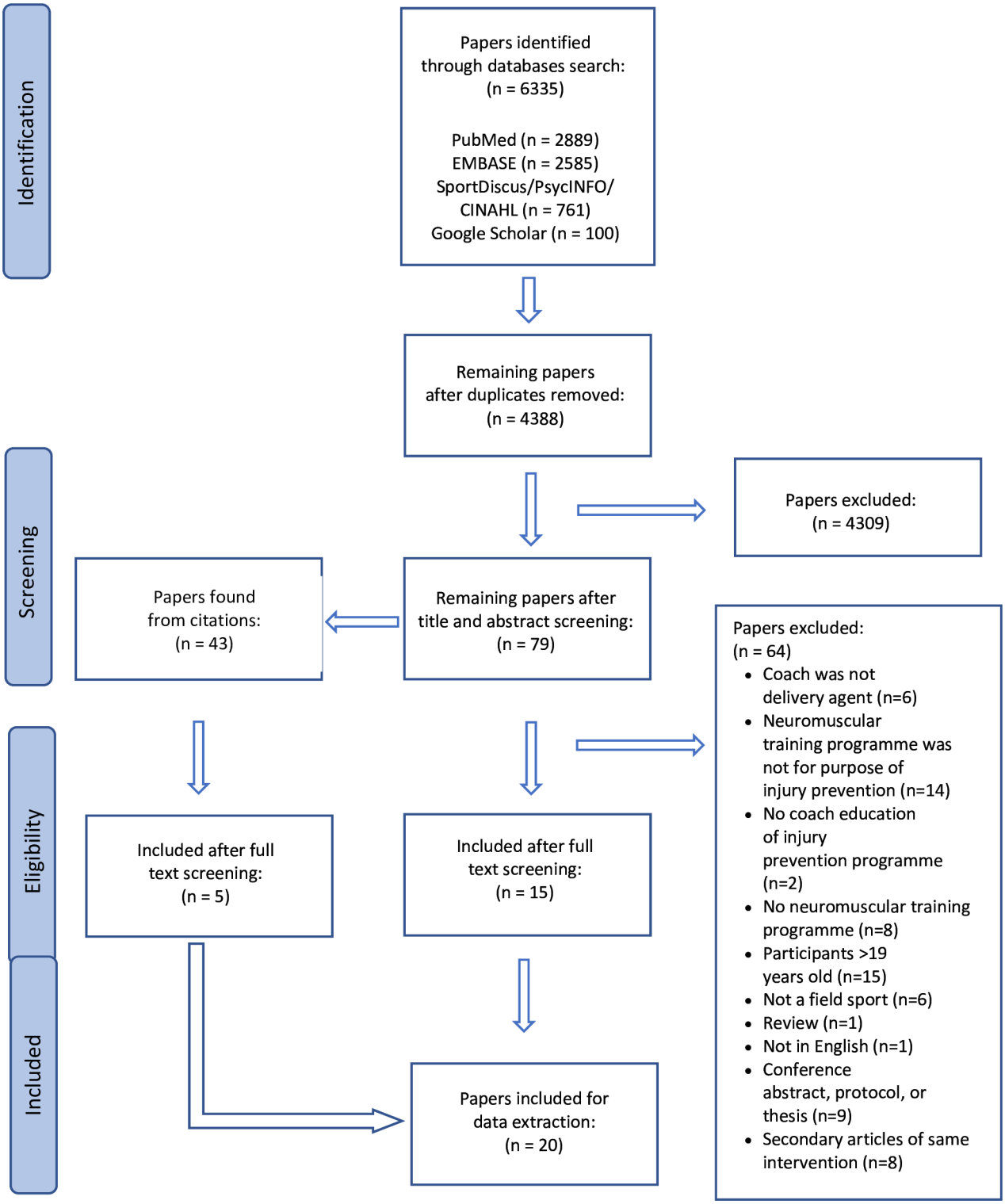

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of the selection of included papers.

ten studies[5 12 13 37 39 40 43 44 47 49] and no teaching methods were reported in three studies.[36 42 48] Teaching methods/behaviour change techniques used are outlined in table 2. The authors or other researchers from a variety of backgrounds (coaching, physiotherapy, sport science, physiology) facilitated the CE in 15 studies,[5 11 13 36–41 44–47 49 50] physiotherapists or physical therapists facilitated in four studies,[5 12 38 43] community coaches from the sporting organisation external to the research group facilitated in one study,[28] and facilitators were not reported in two studies.[42 48] Resources (hard and soft copy) were supplied to coaches in 18 studies[5 11–13 28 37–41 43–50] and unreported in two[36 42] (online supplemental file 3).

Follow-up and evaluation

Twelve of twenty studies reported some form of ongoing support to coaches following the CE primary intervention concurrent with IPP implementation.[5 11 12 36 37 39–41 45–47 49] The

Table 1 Study characteristics

Authors	Country	Sport	Age	Setting	IPP name	Study primary aim
Barden *et al*[28]	England	Rugby Union	11–19 years	School	Activate	To investigate the effect of a workshop on coach perceptions toward injury risk and 'Activate' adoption and adherence
De Ste Croix *et al*[39]	England	Soccer	11–16 years	English FA girls' talent pathway	No specific title	To explore the efficacy of robustness training on injury risk factors
DiStefano *et al*[40]	USA	Soccer	10–17 years	Not reported	No specific title	To compare changes in landing technique between subjects with different baseline levels of movement error after completion of an IPP
Frank *et al*[37]	USA	Soccer	12–18 years	Club	PEAK control training programme	To evaluate the effect of an ACL IPP workshop and implementation packet on coaches' behavioural determinants of attitudes, subjective norms, perceived behavioural control and behavioural intention
Hilska *et al*[41]	Finland	Soccer	9–14 years	Club	Aktivoiva Alkuverryttely	To investigate if the IPP is effective in preventing acute lower extremity injuries
Hislop *et al*[13]	England	Rugby Union	14–18 years	School	Later called Activate	To determine the efficacy of a movement control exercise programme in reducing injuries
Junge *et al*[36]	Switzerland	Soccer	14–19 years	Club	F-MARC Bricks	To evaluate the effects of an IPP on the incidence of soccer injuries
Kilding *et al*[42]	New Zealand	Soccer	8–12 years	Club	FIFA 11	To determine the suitability and effectiveness of the IPP in reducing injuries
Lindblom *et al*[5]	Sweden	Soccer	13–16 years	Club	Knee Control and Knee Control+	To study the performance effects of exercises from two different IPPs
Ljunggren *et al*[43]	Sweden	Soccer	11–18 years	Club	Knee Control or Knäkontroll	To evaluate the inter-rater reliability of IPP exercise fidelity checklist
McKay *et al*[44]	Canada	Soccer	12–16 years	Club	FIFA 11+	To determine the utility of the HAPA behaviour change model in predicting intention to use an IPP
Owoeye *et al*[45]	Nigeria	Soccer	14–19 years	Club	FIFA 11+	To evaluate the effects of the FIFA 11+ programme on male youth football league players
Owoeye *et al*[38]	Canada	Soccer	17–18 years	Club	FIFA 11+	To evaluate the effect of a structured workshop on coach self-efficacy and to explore the relationship between coach self-efficacy and intention to implement an IPP
Pryor *et al*[46]	USA	Soccer	8–14 years	Club	SWSC	To evaluate the influence of prior IPP exposure on movement technique after completing a coach led IPP
Shill *et al*[50]	Canada	Rugby Union	15–18 years	School	The SHRed Injuries Rugby NMT warm-up	To describing coaches' injury prevention beliefs and practices and evaluate intention to use an IPP
Soligard *et al*[11]	Norway	Soccer	13–17 years	Club	FIFA 11+	To examine the effect of an IPP to reduce the risk of injury

Continued

Table 1 Continued

Authors	Country	Sport	Age	Setting	IPP name	Study primary aim
Steffen *et al*[12]	Canada	Soccer	13–18 years	Club	FIFA 11+	To evaluate different delivery methods of an IPP on adherence and injury risk
Waldén *et al*[47]	Sweden	Soccer	12–17 years	Club	Knee Control or Knäkontroll	To evaluate the effectiveness of an IPP in reducing the rate of acute knee injuries
Zarei *et al*[48]	Iran	Soccer	14–16 years	Club	FIFA 11+	To examine the long-term effects of an IPP on physical performance
Zarei *et al*[49]	Iran	Soccer	10–12 years	Football school	FIFA 11+ Kids	To investigate the effects of an IPP on isokinetic strength

ACL, anterior cruciate ligament; HAPA, Health Action Process Approach; IPP, injury prevention programme; NMT, neuromuscular training.

degree of support varied and is outlined in table 3. Explicit evaluation of coach delivery (formative or summative) occurred in only two studies: in the first 2 weeks of implementation[37] and informal assessment during the preseason CE.[46] Six of nineteen studies measured possible determinants of coach behaviour prior to an implementation period (risk perception, intentions, perceived behavioural control, outcome expectancy, self-efficacy)[12 28 37 38 44 50] (table 4).

Table 2 Content and delivery of coach education

Authors	Duration	Topics covered	Teaching methods/behaviour change techniques
Barden *et al*[28]	2–2.5 hours	Injury rates, efficacy findings, videos of exercises, peer coaching, barriers to programme use, coping plan development	Presentation, video display, live demonstration, peer coaching, group discussion, participant self-reflection, planning
De Ste Croix *et al*[39]	~1 hour	'How to instruct and lead the players through the warm-up'	Demonstrations of movements and progressions, provision of coaching cues
DiStefano *et al*[40]	Not reported	'… were taught the exercises', instructions and oral cues	Not reported
Frank *et al*[37]	30–40 min	Impact of injury on team success, importance of movement quality as a foundation for functional athletic activity, efficacy of injury prevention programmes in reducing injury and improving athletic performance, instruction for on-field set up	Presentation, description/instruction
Hilska *et al*[41]	3 hours	Van Mechelen's model of injury prevention, mechanisms of common injuries in youth soccer, prevention strategies, programme overview and materials, programme walk-through, critical teaching points, common exercise errors and how to correct them	Presentation/lecture, question and answer session, demonstration, peer coaching, peer evaluation, instructor feedback, group discussion
Hislop *et al*[13]	~1 hour	Introduction to the programme	Presentation, demonstration by the research team using youth athletes
Junge *et al*[36]	Not reported	Not reported	Practical demonstrations
Kilding *et al*[42]	Not reported	Exercise technique instruction	Not reported
Lindblom *et al*[5]	30–45 min	Programme instructions	Written and oral instructions, practical instructions
Ljunggren *et al*[43]	45–60 min	Instruction of exercises, progressions and key performance techniques	Demonstration
McKay *et al*[44]	2 hours	Instruction of each exercise with clear instruction to identify correct/incorrect technique, rationale for use (development and efficacy)	Demonstration, presentation
Owoeye *et al*[45]	~1.5 hours	Instructions regarding the FIFA 11+ programme	Oral presentation, facilitated discussions, demonstration, hands-on practice
Owoeye *et al*[38]	~3 hours	Overview of injury risk, mechanisms, prevention strategies, programme efficacy and effectiveness, description of programme components, instruction of each component, importance of adhering to exercise volume, intensity and proper technique	Presentation, demonstration, coach engagement in each component of the programme
Pryor *et al*[46]	90 min	Workshop objectives: enhance coach knowledge, enhance implementation ability, enhance aptitude at recognising, correcting and understanding poor movement behaviour	Seminar, practical demonstration, practical application scenarios corrected by coaches
Shill *et al*[50]	2 hours	Injury prevention, introduction to exercises	Presentation (15 min), active component: demonstration and coaches practicing teaching exercises (70 min), debrief discussion (15 min)
Soligard *et al*[11]	3 hours	Importance and awareness of neuromuscular control during standing, running, planting, cutting, jumping and landing	Practical training, peer observation, feedback
Steffen *et al*[12]	2.5 hours	'Teaching of the programme'	Presentation, practical
Waldén *et al*[47]	3 hours	Introduction to programme exercises including how to progress and good exercise technique, knee injury epidemiology in female adolescents	Presentation, practical demonstration
Zarei *et al*[48]	6+ hours	Teaching of exercises	Not reported
Zarei *et al*[49]	4 hours	'How to use the … programme correctly	Theory, practical

Table 3 Within-study coach follow-up support post-workshop and evaluation of delivery

Authors	Follow-up support for coaches	Evaluation of coach delivery
Barden *et al*[28]	No further implementation support for coaches reported	Not reported
De Ste Croix *et al*[39]	A physical performance coach rotated attendance at sessions to help/make sure movements were performed correctly	Not reported
DiStefano *et al*[40]	Research assistants attended teams at least once a week to monitor compliance and correct exercise technique	Not reported
Frank *et al*[37]	Implementation assistance from a research team member, coaches were sent email reminders to implement the injury prevention programme	Coach evaluation of implementation by researchers in first 2 weeks using an evaluation template of their own design
Hilska *et al*[41]	Research team members visited each team 2–3 times during the programme intervention period to support coaches	Not reported
Hislop *et al*[13]	No further implementation support for coaches reported	Unannounced coach evaluation was reported as not possible due to school setting
Junge *et al*[36]	A physiotherapist attended one training session per week to supervise implementation	Not reported
Kilding *et al*[42]	No further implementation support for coaches reported	Not reported
Lindblom *et al*[5]	The first author offered support via telephone if a coach reported difficulties	Not reported
Ljunggren *et al*[43]	No further implementation support for coaches reported	The fidelity of exercise execution (players) was assessed by two physiotherapists, but coaches were not assessed
McKay *et al*[44]	Study ended post-workshop. No further planned implementation support for coaches reported	Study ended post-workshop. No within-workshop evaluation reported
Owoeye *et al*[45]	Coaches were constantly reminded and encouraged to implement the exercise programme through regular phone contacts by one of the authors and during weekly data collection by study physiotherapists	Coaches were provided with feedback on their execution during the workshop. No evaluation is reported
Owoeye *et al*[38]	Study ended post-workshop. No further planned implementation support for coaches reported	Study ended post-workshop. No within-workshop evaluation reported
Pryor *et al*[46]	Questions or concerns could be raised during bi-weekly team visits by members of the research team	Informal assessment of coach delivery during the workshop
Shill *et al*[50]	Study ended post-workshop. No further planned implementation support for coaches reported	Study ended post-workshop. No within-workshop evaluation reported
Soligard *et al*[11]	Researchers kept in regular contact throughout the season by email and telephone. Site visits were organised if deemed necessary based on compliance, but this was not for the purpose of refreshing coaching skills	Coaches were provided with feedback on their execution during the workshop. No evaluation is reported
Steffen *et al*[12]	One of the intervention groups received follow-up support from a study physiotherapist. All intervention groups were permitted to contact study personnel to clarify questions and provide support by telephone if required	Not reported
Waldén *et al*[47]	Issues identified during two unannounced visits were corrected	Two unannounced visits to supervise coaches; to monitor compliance and execution
Zarei *et al*[48]	No further implementation support for coaches reported	Not reported
Zarei *et al*[49]	Study assistants visited each session to confirm implementation. Feedback was provided to the coaches and coaches could ask for support during these sessions	Not reported

Completeness of reporting

The median TIDieR score of included studies was 50% (range 0%–79%). None of the evaluated items were reported completely (figure 2).

Discussion

The primary objective of this scoping review was to systematically map how coaches are trained to deliver IPPs for youth field sport athletes. Despite significant heterogeneity across studies, key characteristics of existing CE have been identified, as well as areas where greater coaching support, or intervention reporting, may be feasible to address competency as an implementation driver.

Eighteen of the twenty studies that reported when CE was conducted, delivered their CE prior to the commencement of the IPP implementation period. This was a stand-alone antecedent intervention consisting of one formal educational contact point on 1 day. Some post-CE support was offered concurrently to the in-season IPP implementation to varying degrees in 12 of 20 studies; although in many cases this was minimal, was not for the purpose of furthering coaches' competency and lacked formal structure. This ranged from distant observation of coaches checking exercise fidelity (as a means to establish programme efficacy), ad-hoc telephone calls with research staff to answer queries; or hands-on support to correct technique at some team sessions. Five of seventeen studies that included an implementation period reported no implementation support for delivery agents in any form. Both preservice and in-service training are core implementation components[51] and while most coaches were in receipt of this at the start of the season/implementation period, little to no in-service training or coaching was reported beyond this offering little opportunity for 'on-the-job' coaching.[19]

Performance assessment is another core component of competency.[51] Structured formal feedback during the in-season period was not a component of the interventions reviewed despite formative feedback being a crucial ingredient in the improvement of knowledge and skill acquisition.[52] Two included studies incorporated an explicit evaluation of coach delivery of the IPP, with only Frank *et al*[37] conducting this during the implementation period. While coaches were made aware of the evaluation in advance, it is not reported if they received feedback during

Table 4 Coach-specific outcome measures

Authors	Measures
Barden *et al*[28]	Coach perceptions of injury risk and prevention, awareness of the IPP, intentions to use IPP*†; HAPA constructs†; adoption of IPP (self-report)§
De Ste Croix *et al*[39]	No coach-specific measures reported
DiStefano *et al*[40]	Coach-reported IPP adherence‡
Frank *et al*[37]	Coach attitudes, subjective norms, perceived behavioural control, intent*; questions regarding upcoming implementation†; coach implementation evaluation to assess level and quality of implementation of IPP‡
Hilska *et al*[41]	Coach-reported IPP adherence‡
Hislop *et al*[13]	Coach-reported IPP compliance at each session‡
Junge *et al*[36]	No coach-specific measures reported
Kilding *et al*[42]	No coach-specific measures reported
Lindblom *et al*[5]	Coach-reported IPP use at each session‡
Ljunggren *et al*[43]	No coach-specific measures reported
McKay *et al*[44]	Coach self-efficacy, outcome expectancies, risk perceptions, behavioural intentions†; barriers and facilitators to IPP implementation†
Owoeye *et al*[45]	Coach-reported IPP compliance at each session‡
Owoeye *et al*[38]	Coach injury risk perception, prevention practices, awareness of the IPP, action and coping self-efficacy*; injury risk perceptions, perceived barriers to using the IPP, self-efficacy constructs and intention to use the IPP in the upcoming season†
Pryor *et al*[46]	Informal assessment of coach implementation during the coach education
Shill *et al*[50]	Coach injury perceptions, injury prevention attitudes, current warm-up practice, knowledge and IPP use*; intention to use the IPP in the upcoming season, outcome expectancy, task and maintenance self-efficacy†
Soligard *et al*[11]	Coach-reported session IPP compliance‡; post-season, a study physical therapist called the coaches to retrospectively evaluate the IPP, the exercises within it and to assess attitudes and beliefs towards injury prevention training in general§
Steffen *et al*[12]	Coach attitudes, beliefs and knowledge about injury risk and injury prevention*; IPP compliance at each session (coach-reported in some teams)‡
Waldén *et al*[47]	Coach-reported IPP compliance at each session‡
Zarei *et al*[48]	Coach-reported IPP compliance at each session‡
Zarei *et al*[49]	Coach-reported IPP compliance at each session‡

*Measured prior to coach education.
†Measured immediately after coach education.
‡Measured during implementation period.
§Measured after implementation period.
HAPA, Health Action Process Approach; IPP, injury prevention programme.

the implementation period or if the findings were used as an assessment of fidelity only.[37] Pryor *et al*[46] did conduct informal coach evaluations during the CE workshop, but feedback is most effective for learning when it is conducted in-season when there is context for the learner.[53] Process evaluation and the feedback that can be drawn following it is a powerful tool for professional development[53] and the provision of this feedback through a mentor, especially in the initial implementation period, may be helpful for driving coach competency.[19 52] Although it is recognised that this may not be sustainable in large-scale strategies nor feasible when conducting efficacy studies.

Barriers, such as integrating the programme into sessions and the number of athletes present,[20] may be first encountered in the implementation stage and thus the opportunity for context-specific support and feedback may aid further competency development. While providing this on a one-to-one basis would be preferred, it is unrealistic especially in nationwide implementation strategies. Thus, facilitating communities of practice for coaches is a suggestion for peer-to-peer provision of ongoing support and discussion to address these fresh challenges.[54] Examples of ongoing professional development for coaches in place of one-off certification courses, similar to one-off CE for IPPs in this review, are gathering support.[55] As one example, a coach-development programme in Australia engaged coaches in three separate phases across an 8-week period. Phase 1 comprised a 6-hour workshop; in phase 2, the research team provided support across the intervention period in the form of facilitated discussion and the provision of training ideas via an online Facebook page (ie, community of practice); and phase 3, where participating coaches had the opportunity to evaluate their mentor's practice, followed by group discussion. Large effect sizes were reported for coach confidence and competence, while 25% more training time was dedicated to desired activities, when compared with the control group indicating a substantial change in coach behaviour.[56] Train-the-trainer models for IPP delivery may be adapted from such an example to evolve the ad-hoc support currently offered to coaches when implementing IPPs with their players.

Despite this review identifying infrastructural components of competency development that may be targeted in future strategies to enhance implementation, this seeks to complement the success already accrued by various sports governing bodies in reducing injury incidences. As one example, a nationwide strategy to implement FIFA 11+ in all soccer clubs in Switzerland saw an 11.5% and 25.3% lower incidence of match and training injuries, respectively.[57] While meta-analysis was not possible given the heterogeneity of reported data, many of the papers included in this review report coaches delivering sessions at least once per week, and adherence of between 53% and 85% indicating that coach behaviour change is possible and further competency support should be explored to optimise this.

In addition to addressing infrastructural components, behaviour change of coaches (in addition to others) is also a requirement to ensure sustained and frequent IPP delivery. No consensus on behavioural change techniques (BCTs) or strategy was apparent in this review. Half of the studies included appear to expose coaches to didactic and observational teaching methods only, contrasting with the experiential learning of coaches practicing the delivery of IPPs to their peers or athletes that was reported in one-third. Interventions that use experiential learning tend to have greater effects on the behaviour of the delivery agent in comparison to didactic teaching methods[58] and are preferred in 72% of continuous professional development for healthcare professionals.[59]

Behaviour demonstration, as just described, is one of many groupings of BCTs that are included in the BCT Taxonomy (v1).[60] Similar to a review conducted by Allan *et al*[61] in coach development programmes, many BCTs are used throughout the reviewed papers. However, it is unclear which BCTs are most effective[61] nor was it possible to code them as per this taxonomy.[60] It is even less clear which behaviour change models are most effective within the coaching context as no dominant or comprehensive theory has yet been identified.[61] Some contributing factors to this lack of clarity may be attributed to the infrequent use of behaviour change theories.[61–63] A review conducted over a decade ago concluded that just 11% of injury prevention research explicitly mentioned the use of a behavioural change theory in the design of their study[27]; lower than the 25% of studies that explicitly report use in this review. Five studies

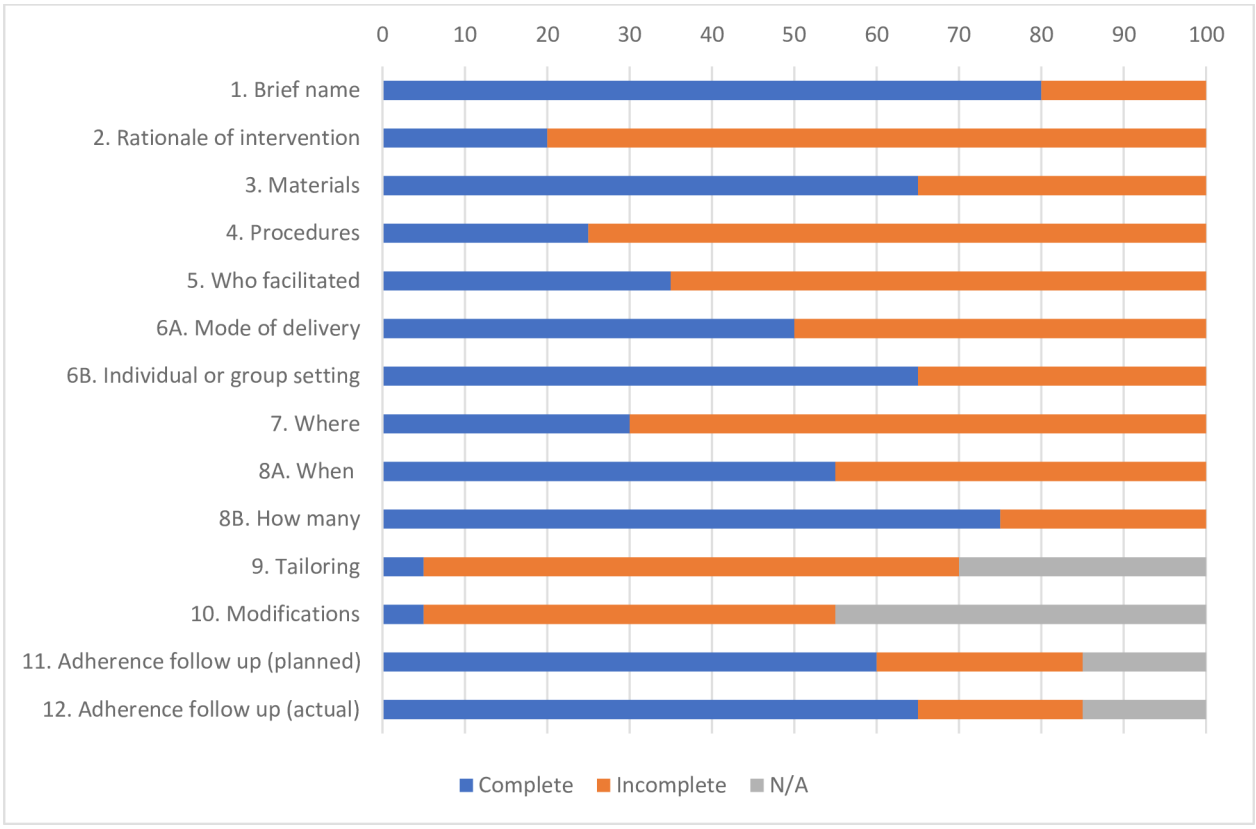

Figure 2 Completeness of reporting (percentage %) across studies using the modified Template for Intervention Description and Replication checklist.

included here used one or more theories in the development of their CE. Four studies used the HAPA model in isolation, while Barden *et al*[28] used this in conjunction with Bandura's Theorised Sources of Self-Efficacy. The HAPA model has not been used previously in coach development programmes[61] but has been used across wider healthcare literature.[64]

It is prudent to emphasise that changing health-related behaviour is a difficult task,[29] and well-intended comprehensive CE designed with both competency and behaviour change in mind may still fail to change the behaviour of every coach. Assumptions that common sense will prevail, simply getting the main message across and supplying information to coaches will be enough to change their long-term behaviour is naïve at best.[29] Some field sport coaches will still believe some injuries are not preventable,[65] coaches and their clubs will be aware of effective IPPs and still choose not to implement them[66] and acquiring knowledge may change intentions, but it may not translate to changing behaviour.[37]

As previously indicated, adopting theoretical implementation science to large-scale strategy is a balancing act. With enhanced CE strategies, as suggested in this review, comes the need for increased resources, both personnel and financial, and this may not be realistic. For example at an organisational level, 'Activate', the IPP developed by England RFU, has been disseminated for use across kids, youth and adult club Rugby grades[67]; which in 2018 accounted for 355 153 registered players.[68] One-to-one mentoring for that volume of community coaches is not feasible, but in-service support through communities of practice may be a suitable alternative option.[54 56] At the individual level coaches, especially in youth sport,[69 70] are typically volunteers otherwise engaged in full time employment elsewhere and express the lack of time as a stressor in addition to lower levels of commitment to their organisation when compared with coaches employed on a full-time basis.[71] These are important considerations to pull future implementation designs back from theory and into reality.

Finally, incomplete reporting of intervention detail for the purpose of replication was evident across all studies. Details of the personnel facilitating the CE sessions were reported in 35% of studies which is similar to the 39% indicated by Dijkers in a review of interventions in healthcare research reports.[72] Detail regarding the timing of CE during the playing season (55%) and the number of sessions (75%) is also less than the broader healthcare research[72] despite its logistical importance. The incomplete reporting of details for the implementation of interventions is an ongoing issue in healthcare education and research as it makes replication and further investigation difficult.[35 59] Fundamental logistical components of CE at the very least (ie, duration, session facilitators, resources, content, teaching methods) when describing CE interventions are needed to progress the identification of both effective and ineffective implementation strategies and to increase the speed at which research can bridge the implementation gap.[14]

Limitations

This review has both strengths and limitations. A scoping review protocol was published prior to commencement of work. Only minor adjustments to the wording of the eligibility criteria were made following a pilot literature search and screen, while the eligibility of grey literature was removed at this point given the volume of peer-reviewed published literature. While the scoping review methodology employed was chosen as an appropriate

vehicle to examine the extent and scope of CE for the purpose of IPP implementation, it does not evaluate the effectiveness of various intervention components. In addition, we recognise that the depth of information reported about the CE intervention may have been limited due to journal word count restrictions, depending on their respective study primary aim. Authors were contacted following data extraction to address this, and additional data are included where provided by the corresponding author. We used a modified version of the TIDieR checklist to evaluate study reporting. However, it is not a rating of research quality[72] and comparisons with TIDieR ratings from other studies are complicated by varying interpretations of reporting completeness.[72]

CONCLUSIONS

Two decades of injury prevention research has surmised that IPPs have a dose–response relationship between programme exposure and injury risk reduction. However, implementation at the team level of these programmes is suboptimal, which impairs potential preventative effects. Coaches of field sport teams are most frequently targeted as delivery agents of these IPPs, but the most effective strategies for CE and for optimal implementation are currently unknown. One-day preseason workshops with minimal in-service support are the most popular model of education preparing coaches for programme delivery. Future research should explore the potential impact of enhanced in-service support and feedback to increase coach competency with the understanding that pragmatic issues such as funding, coach time and personnel resources may limit the extent of this. In addition to addressing competency as an implementation driver, more frequent use of behavioural change theories is needed to facilitate sustainable implementation.

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