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Understanding Youth Sport Coaches' Perceptions of Evidence-Based Injury-Prevention Training Programs: A Systematic Literature Review

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Objective: To systematically review and summarize the knowledge, attitudes, beliefs, and contextual perceptions of youth sport coaches toward injury-prevention training programs by using the Theoretical Domains Framework to guide the organization of results.

Data Sources: Systematic searches of PubMed and Google Scholar were undertaken in November 2021.

Study Selection: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol was followed. Results were limited to full-text articles that were published in peer-reviewed journals and printed in English. Additional studies were added after a citation search of included studies. Studies were eligible for inclusion if researchers evaluated youth sport coaches' knowledge, beliefs, contextual perceptions, or all 3 of anterior cruciate ligament injury-prevention training programs.

Data Extraction: Data charting was performed by 1 author and confirmed by a separate author.

Data Synthesis: Of the 1194 articles identified, 19 were included in the final sample. Among articles in which researchers assessed knowledge (n = 19), coaches' awareness of the existence and components of injury-prevention training programs was inconsistent. Among articles in which researchers assessed beliefs (n = 19), many coaches had positive attitudes toward injury-prevention training programs, but few believed youth athletes are at a high risk of injury. Among articles in which researchers assessed contextual perceptions (n = 13), many coaches did not feel they had access to information about injury-prevention training programs and cited a lack of time, space, support, and other resources as barriers to implementation.

Conclusions: Our findings support the need for programs, protocols, and policies to enhance knowledge of and support for youth sport coaches who wish to implement injury-prevention training programs. A gap exists in the research about addressing the needs of youth sport coaches in the United States high school sports setting. The use of multilevel implementation science frameworks (such as the Theoretical Domains Framework) will be beneficial for identifying constructs that affect implementation and developing train-the-trainer programming to meet the needs of individual youth sport coaches.

Key Words: anterior cruciate ligament injury, implementation science

Key Points

- Coaches had positive attitudes about anterior cruciate ligament injury-prevention programs but were lacking in knowledge and self-efficacy to implement such programs.
- The proactive use of implementation science frameworks and behavioral theories will be important in creating train-the-trainer programming to ensure that the needs and motivations of coaches are addressed and the implementation strategies applied are acceptable, appropriate, and feasible.

Anterior cruciate ligament (ACL) injuries are one of the most devastating injuries sustained in sport. Of the estimated 200 000 ACL injuries in the United States each year, approximately 45% occur in high school or adolescent athletes.[1] Reconstruction surgery is often indicated for young athletes who wish to return to cutting, jumping, or pivoting sports; have concomitant injuries to the knee; experience instability; or all three.[2] Researchers[3] found the 15- to 18-year-old age group to have both the highest rate of ACL reconstruction and the greatest increase in ACL reconstructions from 1990 to 2009. The rate of ACL reconstructions across all age groups rose by 22% from 2002 to 2014, with the 13- to 17-year-old age group displaying the largest absolute increase.[4]

As such, ACL injury among youth athletes is an increasing public health burden. The mean lifetime financial cost to society for a patient who undergoes ACL reconstruction is about $38 000 and increases to $88 500 if

the patient does not opt for surgical repair.[5] These costs are for 1 ACL injury. After an ACL injury, young patients have a 23% chance of sustaining a second ACL rupture to the ipsilateral or contralateral knee and only a 44% chance of returning to competitive sport.[6] Along with the loss of sport participation comes decreased physical activity, increased body mass index, and early-onset knee osteoarthritis.[7–9] The psychological effect of such an injury is also detrimental. Depression, anger, loss of self-efficacy or self-worth, social isolation, and fear of reinjury are just a few of the mental hurdles that patients with an ACL injury may have to conquer.[10–14]

Injury-prevention training programs have provided a way to avert the rising number of ACL injuries. As most ACL injuries (75% to 80%) are noncontact or indirect contact in nature,[1,15,16] injury-prevention training programs focus on improving neuromuscular control through balance, agility, strength, and plyometric exercises.[17,18] When performed correctly and consistently, evidence-based injury-prevention training programs can reduce the rate of noncontact injury by 51% to 62%.[19–24] Furthermore, implementing injury-prevention training programs for preadolescent and adolescent individuals (ranging in age from 10 to 18 years) reduces the magnitude of high-risk movement patterns and mitigates the development of such movement patterns, respectively.[25,26] These programs have primarily been packaged as warm-ups to be incorporated by coaches and sports medicine professionals before practice.

Despite evidence suggesting that such programs can reduce injury, only about 20% of coaches implement them with their teams.[27,28] Injury prevention has traditionally been the responsibility of the athletic trainer. However, only 37% of public and 27% of private schools with access to athletic trainers received full-time coverage,[29] making it difficult to regularly provide care for all athletes. When integrating injury-prevention training programs in youth sport, coaches are an invaluable resource, as they are the primary decision makers driving practice structure and content, present at all practices, and potential injury-prevention training program implementers. Coach engagement is almost universally agreed upon as one of the early steps for successful implementation.[30–32] Due to their position, athletic trainers are key individuals to engage coaches regarding injury-prevention training programs.

To deliver education and training effectively, coaches' motivations and the context in which the intervention will be administered should inform the implementation strategies.[33] As such, a better understanding of their behaviors and motivations is key to successful implementation of injury-prevention training programs. Researchers[30–32] have developed several implementation frameworks specifically for injury-prevention training program implementers to promote successful intervention. Others[34,35] have drawn on existing behavioral theories and frameworks to evaluate the development of interventions and successful implementation of injury-prevention training programs. Although investigators provided roadmaps via these frameworks, the best implementation strategies for integrating injury-prevention training programs in the real world remain unclear.

The Theoretical Domains Framework (TDF) is a multilevel framework that operationalizes factors associated with effective implementation. The original version of the TDF identified 12 theoretical domains focused on the behaviors and perceptions of providers implementing evidence-based programs.[36] Theoretical constructs were organized under each domain. They include constructs identified as relevant to understanding and changing the individual behaviors of health care professionals.[36] Researchers[37] published a revision of the TDF in 2012 (Table 1), updating the framework to consist of 14 domains, 84 constructs, and the assertion that the refinement would better inform interventions aimed at improving implementation and facilitating behavioral change. The TDF can be used to explore the reasons for successful or failed implementation as well as to support the design of interventions to improve implementation.[36] Although the TDF was originally designed to understand and evaluate health care professionals' attitudes and behaviors regarding implementation of evidence-based programs, it has also been successfully used in settings outside health care.[38] As the constructs and domains of the TDF focus primarily on the individual, specifically, the implementer, it lends itself to being used as a tool for examining the underlying knowledge, beliefs, and context influencing the behavior of youth sport stakeholders, such as coaches, regarding the implementation of injury-prevention training programs.

The purpose of our scoping review was to explore and summarize current literature in which authors explored youth sport coaches' knowledge, beliefs, and contextual perceptions of injury-prevention training programs. Although various youth sport stakeholders are affected by or engage in implementing injury-prevention training programs, we focused on the knowledge, beliefs, and contextual perceptions of youth coaches because they often feel the onus of injury prevention rests on them.[39–41] We used the TDF to guide the categorization of results within the domains of the framework. This evaluation and classification will assist in providing a direction for future researchers to both identify appropriate implementation strategies for increasing the use of injury-prevention training programs in youth sport settings and use implementation frameworks and behavioral change techniques to develop those strategies.

METHODS

Literature Search

Based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) method,[42] we identified studies focused on the knowledge, attitudes, and beliefs of youth sport coaches regarding injury-prevention training programs and their implementation. As the study is a scoping review, no protocol was required to be registered with the International Prospective Register of Systematic Reviews (PROSPERO). In November 2021, one author (L.E.H.) completed an electronic database search of the literature. Results were limited to articles printed in English. The search was conducted using PubMed and Google Scholar and combinations of the following search terms: *knowledge*, *attitude*, *belief*, *injury prevention program*, *youth*, *sport*, *ACL*, and *lower extremity*. *Attitude* is defined by the Oxford dictionary as "a settled way of thinking or feeling about someone or something, typically one that is reflected in a person's behavior."[43] As this definition correlates closely with the Belief domains of the

Table 1. The Theoretical Domains Framework Version 2 With Definitions and Constructs[37] Continued on Next Page

Domain (Definition)	Constructs
Knowledge (an awareness of the existence of something)	Knowledge (including knowledge of condition or scientific rationale) Procedural knowledge Knowledge of task environment
Skills (an ability or proficiency acquired through practice)	Skills Skills development Competence Ability Interpersonal skills Practice Skill assessment
Social/professional role and identity (a coherent set of behaviors and displayed personal qualities of an individual in a social or work setting)	Professional identity Professional role Social identity Identity Professional boundaries Professional confidence Group identity Leadership Organizational commitment
Beliefs about capabilities (acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use)	Self-confidence Perceived competence Self-efficacy Perceived behavioral control Beliefs Self-esteem Empowerment Professional confidence
Optimism (the confidence that things will happen for the best or that desired goals will be attained)	Optimism Pessimism Unrealistic optimism Identity
Beliefs about consequences (acceptance of the truth, reality, or validity about outcomes of a behavior in a given situation)	Beliefs Outcome expectancies Characteristics of outcome expectancies Anticipated regret Consequents
Reinforcement (increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus)	Rewards (proximal or distal, valued or not valued, probable or improbable) Incentives Punishment Consequents Reinforcement Contingencies Sanctions
Intentions (a conscious decision to perform a behavior or a resolve to act in a certain way)	Stability of intentions Stages of change model Transtheoretical model and stages of change
Goals (mental representations of outcomes or end states that an individual wants to achieve)	Goals (distal or proximal) Goal priority Goal or target setting Goals (autonomous or controlled) Action planning Implementation intention
Memory, attention, and decision processes (the ability to retain information, focus selectively on aspects of the environment, and choose between 2 or more alternatives)	Memory Attention Attention control Decision making Cognitive overload or tiredness
Environmental context and resources (any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence, and adaptive behavior)	Environmental stressors Resources or material resources Organizational culture or climate Salient events or critical incidents Person × environment interaction Barriers and facilitators

Table 1. Continued From Previous Page

Domain (Definition)	Constructs
Social influences (those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviors)	Social pressure Social norms Group conformity Social comparisons Group norms Social support Power Intergroup conflict Alienation Group identity Modelling
Emotion (a complex reaction pattern, involving experiential, behavioral, and physiological elements, by which the individual attempts to deal with a personally significant matter or event)	Fear Anxiety Affect Stress Depression Positive or negative affect Burnout
Behavioral regulation (anything aimed at managing or changing objectively observed or measured actions)	Self-monitoring Breaking habit Action planning

TDF, we chose *attitude* as a search term to ensure inclusion of all relevant articles.

Study Selection

We merged studies in which researchers reported on data from the same datasets and removed duplicate studies. To qualify for inclusion, studies must have been printed in English and published in a peer-reviewed journal. Unpublished manuscripts and conference abstracts were excluded. Inclusion was not limited by year of publication. A critical appraisal was not conducted. No specific study design was targeted in order to include all results. When a specific age was missing but the authors stated participants coached "youth" or "adolescent" athletes, we assumed the athletes were under 18 years old. To meet the inclusion criteria, investigators must have evaluated the knowledge, attitudes, beliefs, contextual perceptions, or all 4 of youth sport coaches regarding ACL injury-prevention training programs. If an intervention was provided to educate implementers about injury-prevention training programs, we examined only the knowledge, attitude, belief, and contextual perception responses before the intervention, as we were interested in baseline measures.

After the database search, we reviewed the titles and abstracts and excluded those that did not pertain to injury-prevention efforts. Full texts of the remaining articles were retrieved. Upon a full-text review, those articles that did not pertain to the lower extremity; did not address ACL injury-prevention training programs; did not include coaches' knowledge, attitude, beliefs, or contextual perceptions; or were not specific to youth sports were excluded. Sixteen articles qualified for inclusion. A citation search of the original 16 articles was completed by the first author (L.E.H.), who identified additional titles to be retrieved for assessment of eligibility. Of these titles, and following the same exclusion criteria, 3 additional articles were deemed eligible for the review. A total of 19 studies were included in our final review, which was agreed upon by 2 authors (L.E.H. and D.A.P.).

Data Charting

Information on authors, study design, location (country in which the study was performed), sport, level of play, injury-prevention training program used (if applicable), and implementation framework or behavioral theory used was charted.

Implementation frameworks are used to support the application of evidence-based practices and often consist of processes and factors that are important to consider throughout the implementation process.[44] For the purposes of this review, we charted implementation frameworks to gauge the general use and variety of frameworks used when evaluating the application of ACL injury-prevention training programs. *Health behavior* refers to "actions of individuals, groups, and organizations as well as those actions' determinants, correlates, and consequences," and may also include the measurable "mental events and feeling states" of individuals.[45] Behavioral theories are used to understand health behavior and were therefore of interest in this literature review.

The terms *youth* and *adolescent* were used interchangeably in this review to indicate those under 18 years of age. Competitive level was characterized as the level stated in the original study. Researchers of the original studies used terms such as *school* or *high school*, *club*, *elite*, *grass-root*, *amateur*, and *youth* or *adolescent* to label the level of competition. For this review, if the level was identified with the word *school*, we considered it a school-organized activity. All other identifiers were considered independently organized sport.

Data Synthesis

The charted data were organized and summarized using the following 4 domains of the TDF: Knowledge, Beliefs About Capabilities, Beliefs About Consequences, and Environmental Context and Resources. Although additional domains (eg, Skill, Professional Role, and Social Influences) are also important, few to no evaluations of these

Table 2. Guiding Domains, Constructs, and Questions Used to Organize Charted Data

Domain	Constructs	Guiding Questions[37]
Knowledge	Knowledge (including knowledge of condition or scientific rationale) Procedural knowledge Knowledge of task environment	• Do they know about the guideline(s) [for injury-prevention training programs]? • What do they think about the guideline(s) [for injury-prevention training programs]? • What do they think the evidence is [for injury-prevention training programs]? • Do they know they should be doing [injury-prevention training programs]? • Do they know why they should be doing [injury-prevention training programs]?
Beliefs about capabilities	Self-confidence Perceived competence Self-efficacy Perceived behavioral control Beliefs Self-esteem Empowerment Professional confidence	• How difficult or easy is it for them to do [injury-prevention training programs]? • What problems have they encountered [with injury-prevention training programs]? • What would help them? • How confident are they that they can do [injury-prevention training programs] despite the difficulties? • How capable are they of maintaining [injury-prevention training programs]? • How well equipped/comfortable do they feel to do [injury-prevention training programs]?
Beliefs about consequences	Beliefs Outcome expectancies Characteristics of outcome expectancies Anticipated regret Consequents	• What are the costs of [injury-prevention training programs]? • What do they think will happen if they do or don't do [injury-prevention training programs]? • Do the benefits outweigh the costs? • How will they feel if they do or do not do the [injury-prevention training program]? • Does the evidence suggest that doing [injury-prevention training programs] is a good thing?
Environmental context and resources	Environmental stressors Resources or material resources Organizational culture or climate Salient events or critical incidents Person × environment interaction Barriers and facilitators	• To what extent do physical or resource factors facilitate or hinder [injury-prevention training programs]? • Are there competing tasks and time constraints? • Are the necessary resources available to those expected to undertake [injury-prevention training programs]?

domains were available in the included population, perhaps indicating a need for future evaluation of these factors.

The TDF defines *knowledge* as "an awareness of the existence of something."[37] Beliefs are categorized into 2 separate domains, namely, Beliefs About Capabilities and Beliefs About Consequences. *Beliefs About Capabilities* is defined as an "acceptance of the truth, reality, or validity about an ability, talent, or facility that a person can put to constructive use."[37] *Beliefs About Consequences* is defined as "acceptance of the truth, reality, or validity about outcomes of a behavior in a given situation."[37] Factors outside the individual, including features of the context in which he or she lives and works, can also affect implementer perceptions. This defines the TDF domain of *Environmental Context and Resources*.[37] Responses were categorized into each of the domains based on whether they fit the constructs associated with the domain or aligned with the domain's guiding questions. The domains, constructs, and associated questions can be found in Table 2.

RESULTS

Characteristics of Studies

The strategy used for searching, screening, and inclusion per the PRISMA-ScR guidelines is depicted in Figure 1.[42] The 19 studies consisted of responses from 4191 sport stakeholders, of whom 2473 were youth sport coaches (age = 18–66 years; sex = 629 males, 196 females, 1648 not reported by the study authors; coaching experience = 1–40 years). Only a few investigators described coach demographics that affect social determinants of health. Four groups addressed coach education levels,[27,46–48] 2 noted the rural or urban nature of teams,[27,49] and only 1 provided the race or ethnicity of coaches.[46] Stakeholders who did not identify as coaches included fitness coaches (n = 4), physiotherapists (n = 5), parents (n = 292), and athletes (n = 1417). Responses from athletes and parents who did not serve as coaches were excluded. O'Brien and Finch[41] did not separate responses according to participant role; therefore, the views of fitness coaches and physiotherapists were included in the results. All 19 groups evaluated knowledge and beliefs, and 13 groups[27,28,40,46–55] evaluated environmental context and resources.

In 11 studies, researchers assessed knowledge or beliefs regarding general ACL injury-prevention programming*; in 5, they asked specifically about the Federation Internationale de Football Association (FIFA) 11+[39,41,48,49,55]; and in 3, they considered other injury-prevention training programs (ie, *Activate*,[60] Knee Control,[50] and Knokl for dit knæ[40]). A behavioral theory (Health Belief Model[40,41,46,50,58] [n = 5]; Theory of Planned Behavior/Reasoned Action[28,39,57,58] [n = 4]; Transtheoretical Model[46] [n = 1]); or implementation

*References 27, 28, 46, 47, 51, 52, 54, 56–59.

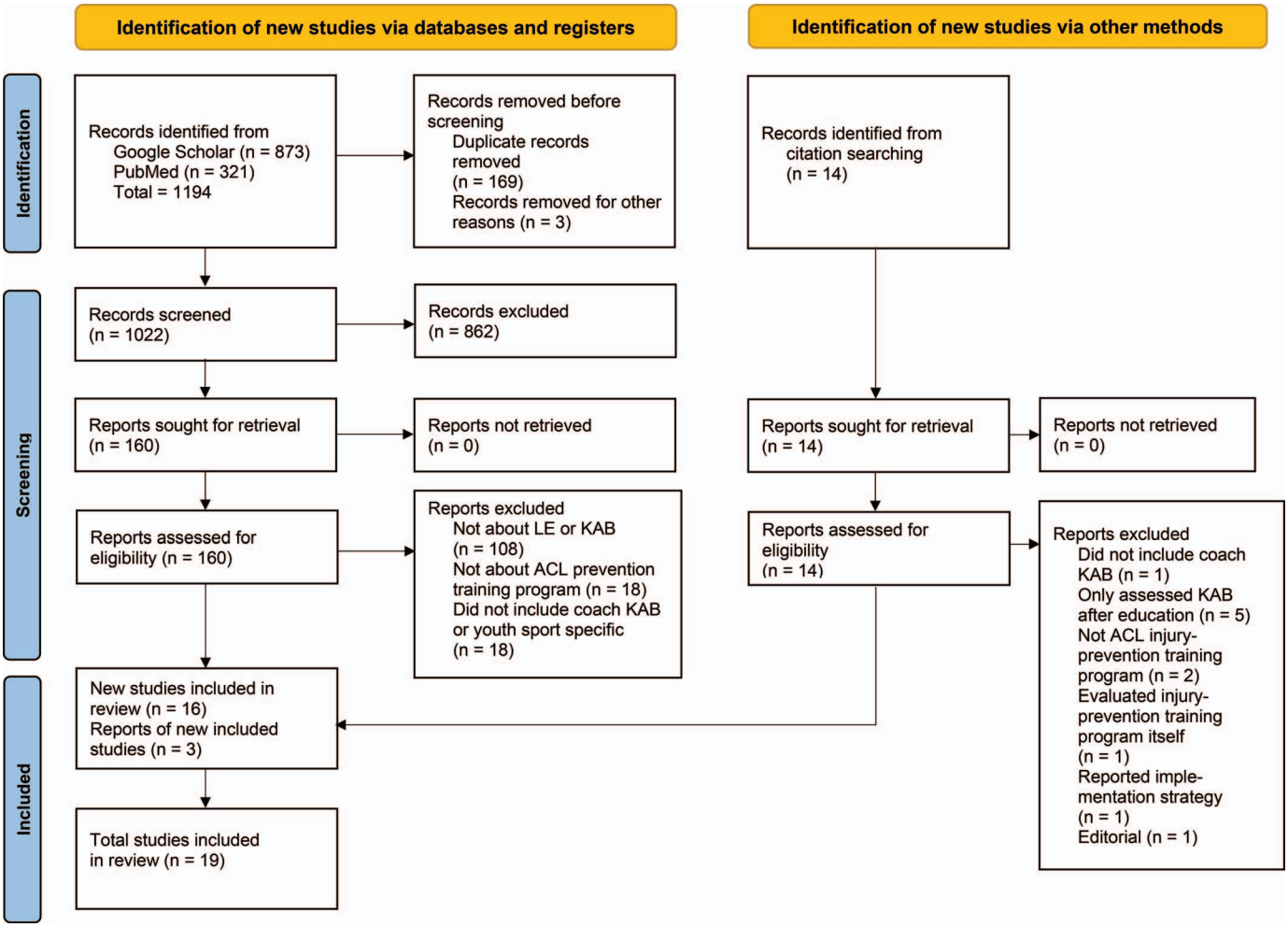

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram of included studies. Abbreviations: ACL, anterior cruciate ligament; KAB, knowledge, attitudes, beliefs; LE, lower extremity.

framework (Reach, Effectiveness, Adoption, Implementation, Maintenance [RE-AIM][39–41,49,51,56,58] [n = 7]; Health Action Process Approach[47,48,59,60] [n = 4]; Predisposing, Reinforcing, and Enabling Constructs in Education/Ecological Diagnosis & Evaluation [PRECEDE]/Policy, Regulatory, and Organizational Constructs in Educational & Environmental Development [PROCEED][52] [n = 1]) was applied in 16 of the 19 studies, indicating widespread use of both behavioral theories and implementation frameworks to understand the function of ACL injury-prevention training programs. Diversity of frameworks and theories was lacking, as only 3 frameworks and 3 theories were used.

Most investigations (n = 16) focused on youth soccer or basketball.[27,28,39,41,46–52,54–58] Thirteen studies were conducted outside the United States.[39–41,47–51,54–56,59,60] Of the 6 studies conducted within the United States, 4 examined high school alone[28,46,52,57]; 1 examined solely club (U9–U19)[58]; and 1 looked at club, high school, and collegiate (U12–college age) athletes.[27] In many studies (13), the knowledge, beliefs, or contextual perspectives of coaches engaged in independently organized sport were evaluated.[27,39–41,47–51,54–56,58] Nearly half (n = 8) examined school-organized athletics.[27,28,46,47,52,57,59,60] Two included coaches from both settings.[27,47] The studies and study characteristics are described in Table 3.

Knowledge

Coaches were generally lacking in knowledge of injury-prevention training programs. Specifically, they lacked knowledge of the TDF constructs of knowledge of condition or scientific rationale and procedural knowledge (see Table 2). Findings in the construct of knowledge of condition or scientific rationale included a lack of knowledge about knee injuries or injury prevention[39,46,50,51,54,56,58] and the existence of injury-prevention training programs.[28,40,49,55,56] Findings in the construct of procedural knowledge included a lack of knowledge about appropriate exercises to include[47,49,52,54,59] and implementation of injury-prevention training programs.[27,40,49]

Although some coaches were aware of the injury risk among youth athletes,[41,48] that knowledge was inconsistent[50,51,54] and varied depending on the age and sex of the athletes with whom coaches interacted.[28,39,58] Additionally, coaches were not aware of the long-term health effects an ACL injury can have on a youth athlete.[58] Just over half knew of the decreased injury risk associated with injury-prevention training programs.[27,58] Coaches who attempted to increase their knowledge did so in several ways, including learning from other coaches[40,47,49,50,52] or from health care providers,[47,54] attending courses,[40,47,49–52,57] and relying on personal experience.[27,47,51,52]

Table 3. Summary of Included Studies Continued on Next Page

Author, Study Design	Study Location	Sport Descriptions	Population (n)	Methods		Theoretical Domains Framework		
				Injury-Prevention Training Program	Framework or Theory Used	Knowledge	Beliefs About Capabilities and Beliefs About Consequences	Environmental Context and Resources
Barden et al,[60,a] pragmatic	United Kingdom	Sport: Rugby Setting: School based Age: U12–U19 Sex of athletes: Not reported	Coaches (76)	*Activate*	Health Action Process Approach	Coaches (average 75% of respondents) generally aware of program	*Strongly agree* rugby injuries shorten player career *Agree* rugby injuries are preventable	NA
De Ste Croix et al,[56,a] cross-sectional survey	Czech Republic, United Kingdom, Spain	Sport: Soccer Setting: Recreational (grass-root) Age: Youth Sex of athletes: Not reported	Coaches (269)	No specific program	RE-AIM	16% of coaches had knowledge of any IPEP 19% of coaches categorized injury-prevention knowledge as *good* or *very good*	84% believed it possible to prevent injuries with IPEPs 100% said coach education needed 100% thought injury prevention important 40% had positive attitudes about IPEPs 25% confident in ability to deliver IPEP 59% believed lower limb injuries in youth can affect their quality of life	NA
Donaldson et al,[49] cross-sectional survey	Australia	Sport: Soccer Setting: Club Age: 12–18 years Sex of athletes: Female	Coaches (64)	FIFA 11+	RE-AIM	42% did not know of program Of those who knew of program, 51% fully knew what it was, 36% partially knew, and 12% gave inappropriate response	79% who knew of program believed it ↓ injuries, about 2/3 believed it improved player and team performance	18% aware of program due to coaching course, 15% through FFA and FIFA, 12% through FFV and someone at their club, 6% from another coach Barriers: lack of time during practice or took away time from soccer training (44%), lack skills and knowledge to adequately implement 11+ (38%), did not know how to give feedback to athletes (35%), 11+ did not include appropriate progression (38%)
Iversen and Friden,[57,a] prospective, pre-post design	United States (Massachusetts)	Sport: Basketball Setting: High school Age: 14–18 years Sex of athletes: Female	Coaches (12) and athletes (113) (athlete responses not included)	No specific program	Theory of Reasoned Action and Theory of Planned Behavior	Coaches scored 68.8% average on knowledge of knee anatomy and function of ACL	Coaches had positive attitudes toward injury-prevention techniques (mean score = 88.6 out of 100)	NA
Jang et al,[46] mixed methods (qualitative interviews informed development of quantitative survey delivered to coaches)	United States (Florida)	Sport/Sex: Boys' baseball, basketball, cross-country, football, golf, soccer, swimming, tennis, wresting, and track and girls basketball, cheerleading, cross-country, flag football, golf, soccer, softball, swimming, tennis, track, and volleyball Setting: High school Age: Not reported	Coaches (111)	No specific program	Health Belief Model Transtheoretical Model	25.2% scored high on knowledge of sports injury prevention	22% of coaches believed athletes had a high susceptibility to injury 71.1% had high levels of belief in injury-prevention benefits 78% had high self-efficacy scores	Lack of training for injury-prevention activities, too much time and effort to implement injury prevention programs, and no administrative support to work on injury-prevention activities all contributed to validity of barriers as a factor in injury prevention

Table 3. Continued From Previous Page

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Joy et al,[27] interviews	United States (Utah)	Sport: Soccer Setting: Club, high school, and collegiate Age: U12–college Sex of athletes: Female	Coaches (14)	No specific program	NA	64% reported lack of knowledge of how to implement IPEP and give adequate feedback to athletes during exercises as barriers to implementation 36% pursued self-education	14% acknowledged that learning of ↑ injury risk among female soccer athletes prompted prevention program use 43% reported positive attitude and acceptance of change helped with implementation	92% believed soccer organizations should be responsible for disseminating information on ACL IPEPs Unanimous agreement that education on ACL injury prevention should be required for coach licensure 43% cited time as barrier 14% received pressure from parents to implement programs 14% influenced by someone they knew suffering injury
Lindblom et al,[50] semistructured interviews	Sweden	Sport: Soccer Setting: Club Age: 10 years to senior level Sex of athletes: Male and female	Coaches (20) (16 were also parent of athlete)	Knee Control	Health Belief Model	Knew multiple factors can contribute to injury occurrence Expressed lack of knowledge about injuries Thought reason for injury unclear	Some felt injury prevention was necessity Most driven by own conviction about importance of injury prevention and own experience of injury and consequences Some parental coaches lacked conviction that injury prevention was important Believed program had effect if used consistently and with continuity	Coaches reported participating in coaching courses enhanced their ability to describe different injury-prevention methods Support from other coaches, club, and district soccer association Availability of resources for knee control use Peer exchange of information Practical education Financial resources, time, access to venues, coach availability
Mawson et al,[51] cross-sectional survey	Canada	Sport: Soccer Setting: Club Age: U12–U18 Sex of athletes: Female	Coaches (101)	No specific program	RE-AIM Sports Setting Matrix	Did not know noncontact injury mechanism was more likely than dangerous aggressive play and player collisions	84% stated knowing program ↓ injury by 45% would ↑ likelihood of implementation 84% believed they could properly demonstrate exercises	About a third stated coaching courses discussed risk of injury for youth soccer athletes or advocated for interventions Over half stated clubs were not a source of injury awareness and had not advocated for interventions Knowledge of programs came from incidents of injury and personal research 74% of coaches would use program if less than 20 minutes and delivered in place of warm-up 84% stated they could access information about exercises

Table 3. Continued From Previous Page

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				Injury-Prevention Training Program	Framework or Theory Used	Knowledge	Beliefs About Capabilities and Beliefs About Consequences	Environmental Context and Resources
McKay et al,[39] repeated-measures survey (secondary analysis of data from cluster-randomized controlled trial)	Canada	Sport: Soccer Setting: Club Age: 13–18 years Sex of athletes: Female	Coaches (43) and athletes (385) (athlete responses not included)	FIFA 11+	RE-AIM framework, Theory of Planned Behavior	88.4% of coaches accurately identified ankles and knees as most injured Over half of coaches knew males and females have different injury risks 0% and 2% of coaches cited stretching as an adequate prevention strategy for knee and ankle injuries, respectively	Half of coaches believed knee injuries could be prevented 93% believed coaches are responsible for injury prevention	NA
Mller et al,[40] mixed methods (quantitative surveys, qualitative interviews)	Denmark	Sport: Handball Setting: Club Age: 14–18 years Sex of athletes: Male and female	Coaches (33) and athletes (481) (athlete responses not included)	Knee program (Knokl for dit knæ) Shoulder program (Skudklar Skulder)	RE-AIM, Health Belief Model	Awareness of established IPEPs low 100% of coaches thought injury prevention was important Lack of correct implementation among coaches	Sport-specific programs would ↑ effectiveness and adoption Recognize importance of injury prevention Vast majority thought injuries occurred due to bad luck 100% of coaches thought it was the coach's responsibility to implement	100% of coaches thought IPEPs should be essential part of coach education Learned about IPEPs from peer networks or self-imposed professional development IPEPs were not handball specific IPEPs were not youth handball specific
Morgan et al,[58] cross-sectional survey	United States (Oregon and Washington)	Sport: Soccer Setting: Club Age: U9–U19 Sex of athletes: Female	Coaches (54)	No specific program	Theory of Reasoned Action, RE-AIM, Health Belief Model	65% of teams had a coach who knew IPEPs have been shown to ↓ risk of lower extremity injury Coaches neutral on whether injuries cause physical problems later in life or have negative effect on quality of life Coaches of older athletes more likely to think athletes were at risk of injury	Majority of coaches believed programs proven to ↓ injury should be implemented Majority of coaches thought injuries preventable	NA
Munoz-Plaza et al,[52] semistructured interviews and focus groups	United States (California)	Sport: Basketball Setting: High school Age: 14–18 Sex of athletes: Male and female	Coaches (12) and athletes (30) (athlete responses not included)	No specific program	PRECEDE-PROCEED	Coaches knew completing warm-up ↓ injury risk Coaches relied on experience rather than knowledge to inform warm-up Coaches had varying ideas on best exercises to use	Believed it was important for coaches and players to know current injury-prevention strategies Lack of confidence in ability to select appropriate exercises, properly sequence exercises, teach players proper form	Rely on varying sources of information for knowledge: school district materials required for coaching certification, information from players' parents, coaching magazines, observation, colleagues Barriers: lack of time, lack of space, player attitudes, competing priorities for coach or distractions Facilitators: player and team injury experience, coach engagement

Table 3. Continued From Previous Page

				Methods		Theoretical Domains Framework		
Author, Study Design	Study Location	Sport Descriptions	Population (n)	Injury-Prevention Training Program	Framework or Theory Used	Knowledge	Beliefs About Capabilities and Beliefs About Consequences	Environmental Context and Resources
Norcross et al,[28] cross-sectional survey	United States (Oregon)	Sport: Basketball and soccer Setting: High school Age: Not reported Sex of athletes: Male and female	Coaches (66)	No specific program	Theory of Reasoned Action	52% of coaches knew IPEPs ↓ risk of injury Coaches of girls' teams more likely to be aware of IPEPs	100% believed lower extremity injury prevention was important and current knowledge of injury-prevention strategies was important for coaches and athletes 97% would implement IPEP if proven to prevent injury and/or improve performance Fewer than half perceived lower extremity injuries to be a problem for their team	30% said practice was not long enough to give time to an IPEP 25% said players did not want to complete IPEPs Less than 10% cited cost, negative attitudes, or lack of availability of training or assistance in implementing a program as barriers
O'Brien and Finch,[41] cross-sectional survey	Europe	Sport: Soccer Setting: Club Age: Youth Sex of athletes: Male	Coaches (9), fitness coaches (4), and physiotherapists (5)	FIFA 11+	RE-AIM framework, Health Belief Model	89%–100% knew professional soccer players had ↑ risk of injury 100% knew lower limb injuries could be prevented by completing balance, eccentric strengthening, controlled jumping or landing and cutting exercises 61% had heard of FIFA 11+ program Half did not believe FIFA 11+ was soccer specific	100% believed exercises should be varied and progress over time Most believed FIFA 11+ could prevent injuries on their team Believed ultimate responsibility for injury prevention rests on head coach (35%), athlete (24%), and fitness coach (24%) Less than a quarter believed FIFA 11+ had adequate variation and progression 44% believed program could be maintained over multiple seasons	Most barriers and facilitators to IPEP maintenance fell under IPEP delivery and support, specifically, support at team staff level 94% thought evidence-based exercise should be included in practice guidelines Varied thoughts on how much time program would take
Orr et al,[54] descriptive survey	Canada	Sport: Soccer Setting: Club Age: U14, U16, U18 Sex of athletes: Female	Coaches (73), parents (292), and athletes (408) (parent and athlete responses not included)	No specific program	NA	Over half had not received information about knee injuries 16% of coaches thought risk for knee injury was lower than reported Varied knowledge about which exercises were most effective; chose stretching (82%), quadriceps strengthening (62%), balance (49%), and jump training (40%), with recreational coaches more likely to choose incorrectly	62% of coaches thought knee injuries were preventable	Received information on knee injuries from multiple sources, most commonly health care providers
Owoeye et al,[48,a] quasiexperimental pre-post	Canada	Sport: Soccer Setting: Club Age: U18 Sex of athletes: Not reported	Coaches (73)	FIFA 11+	Health Action Process Approach	74% of coaches knew about 11+ program 85% of coaches knew injury risk in youth soccer was high	60% of coaches believed injury was preventable 93% of coaches believed 11+ could ↓ injury risk	Barriers: time constraints (52%), lack of player interest (10%), lateness of players to sessions (10%), limited space (9%), and cost (7%)

Table 3. Continued From Previous Page

Author, Study Design	Study Location	Sport Descriptions	Population (n)	Methods		Theoretical Domains Framework		
				Injury-Prevention Training Program	Framework or Theory Used	Knowledge	Beliefs About Capabilities and Beliefs About Consequences	Environmental Context and Resources
Räisänen et al,[47] cross-sectional survey	Canada	Sport: Basketball Setting: High school and club Age: Youth Sex of athletes: Male and female	Coaches (50)	No specific program	Health Action Process Approach	Half of coaches learned of IPEPs in last 12 months Did not all use effective exercises: aerobic (100%), agility (80%), strength (71%), and balance (27%)	92% of coaches agreed that neuromuscular training ↓ injury All coaches believed injury prevention was important 67% disagreed that none of their players would be injured during next season	Information gathered from colleague or coach (68%), internet (32%), health care professionals (23%), other sources such as coaching courses, university courses, experience in sport, or other experts (45%)
Shill et al,[59,a] pre-experimental pre-post survey	Canada	Sport: Rugby Setting: High school Age: Not reported Sex of athletes: Not reported	Coaches (48)	No specific program	Health Action Process Approach	Exercises used *most of the time* or *always* in warm up routines included aerobic (∼93%), flexibility (∼88%), agility (∼78%), sport specific (∼78%), strength (∼74%), and balance (∼32%)	92% intended to implement program before every game next season 45% believed they would have a player experience injury next season 94% believed it possible to prevent some injuries	NA
Wilke et al,[55] cross-sectional survey	Germany	Sport: Soccer Setting: Club Age: 12–18 (53% of respondents) Adult (47% of respondents) Sex: Male	Coaches (1223)	FIFA 11+	NA	43% of coaches knew of 11+ program	Believed most important purpose of warm-up was injury prevention	Those with coaching license, who coached at highly competitive levels, and who coached a youth team were more likely to be aware of program If team employed a strength and conditioning coach, knowledge of program was more likely

Abbreviations: ACL, anterior cruciate ligament; FFA, Football Federation Australia; FFV, Football Federation Victoria; FIFA, Federation Internationale de Football Association; NA, data not available; IPEP, injury-prevention exercise program; PRECEDE-PROCEED, Predisposing, Reinforcing, and Enabling Constructs in Education/Ecological Diagnosis & Evaluation/Policy, Regulatory, and Organizational Constructs in Educational & Environmental Development; RE-AIM, Reach, Effectiveness, Adoption, Implementation, Maintenance.

[a] Indicates study that included coach education intervention (only baseline results included in synthesis and analysis).

Beliefs

Coaches' perceptions of injury risk fell under the TDF domain Beliefs About Consequences. Few coaches perceived lower extremity injuries to be a problem for their teams.[28] Some coaches did not anticipate their athletes would be injured in the near future[46,59] and believed that if they did, it would be due to "bad luck."[40] A subset of coaches did not believe their athletes would sustain knee injuries, most believed that knee injuries were preventable, injury prevention was important, and injury-prevention training programs would assist in lowering the injury risk.† Although coaches generally believed that injury-prevention training programs would reduce the injury risk, others were looking for statistical assurance that injury-prevention training programs reduced injury, improved performance, or both.[27,28,40,51,58]

A coach's perception of his or her ability to reduce the injury risk falls under the TDF domain Beliefs About Capabilities. Coaches displayed positive perceptions of injury-prevention training programs[56,57] and believed that injury prevention was their responsibility,[39,40,53] yet many expressed doubt about their ability to implement these programs. De Ste Croix et al[56] found that only about a quarter of European grass-root soccer coaches self-identified as confident to deliver injury-prevention training to their youth athletes. Interviews with 12 southern California high school coaches highlighted a lack of confidence in their ability to choose exercises, properly order them, and adequately teach their athletes how to perform them.[52] Researchers in 1 study noted that most coaches (78%) displayed high self-efficacy scores; however, only 25.2% of the same sample demonstrated high injury-prevention knowledge scores.[46]

Environmental Context and Resources

Findings pertaining to coaches' contextual perceptions fell under the TDF constructs of resources or material resources, environmental stressors, organizational culture or climate, and barriers and facilitators (Table 1). Currently, coaches individually research injury prevention and injury-prevention training programs, which results in information obtained from various sources, not all of which is correct or up to date.[39,40,47,51,52,54] Coaches also cited a lack of time,[27,28,48,49,52] space,[48,52] athlete interest,[28,48,52] support,[46,51] and resources[28,46,48] as barriers to implementation. Investigators in 2 studies[27,40] observed that coaches unanimously agreed that education on injury prevention and injury-prevention training programs should be an essential part of coach education or licensure. Although 84% of coaches said they could access injury-prevention information, only a third said coaching courses included information about injury risk and interventions, and half of those with access to information stated that their clubs were not advocates for interventions or sources for awareness.[51] Additionally, coaches cited a lack of training, administrative support, and availability of materials as factors influencing their use of injury-prevention training programs.[46,50,56]

†*References 28, 39, 41, 47–50, 52, 54–56, 58–60.*

DISCUSSION

The aim of our scoping review was to explore and summarize the current literature regarding youth sport coaches' knowledge, attitudes, beliefs, and contextual perceptions of injury-prevention training programs. We organized these findings within the TDF. Coaches displayed largely positive attitudes toward injury-prevention training programs and believed they could reduce injury (Beliefs About Capabilities and Beliefs About Consequences domains), but large gaps in coach knowledge persisted (ie, constructs of general knowledge and procedural knowledge). Additionally, the effects of environmental context and resources on implementation were not evaluated as frequently as knowledge, attitudes, and beliefs, and when they were assessed, important factors related to social determinants of health were often left out.

Based on these results, we are the first to demonstrate that information about the effectiveness of training programs to prevent ACL injury has not reached youth sport coaches. These coaches are charged with training young athletes whose risk of injury has risen exponentially in recent years.[4] Our findings also indicate varied degrees of knowledge among coaches about risk factors for and consequences of an ACL injury, as well as the interventions available to reduce risk and how to successfully implement them. Developing mechanisms to broaden coaches' knowledge of the effect that participation in an ACL injury-prevention training program can have on their athletes is essential.

Use of the TDF and associated frameworks is a viable option to aid in the development of such mechanisms. The TDF creators, namely, Susan Michie and her research team,[61] also identified specific behavioral change strategies to address the barriers and facilitators in each domain. These strategies can be further developed into interventions through the use of the Michie et al[62] COM-B framework and Behavior Change Wheel. Developers of the COM-B suggested that 3 conditions, namely, capability, opportunity, and motivation (COM), can be used to influence behavioral (B) change. This technique of mapping strategies to TDF domains has been successful in a school setting. After the barriers, TDF domains in which they fell, and application of appropriate intervention strategies were identified, researchers[63–65] found increases in overall compliance with a nutrition program in Australia. Based on the barriers we identified in this review, potential intervention strategies based on the Michie guides include those that provide information regarding behavior and its outcomes, increase and rehearse skills, and provide feedback. All of these strategies could be taught through coach education programming.

Injury-prevention education for coaches was suggested by a number of authors.[40,48,50,55–57,60] Investigators in 4 studies[27,46,51,54] went so far as to propose policy changes mandating the incorporation of such information in coach education and licensure requirements. Injury-prevention education programs have been effective strategies in the past. After an educational intervention, coaches were successful in delivering an injury-prevention training program consistently to their teams.[27,66–68] Switzerland and New Zealand were successful in implementing injury-prevention training programs countrywide[69,70]; however, such an undertaking would be considerably more difficult

in a country the size of the United States with less cohesive youth sports organizations. Targeting individual coaching associations or school districts instead may be more feasible.

Athletic trainers are in ideal positions to deliver such train-the-trainer education to coaches. Although it is difficult for secondary school athletic trainers to reach every team every day, they do have established, trusting relationships with coaching staffs. Athletic trainers are health care providers who are experts in injury prevention and reliable sources of injury-prevention information. Training coaches to deliver injury-prevention training programs allows information to be delivered more widely to student-athletes, with little increased demand on athletic trainers' already limited time. Providing athletic trainers with intervention strategies that coaches find acceptable, appropriate, and feasible will be important if we are to make the most of this opportunity.

Previous researchers[69,71] suggested that educational programs appeal most to coaches when their individual experiences are acknowledged and appreciated and the material is delivered in a "propose" rather than "impose" manner, allowing coaches to adapt the program to their sport and team needs. Additionally, coaches place a great deal of importance on practical, field-type experiences and training, as it applies to both injury-prevention education[27,48,50,56] and general coach education and development.[71,72] Just as important is the opportunity for coaches to interact with and learn from each other. Mentoring is a crucial piece of a coach's development; therefore, allowing time to practice skills together, receive critiques from peers rather than program implementors, and engage in critical thinking with like-minded colleagues to troubleshoot common barriers is essential.[48,71–73] Packaging injury-prevention information appropriately may increase its appeal to coaches. Furthermore, providing accessible and applicable injury-prevention education to youth sport coaches takes the onus off coaches to find and determine what information can be trusted.

Here, we demonstrated that coaches believe injury prevention is important and that injury-prevention training programs work. However, if they do not believe their athletes will experience ACL injuries, implementation remains in question. Although McKay et al[39] found no correlation between coaches' knowledge and beliefs about injury risk and prevention and team adherence to injury-prevention training programs, they did suggest that injury-prevention programs should be tailored to the needs and motivations of the intended audience. Conversely, Møller et al[40] identified that beliefs and attitudes, along with experiences, about injury risk and prevention affected injury-prevention training program uptake and posited that these factors should be better understood by program developers. Continued research is needed in this area to further clarify beliefs about injury risk (TDF domain of Beliefs About Consequences) and injury-prevention training programs that contribute to implementation decisions.

Of the investigations included in this review, researchers of 5 studies[46,48,51,52,56] evaluated self-efficacy and its effect on implementation or planned implementation. It is important to note that self-efficacy is a construct in the TDF domain of Beliefs About Capabilities and thereby influences implementation. In 1 study,[46] the authors reported high levels of self-efficacy among 78% of coaches, and yet, 75% of coaches displayed poor injury-prevention knowledge scores. This information indicates that, in some cases, coaches may not be applying appropriate injury-prevention strategies, highlighting the need for better knowledge translation from research to practice in this population. Self-efficacy, although important, is insufficient to ensure appropriate implementation. In Spain, where 37% of coaches expressed confidence in their ability to implement programs, implementation remained around the 20% mark (22%).[56] Similarly, Frank et al[74] discovered that soccer coaches' intent to implement injury-prevention training programs did not result in actual implementation. Future researchers should continue to hone the use of behavioral theory, not just as a postintervention measure but in the creation of the intervention itself. Application of the COM-B model and Behavior Change Wheel[62] lends itself well here. As the authors of the studies included in this review described, creating tailored interventions that address the needs, motivations, and perceived barriers of coaches is important[41,48,49,51,52,60] and currently missing in the United States.

Along with addressing the individual factors that affect implementation, more exploration is required to fully understand the effect of environmental context on the implementation of injury-prevention training programs. Historically in sports medicine, we have thought of ACL injury-prevention training program implementation as a 1-phase process. As researchers realized that evidence-based ACL injury-prevention training programs were not being used, much work was done to understand barriers to and facilitators of (Environmental Context and Resources domain constructs) program implementation. Despite the recognition of common barriers (lack of time, knowledge, and resources[28,48–50,52,56]) and common facilitators (administrative support, access to education programs, and confidence in the ability to deliver programs[27,40,50,55]), few investigators have evaluated viable implementation strategies to address these barriers and facilitators. The identification and development of implementation strategies and preparing implementors for the injury-prevention training program are phases we have failed to target in the larger implementation context.

The use of implementation science strategies is supported in the realm of sports injury prevention,[75–77] and the field of implementation science offers an array of frameworks to help tackle gaps in the current implementation procedure. Nilsen[78] identified several categories of implementation theories, models, and frameworks that provide guidance for choosing the appropriate framework for the task at hand. Nilsen's categories included process models, determinant frameworks, classic theories, implementation theories, and evaluation frameworks.[78] Some of these frameworks and theories have already been used in an injury-prevention context. For example, RE-AIM,[79] PRECEDE/PROCEED,[80] and the Consolidated Framework for Implementation Research (CFIR)[81] have all been applied to evaluate barriers to and facilitators and implementation of ACL injury-prevention training programs.[34,49,52] Moreover, Padua et al[31] and Finch et al[32,82] provided the injury-prevention community with process models specific to our context. The field of injury prevention would benefit by broadening our use of implementation frameworks beyond

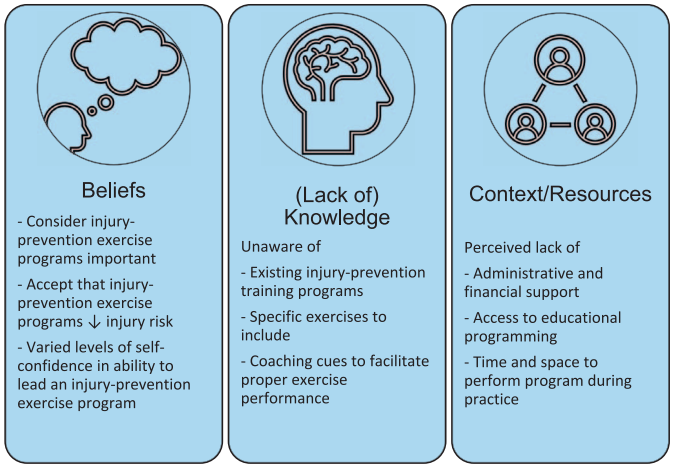

Figure 2. Main themes synthesized from the literature review.

process and evaluation. As both CFIR and TDF fall under determinant frameworks and address domains of concern identified through this literature review, their use in future research may be helpful.

A gap in the literature about identifying the motivations, needs, and priorities of school-organized, youth sport coaches in the United States remains. One reason for this lack of attention in the United States may stem from the largely decentralized structure of youth sport. Whereas the United Kingdom and other European countries have organized youth club soccer so that organizations are under the same umbrella, this is not the case in the United States. Some teams are associated with organizations such as USA Basketball and the US Soccer Federation, but countless independent clubs and Amateur Athletic Union organizations, in addition to middle and high school teams, provide opportunities for youth athletes to play. This decentralized structure makes it more difficult to gather information and also decreases the applicability of injury-prevention training programs as well as coach education programs. As sport is such an important part of the culture in the United States, we need to make sure young athletes are participating safely, regardless of the organization in which they play. The wide variety of organizations, coaches, and athlete needs makes it all that much more important to understand the context, needs, and motivations to help facilitate successful implementation of injury-prevention training programs.

The use of a determinant framework focused on individual domains, such as the TDF, will be helpful in organizing constructs contributing to the decision to implement ACL injury-prevention training programs. Our synthesis of the available evidence revealed coaches' disappointment in the lack of support, resources, and time related to the implementation of injury-prevention programming as well as their inability to access injury-prevention education (Figure 2).[39,41,46,49,56] Reaching coaches of all athletes, regardless of race, location, and socioeconomic status, is necessary to ensure nondiscriminatory access to injury-prevention training programs, which can then influence equitable quality of life post–sport participation.

A limitation of the studies fitting the inclusion criteria for our scoping review was the lack of information regarding coaches' race or ethnicity, the rural or urban nature of the teams they coached, the socioeconomic status of the area in which they coached, and the level of education of the coaches themselves. As such, in future examinations, pairing the TDF with another determinant framework that considers constructs outside the individual, such as CFIR, will assist in addressing those concerns. Additionally, most of the studies that qualified for this review were conducted in high-income countries, focused on sport organizations classified as *elite*, *top tier*, or *of the highest level* and primarily included coaches of male basketball and soccer teams. Future authors should evaluate the knowledge, beliefs, and perceptions of coaches located in nations of different income levels who work with lower-level athletic organizations across sport and gender categories to ensure the appropriate development of intervention strategies.

Our study was not without limitations. As a systematic scoping review, it was not eligible for registration with PROSPERO. Also, due to the nature of scoping reviews, no critical appraisal of the studies was conducted. Except for these limitations, the remainder of the items on the PRISMA-ScR checklist were addressed and reported (see Supplemental Table, available online at 10.4085/1062-6050-0215.22.S1). Furthermore, although only 1 author (L.E.H.) performed the database search and initial extraction of studies, final inclusion was confirmed separately by 2 authors (L.E.H. and D.A.P.).

The integration of implementation science strategies in the area of injury prevention remains a new concept with much opportunity to expand the field and develop a greater understanding of their interplay. Researchers thus far have primarily used implementation science frameworks in an evaluative manner. Additionally, although researchers have been successful in the identification of appropriate components of injury-prevention training programs, less has been done to prepare coaches for implementation. Athletic trainers, once equipped with effective strategies, are perfectly positioned to prepare and assist coaches in delivering programs. Moving forward, it is important to understand diverse, American youth sport coaches' readiness to implement and integrate determinant frameworks to identify domains that should be attended to. Strategies used to address readiness for and barriers to implementation should align with identified domains of determinant frameworks and be rooted in behavioral change techniques.

SUPPLEMENTAL MATERIAL

Supplemental Table. Preferred Reporting Items for Systematic Review and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) Checklist.

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