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The Effect of a Tailored Pre-Season Workshop on Preventive Training Program Adoption and Related Athlete Outcomes

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The Effect of a Tailored Pre-Season Workshop on
Preventive Training Program Adoption and Related Athlete Outcomes

Hayley Jordan Root, PhD
University of Connecticut, 2017

ABSTRACT

Background: Over 40 million children participate in organized sport in the United States annually, but each day approximately 8,000 children are treated in emergency departments (EDs) due to sport-related injuries, resulting in over \$925 million in health care costs. Exercise-based preventive training programs (PTPs) used as a team warm-up can reduce injuries dramatically but youth coaches do not commonly use PTPs. Understanding barriers and facilitators that drive PTP adoption and compliance at the youth sport level could dramatically enhance PTP dissemination and propagate injury reduction in athletes. Further, determining the relationship between coach compliance with PTPs and the effect on athlete injury risk is necessary to promote PTP adoption.

Purpose: The purposes of this dissertation were to evaluate the impact of different educational strategies (Generalized, Tailored) on youth soccer and basketball coaches' behavior drivers for PTP implementation. A secondary purpose was to apply an implementation framework to different youth sport organizations to evaluate which areas of implementation may be more challenging. A final purpose was to evaluate the impact of a coaches' educational workshop on athlete movement technique following one season.

Study Design: Cluster randomized controlled trial.

Methods: Mixed methods approach. Youth soccer and basketball coaches volunteered to participate. Coaches were randomized by league into a Tailored or General workshop. We

evaluated coaches' attitudes, subjective norms, perceived behavior control, and behavioral intention to adopt a PTP using a pre- and post-workshop survey consisting of Likert-scale and open-ended questions, as well as a post-season questionnaire to evaluate PTP implementation. Athletes completed a PRE and POST season movement assessment.

Results: There were no significant differences between workshop groups on attitudes, subjective norms, perceived behavioral control, or behavioral intention to adopt. Establishing the administrative team was the most challenging framework step to complete. There were no significant differences between workshops on athlete movement technique from PRE to POST but there was a main effect for time ($P=0.03$).

Conclusions: A generalized workshop design was as effective as a tailored workshop in increasing some aspects of coach injury prevention behavior as well as athlete movement technique.

Key Words: Injury Prevention; Athletes; Education; Adolescent; Sports

END OF ABSTRACT

The Effect of a Tailored Pre-Season Workshop on Preventive Training Program Adoption and
Related Athlete Outcomes

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B.A., The University of North Carolina at Chapel Hill, 2011

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A Dissertation

Submitted in Partial Fulfillment of the

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University of Connecticut

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Hayley Jordan Root

2017

APPROVAL PAGE

Doctor of Philosophy Dissertation

The Effect of a Tailored Pre-Season Workshop on Preventive Training Program Adoption and
Related Athlete Outcomes

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CHAPTER I: INTRODUCTION

Background

Over 40 million children participate in organized sport in the United States annually, but each day approximately 8,000 children are treated in emergency departments due to sport-related injuries, resulting in over \$925 million in health care costs.(2) One solution to temper these costly injuries is to implement exercise-based preventive training programs (PTPs). PTPs that focus on neuromuscular control training can reduce injury risk by 50-70% at no financial cost to the athlete.(3) Further, focusing PTP efforts in a youth population may be most efficacious in order to improve neuromuscular control prior to the maturation growth spurt and prior to late adolescence, when an individual is at greatest risk for sustaining an anterior cruciate ligament injury.(1, 4-6) Initial research promoting PTP adoption in youth sport focused on researcher-led PTPs to evaluate program effectiveness. Researcher-led PTPs have been shown to reduce injury risk, injury rate, and improve sport performance, but are not sustainable. Current evidence suggests that there is a direct relationship between high PTP dosage and long-term injury risk reduction, indicating a need for athletes to adhere to PTPs with high fidelity. In order to facilitate long-term PTP compliance and maintenance, coaches must be empowered to conduct PTPs independently. However, in community level youth sports, coaches have a spectrum of injury prevention knowledge and experiences, frequently resulting in inadequate PTP compliance.(2) Coach attitudes and knowledge may influence the intention to adopt a PTP.(6) Other perceived barriers or facilitators, such as league oversight or support from other coaches, may predict a coaches' PTP adoption. As initial adoption is the first step toward PTP compliance, there is a need to identify predictive factors, barriers and facilitators, that impact coach adoption behavior

and make PTPs feasible for widespread dissemination.

Objective

The overall objective of this study is to refine coaching education strategies to promote PTP dissemination at the youth sport level. Once we determine barriers and facilitators to coaches' behavior change through an initial needs assessment, we will be able to streamline education and training to promote PTP adoption and compliance. Traditional approaches to PTP education have targeted coaches by addressing barriers and facilitators with general education components. A tailored approach to PTP education would use an initial assessment to gather information about the specific group of coaches and to then personalize the education to address self-identified barriers. Our **central hypothesis** is that an educational workshop focusing on areas of the coaches' perceived greatest deficit (Tailored) will lead to greater rates of PTP adoption and compliance, as well as decreased athlete injury risk outcomes, compared to a traditional educational workshop (Basic). Tailored approaches have been shown to increase attendee motivation and make a sustained impact to behavior change.⁽¹⁾ We are strongly qualified to successfully complete this project based on a combined 15 years of experience collaborating with sport leagues, implementing researcher-led PTPs, and evaluating injury risk in youth athletes.

Research Questions

Research Question #1: Do knowledge, attitudes, and/or intention behaviors regarding PTP implementation change immediately following a coaches' workshop?

- Independent Variables: time (PRE, POST-workshop)
- Dependent Variables: knowledge, attitudes, intention behaviors as measured by an adapted questionnaire (Appendix)
- Potential Covariates: age of coach, sex of coach, age group of team, sex of team, years of experience, years within league, previous PTP experience
- Working Hypothesis: knowledge, attitudes, and intention to adopt a PTP will improve immediately following a coaches' workshop as compared to pre-workshop.

Research Question #2: What are key predictors for PTP initial adoption by coaches in youth soccer league? Do predictors differ between soccer organizations?

- Independent Variables: age of coach, sex of coach, age group of team, sex of team, years of experience, years within league, previous PTP experience, personal injury history, athlete injury history, knowledge/attitudes/behaviors following coaches' workshop
- Dependent Variables: PTP initial adoption in first 2 weeks of season
- Working Hypothesis: Performance benefits and perceived relative advantage of PTP over current practices will positively influence coach PTP adoption. The more elite level soccer organization will be more driven by performance benefits.

Research Question #3: What are the effects of a Tailored workshop compared to a Basic workshop on in-season PTP compliance?

- Independent Variables: workshop group (Tailored, Basic)
- Dependent Variables: implementation of PTP by each team as measured through post-season coach questionnaires
- Working Hypothesis: Coaches in Tailored will show increased compliance compared to coaches in Basic.

Research Question #4: What are the effects of a Tailored workshop compared to a Basic workshop on athlete injury risk?

- Independent Variables: workshop group (Tailored, Basic)
- Dependent Variables: athlete injury risk (LESS) score at POST
- Potential Covariates: age, sex, baseline LESS score, team adoption/compliance (dosage), sport hx, injury hx
- Working Hypothesis: Athletes on teams whose coach attended Tailored will show greater improvements in LESS compared to athletes on teams whose coach attended Basic.

Research Question #5: Do knowledge, attitudes, and/or intention behaviors regarding PTP implementation change following a single sport season?

- Independent Variables: time (PRE, POST-season)
- Dependent Variables: knowledge, attitudes, intention behaviors as measured by an adapted questionnaire (Appendix)

- Potential Covariates: age of coach, sex of coach, age group of team, sex of team being coached, years of experience coaching, years within specific organization, previous PTP experience, level of adoption/compliance
- Working Hypothesis: Coaches who attended Tailored will show greater improvements in knowledge, attitudes, and intention behaviors compared to coaches who attended Basic.

This proposed study is conceptually innovative as it will provide a tailored, evidence-based PTP education strategy to community-level coaches with diverse backgrounds and experience. We will identify specific barriers and facilitators and simplify pre-season education to succinctly address the coaches' own concerns. This approach will refine implementation frameworks for community level youth sport coaches. Information garnered from this study will serve as a foundation for future e-health models with automated needs-assessments and educational materials to promote widespread dissemination of coaching education.

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CHAPTER II: REVIEW OF THE LITERATURE

Impact of Sport-Related Injury

Benefits of Sport and Physical Activity

Involvement in sport plays an important role in youth physical, mental and emotional

development.⁽²⁾ Serving as a catalyst for lifelong physical activity, participation in youth sport has been linked to decreased risk of chronic diseases, such as Type II Diabetes, heart disease, stroke, cancer and obesity. Physically active children have increased mental and emotional development, improved self-concept, and physical activity may have a protective effect against depressive symptoms and non-suicidal self-injury in adolescent populations.⁽²⁻⁵⁾ Additionally, active children are 15% more likely to attend college and have roughly 40% higher test scores in the classroom compared to youth who are not physically active.^(2, 4)

Youth Sport-Related Injury

Anatomical Differences in Adolescents

However, youth sport can also result in injury. As children are growing and physically maturing, there are anatomical characteristics that predispose adolescents to injury. When comparing a child's musculoskeletal system to an adult, children have ligaments that are functionally stronger than their bones and the bones typically grow prior to muscle and tendon lengthening, leading to functional challenges for motor control of the body and increasing risk of sport-related injury.⁽⁶⁻⁹⁾

Risk of Injury and Consequences

Sport-related injuries constitute 20% of all emergency department visits in children aged 6-19,² contributing over \$935 million to the health care burden annually.^{3,(10)} Logically, the more time one spends engaging in a sport or physical activity, the greater the possibility of sustaining an

injury.(11, 12) In one study examining risk factors for sports injuries, increases in number of sport participation hours per year was linked to an increased risk for sustaining a sport-related injury. Further, older age and playing a contact sport were both associated with using non-steroidal anti-inflammatory drugs (NSAIDS) for sports injuries and likelihood of having surgery for a sports injury.(13) One specific example involves anterior cruciate ligament (ACL) injuries, where males are most likely to sustain an ACL injury between 19-25 years of age and females are most likely to sustain an injury between 14-18 years of age.(14) Improving neuromuscular control and teaching coordination prior to and throughout maturation may be most efficacious to prevent sport-related injuries, making youth a target population for interventions.

The Anterior Cruciate Ligament (ACL) and Knee Osteoarthritis (OA)

ACL injury is a debilitating knee injury for physically active individuals. Mechanisms of injury can include contact and indirect contact methods. For contact ACL injuries, a person receives a large external force directly to the knee, such as a direct blow from an opponent, object, or the ground. An indirect ACL injury would be when no large external force is directly applied, for instance when a person is running, plants and cuts in a different direction.(15) Estimates suggest roughly 250,000 ACL injuries occur each year in an athletic population and of those injuries, 175,000 elect to undergo surgical reconstruction.(16) Registry databases show that ACL injury rates, as well as ACL reconstruction rates, have increased since 1994, potentially due to patients' desires to return to high levels of activity.(14) These injuries can increase the likelihood of future orthopedic chronic conditions and athletes who experience ACL tears are less likely to return to pre-injury level of sport and are more likely to experience long-term sequelae.^{3,(17, 18)} This is significant when considering long-term outcomes and risk for future disability in a youth cohort. Knee osteoarthritis is a condition that can be initiated or exacerbated by age or from an acute orthopedic injury.(19) Knee osteoarthritis is a degenerative joint disease with a combination of: articular cartilage erosion, bone remodeling, osteophyte

formation, ligamentous laxity, weakening of surrounding musculature, and synovial inflammation.(20) These symptoms drive the development of clinical symptoms such as joint pain, stiffness, and range of motion limitations. Because the disease progresses over time, symptoms may become so severe that the patient has issues with daily living mobility or requires a total knee arthroplasty.(21, 22) People over the age of 50 who had a previous history of knee injury had a 283% increased risk of developing osteoarthritis (OA) compared to people who did not have a history of knee injury.(23) One systematic review showed that, specifically for people who sustained an ACL injury, the risk of developing radiographic signs of OA seemed to occur regardless of surgical intervention.(24) However, recent evidence with a mean follow-up of 13.7 years after surgery indicates that early ACL-reconstruction (ACL-R), or deciding to have surgical reconstruction within a year of injury, resulted in decreased likelihood of developing a secondary meniscal tear, being diagnosed with symptomatic knee osteoarthritis, and undergoing total knee arthroplasty.(25)

While there are clear benefits of physical activity, the risk of injury and long-term sequelae also indicate a need to implement injury prevention methods to optimize a safe playing environment and minimize sport-related injury.

Benefits of Preventive Training Programs

What is a Preventive Training Program?

Fifty to 75% of lower extremity injuries, including ankle sprains, stress fractures, and ACL injuries, can be prevented through the use of cost-effective exercise-based neuromuscular control (NMC) preventive training programs (PTPs). PTPs can be designed as a 10-12 minute pre-athletic participation warm-up. A typical PTP includes components of: flexibility with a focus on the lower extremity, balance, agility plyometrics, and core strength.(26, 27) Additionally, the warm-up is designed to gradually increase in intensity and contain dynamic movements that

mimic actual game play (i.e. shuffling and back pedaling). A final key component of effective PTPs is the emphasis on proper movement instruction and feedback.(28, 29) Research-led PTPs designed with these components in mind have been shown to successfully reduce injury risk, reduce injury rate, and improve performance in youth athletes.(30-33)

Reduced Injury Rate

To promote PTP adoption potential, PTPs should be specific to each team's athletes and organizational needs. Due to the inherent variation in athletes, teams, and sports, previous literature evaluating the impact of PTPs on injury rate reduction in a youth population have found mixed results.(32, 34-59)

Some PTPs require outside materials, such as wobble boards, for the prescribed intervention, with varying success in reducing injury rates;(34, 36, 40, 47, 49-52, 55, 59) however, this may not be feasible for all teams, ages, etc. Other PTPs, such as the PEP, F11+, and HarmoKnee, are programs that take 15-25 minutes to complete, replace the team pre-activity warm-up, require no outside equipment, and have found overwhelming success in reducing injury rates.(32, 35, 41, 44-46, 48, 54, 56, 58) Programs that did not see changes or improvements in injury rate reduction often cited poor compliance with the prescribed programs, an important consideration for PTP implementation.(57, 60, 61) Overall, however, there is potential for short, free, adaptable warm-up programs that can provide injury rate reduction benefits in a youth population.

Reduced Injury Risk

Musculoskeletal injury risk is multifaceted and is affected by several different factors (Figure 1 below). Muscle fatigue, flexibility or strength imbalances, or a lack of proprioception and balance have been cited as potential risk factors for sport-related injury.(62-69) PTPs aim to improve

modifiable risk factors in order to temper injury risk and literature indicates that these factors can

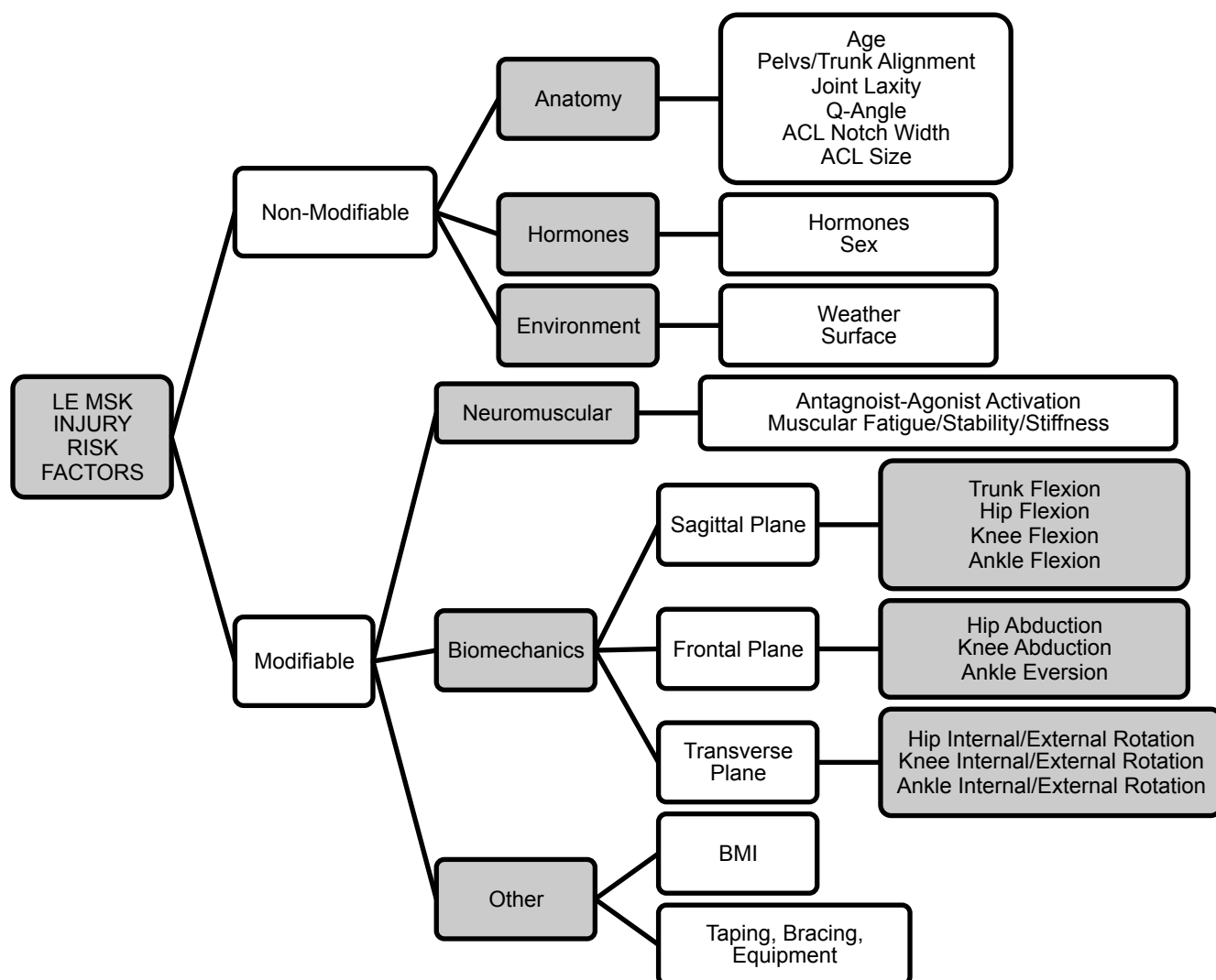


Figure 1. Lower Extremity (LE) Musculoskeletal (MSK) Injury Risk Factors

be improved with a PTP warm-up format in a youth population.(30, 31, 70-72)

Further, a study by Leppanen et al.(73) evaluated knee control during a jump landing task between youth basketball and floorball athletes. This study found that basketball athletes, who presumably engage in high levels of jumping during sport, had poorer knee control compared to floorball athletes whose sport inherently involves much less, if any, jumping. These findings indicate that biomechanics and motor control may not be inherited through the demands of a

sport and rather movement control needs to be consciously taught to athletes, particularly in high musculoskeletal injury risk sports such as basketball, which has a high injury rate in general and at the ACL specifically.(10, 74) Additionally, motor competence, or the ability to execute different motor tasks like coordination and fine motor skills, has been shown to positive correlate with self-perceptions and an adolescent's likelihood of participating in sport. Thereby, improving motor control may reduce an athlete's risk of sustaining injury and it may also increase an athlete's desire to engage in physical activity, exponentially increasing a person's odds of staying physically active longer.(75)

Cost Saving Strategy

Defining the exact financial burden of youth sport-related injury can be challenging. This is in part due to breadth of healthcare providers parents choose to take their children, which can range from emergency departments, urgent care offices, family pediatricians, orthopedics, etc., making data collection and interpretation difficult. However, one Canadian exploration of youth sport-related injury estimated that for every 100 youth participating in sport there are nearly 30 injuries that are treated medically.(76) In a randomized controlled trial comparing youth soccer teams implementing neuromuscular PTPs and control teams, teams using PTPs had a 43% reduction in healthcare cost utilization, which could be extrapolated to nearly \$3 million dollars in savings.(77) Reviews of a specific PTP popular in Europe and Canada, the FIFA 11+, have further supported that use of the PTP reduces healthcare costs, and decision-analysis models have estimated that implementing a PTP could save approximately \$100/athlete/season.(78-80)

Improved Performance

Athletes and coaches in a competitive league may be most motivated by performance measures.(81) There are a limited amount of studies evaluating a short-duration PTP (15-25 minutes) impact on performance measures,(31, 71, 82-85) and baseline levels of functional

movement ability, relative age, and development age and maturation may complicate interpretations.(86, 87) However, as coaches may find performance improvements most worthy of time, the relationship between PTP and meaningful performance measures should be evaluated.(88-90)

An emerging movement in youth sport is the concept of physical literacy, defined as “the motivation, confidence, physical competence, knowledge, and understanding to maintain physical activity throughout the life course.” This moves beyond the idea that physical ability is the singular determinant of athletic success. Instead, physical literacy champions that the intersection of internal motivation, perceived ability, and actual ability is what will allow an athlete to develop and continue to engage in physical activity. Due to the previously mentioned variability in sport experience, sport exposure, and physical maturation skewing the impact of PTPs on performance measures, perhaps physical literacy would be a more appropriate measure of PTP performance benefit at the youth level.(86, 87, 91-93)

PTP Compliance, Fidelity, and Adherence

In order to experience and retain positive training results, PTPs must be done with high compliance, fidelity, and adherence. Operationally, compliance indicates that a PTP was completed in general and answers the question, “*Was a program completed?*”, whereas fidelity refers to the quality of the performance and if the exercises were performed correctly.(60, 94) Adherence describes the continued PTP behavior – does the team or player utilize the PTP regularly across time.(60) In general, the PTP implementation process begins with (1) a coach or team possesses the appropriate knowledge, attitudes, and behaviors to buy-in and intend to adopt a PTP, leading to (2) initial adoption of a PTP, which if continued over a period of time would develop characteristics of (3) compliance, fidelity and adherence with PTPs. Ultimately, compliance, fidelity, and adherence contribute to program dosage, which is a measure of how much exposure an individual athlete gets to a PTP – there are multiple components impacting

this measure including: duration of individual session, number of times the PTP is performed in a given week, number of weeks in a given season, etc. Research has indicated that increased PTP dosage can improve retention of neuromuscular outcomes.(33) With that, Step 3, components that impact dosage, leads to our step (4) of athlete outcomes, where the goal of PTP usage is to reduce injury risk and injury rate long term (Figure 2, below).

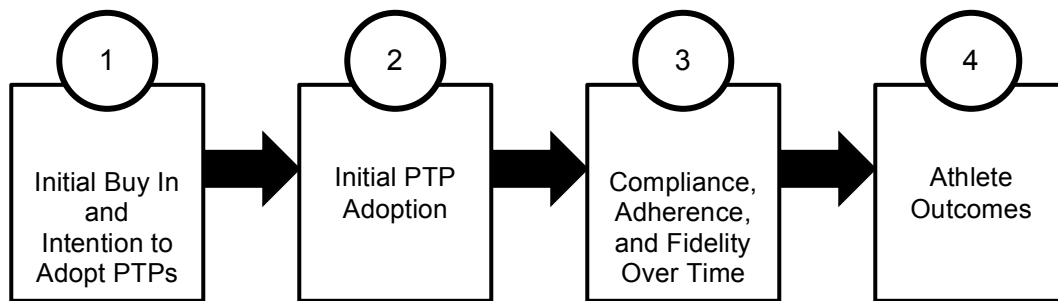


Figure 2: Simplified Flow of the Implementation Process

Promoting Health Behavior Change

Health Behavior Frameworks

To examine barriers and facilitators to health behavior change, the *Theory of Planned Behavior* is composed of three main constructs: attitudes, subjective norms, and perceived behavioral control, that are reasoned to impact a person's intention and subsequent control over a specific behavior. Frank et al.(95) recently utilized the Theory of Planned Behavior in conjunction with RE-AIM SSM (*Reach, Effectiveness, Adoption, Implementation, Maintenance in a Sports Setting Matrix*), an evolution of the TRIPP framework, to determine the impact of a coaches' workshop on behavioral determinants and initial adoption of PTPs. This study determined that the pre-season workshop improved behavioral determinants but those improved determinants did not translate into initial adoption of PTPs. Future research is needed to uncover what barriers and behavior drivers motivate PTP implementation.

The *Social-Ecological Model* is a multi-level framework that considers the interplay of relationships (Figure 3, below). This type of model has been used in promoting physical activity to reduce childhood obesity and could be applied to PTP implementation research as a means to illuminate barriers and facilitators to PTP use in terms of key relationships between coaches and their environments. One study examined 3 different states (Arkansas, Georgia, New Jersey) who had recently passed state-level regulations for preventing sudden death in sport in high school athletes.(96) This study sought to identify the “gate-keepers” who worked to create change within each state. Each state had unique infrastructures and personnel that resulted in different answers across states. Understanding a sport league’s own infrastructure and hierarchy is critical to creating meaningful change.

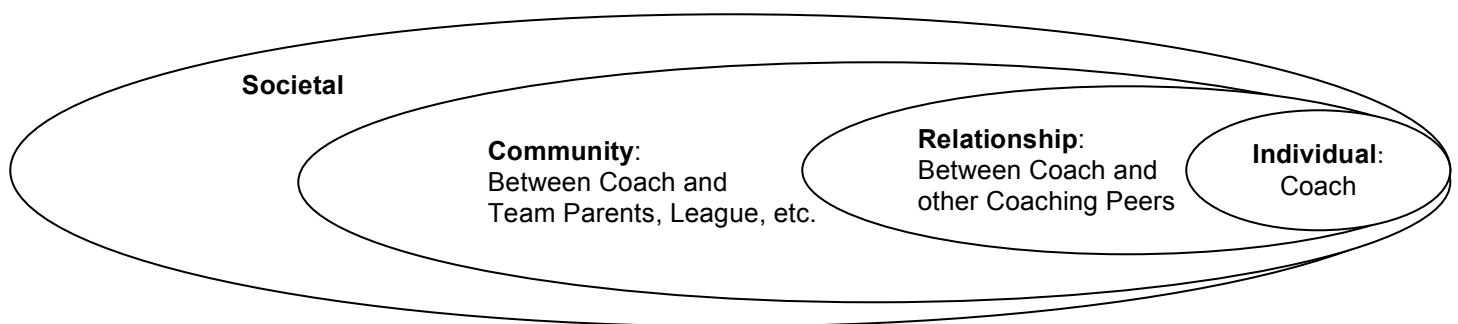


Figure 3. Societal-Ecological Model(1)

Using Frameworks in PTP Implementation

While researcher-led PTPs have increased the efficacy knowledge base, implementation research occurs in a real-world context and health behavior strategies need to be employed in order to account for the variation in human behavior and environment. Over the last decade, few studies outlined appropriate methods for effective real-world dissemination.(97, 98) Finch et al.(99) specifically identified the *Translating Research into Injury Prevention Practice* (TRIPP) framework as a good model to describe injury prevention studies, where Stages 5 and 6 are of particular importance for widespread diffusion and application to different populations (Figure 3).

Stage 5 calls for a thorough description of the context of a given study so that the methodology can be more accurately applied to other populations. Stage 6 is an evaluation of a PTP's effectiveness within the given setting of a study. Padua et al.(100) built on this framework by providing 7-steps to further operationalize the development and implementation of PTPs within the TRIPP framework (Figure 4, below). This expansion is a step-wise approach from identifying the population, to compromising on an effective PTP, to ultimately leaving the population autonomous. Together, these two guides provide a way to systematically understand barriers and facilitators to health behavior within the context of PTP effectiveness. However, despite efficacious, evidence-based programs and roadmaps for implementation, PTPs are not always successful.

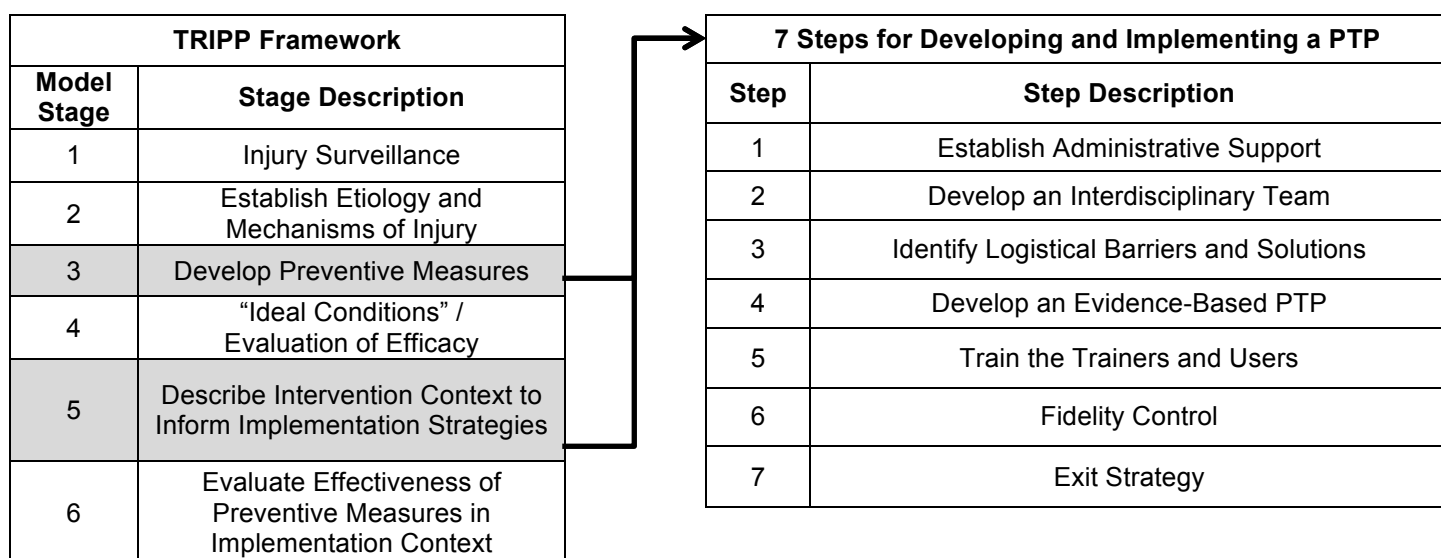


Figure 4: TRIPP Framework Components that Give Rise to Padua's 7 Steps (Adapted from Padua et al.(100))

Why Does Implementation Fail?

Despite progress in reporting and describing of evidence-based PTPs(95, 101), implementation sometimes fails.(102) While many social-cognition and health-behavior change theories exist, the layers and complexities involved with widespread implementation can be challenging – what

makes sense for one population may be unrealistic or ineffective in a different setting. In order to best elucidate why implementation may fail, we need to take another step back from the TRIPP framework identified above to a more generic approach. Intervention Mapping broadly outlines the process(103) (Table 1).

Intervention Mapping		
Step	Step Description	Relevant Theories
1	Needs Assessment	Socio-Ecological Approaches to: (a) the Problem and (b) the Solution
2	Choose Approach	Social Cognition Models: Theory Reasoned Action, Theory of Planned Behavior, Health Belief Model, Protection Motivation Model
3	Plan Feasibility	
4	Plan, Revise, Produce Program Materials	<ul style="list-style-type: none"> • The PTP • Training materials/techniques
5	Plan Adoption, Implementation, and Maintenance	RE-AIM, Context-Specific Community Diffusion
6	Plan Evaluation	Process, Outcome, etc.

Table 1: Steps to Intervention Mapping and Relevant Theories

When viewing the Intervention Mapping technique as a cascade of events, it is easier to see where breakdowns in the process may occur and impede successful attitude and behavior change. The focus of PTP research has been on the implementation process with respect to Steps 1, 2, 5, and 6. This body of evidence has helped to clearly support that there is a direct relationship between PTP dosage and long-term injury risk reduction, indicating a need for athletes to continuously utilize PTPs with high fidelity over the long term.(104, 105)

However, in order to facilitate long-term PTP compliance and maintenance, coaches must be empowered to conduct PTPs independently. In community level youth sports, coaches have a spectrum of experiences and injury prevention knowledge, frequently resulting in inadequate PTP compliance.(106) Up to this point, the push for implementation description has focused on, “Is this PTP effective? Is this PTP worth implementing?” Now that the answer is a clear “Yes”,

conversations need to be directed to, “How can I convince anyone to use this program effectively?”

Few studies have clearly described educational components to use during workshops,(83, 89, 90, 95, 107, 108) and even fewer have followed-up to ensure that the coaches demonstrate the behavior.(83, 95) There is a need to better understand approaches to PTP education in order to reach a variety of coach audiences and to promote attitude and behavior change.

Educational Techniques to Stimulate Learning

Determinants of Behavior – Knowledge, Attitudes and Behavior

“Development of Program Materials” in Step 4 of the Intervention Map (Table 1) can be further broken down into developing (1) the PTP itself and (2) training materials and education techniques to train the trainers. While evidence-based researcher-led PTPs have been identified,(30, 31, 56, 105, 109) there is limited information regarding appropriate curricula and education techniques for workshops.(95, 100, 101)

Initial research into this area has looked at determinants of stakeholder behavior through analysis of knowledge, attitudes, and behaviors.(88, 90, 95, 106, 108, 110, 111) This is framed with the logic that if you know what coaches or players do not know, a researcher can better understand what to review in a training session. This would seem to be a logical flow of events, where if you can improve someone’s knowledge, attitudes, and behaviors, you are at least

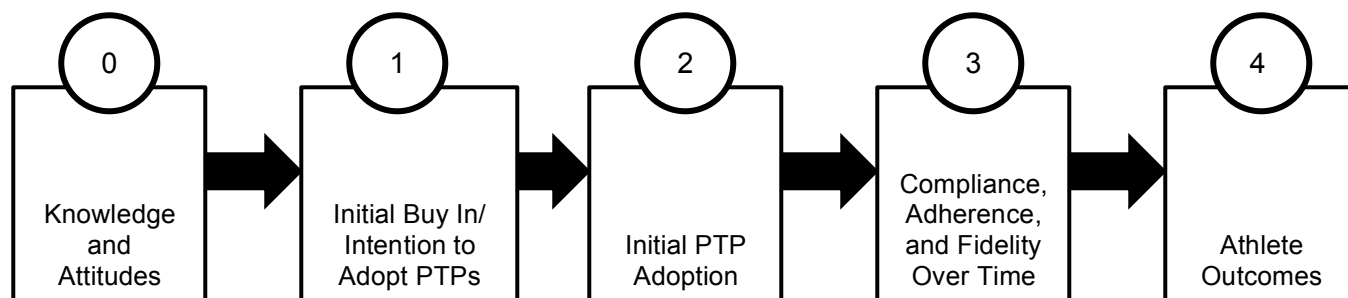


Figure 5: Augmented Flow of the Implementation Process

beginning the cascade toward PTP adoption (Figure 5).

Unfortunately, while pre-season education training sessions have been shown to increase knowledge, attitudes, and intention to adopt PTPs,(83, 95, 107) intention to adopt a PTP does not necessarily predicate actual behavior change.(95) This may be in part because what has been studied thus far are determinants of *behavior*, such as knowledge and attitudes, and these components are not necessarily the same thing as determinants of *behavior change*.(103) Studies investigating coach behavior determinants have called for more exploration of behavior change determinants.(89, 95)

Content of Education

Padua et al.(100) identified pertinent topics of discussion to review during a train-the-trainers session for the US military academy. Over the course of a 2-hour educational workshop, this study prioritized:

- PTP effectiveness
- Alignment with organizational supports
- Knowledge
- Self-efficacy
- Feedback

The effectiveness component focused on the positives of PTP use, such as injury reduction and improved athletic performance. During the training sessions, the research group was able to thoroughly describe each exercise and conduct hands-on training for implementation. While this is a good explanation of a training session, this particular study was afforded 2-hours of the trainees' attention. Conversely, Frank et al.(95) sought to implement a PTP in a youth soccer league and was given 30-minutes to train the coaches. Frank et al.(95) also emphasized PTP

effectiveness in reducing injury and improving sport performance as well as describing individual exercises but had a much shorter amount of time available. Both studies also directed the attendees to supplemental materials online for further reference following the workshop.

The difference in time allotment between these two studies may be a common problem across implementation studies. There is a need to define specific strategies to use when brevity and succinctness are necessary.

Selecting Content - Targeted vs. Tailored Approaches

One way to ensure that a coaches' training includes relevant behavior change determinants is to use a tailored education approach. Previous approaches to coach education have been *targeted* in nature, focusing on general behavior determinants found to be relevant for a coaching population. However, coach populations can vary tremendously, from coaching experience, if the person is a parent or not, what age and competition level the person is coaching, which gender the person is coaching, etc. All of these factors can contribute to a variety of information interests.

A *tailored* approach, on the other hand, would take the specific population of coaches being trained, for instance a single soccer league, conduct a needs-assessment to determine which information would be most motivating for each person, and to then design the educational training based on the findings.(112) While this may seem unrealistic for widespread dissemination, growth in automated algorithms and technology may help to streamline this process in the future. This approach has been successfully utilized in health and wellness strategies as well as in medical school curricula.(112, 113)

Application of Educational Techniques from Other Fields

Discourse

Discourse, or communication language between a teacher and student or student with another student, helps learners to apply content into practice.(114) PTP implementation has been closely linked to program fidelity, and frequently emphasizes the need for continuous feedback on exercise form.(30, 82) During training, it may important to encourage participant communication and to make training as interactive as possible, while limiting didactic lecture.(115) This type of strategy should increase the learners' time spent on task and help the person to engage with the material more deeply, which in turn may improve the learners' self-efficacy and confidence with implementing PTPs independently in the future.(116-118)

Social Cognitive Theory

Social Cognitive Theory (SLT), an expansion of the Social Learning Theory, where a learner is able to learn a behavior based on a combination of observations of the behavior and an understanding of the positive and negative consequences of the behavior.(119) With observational learning, a coach would be watching a researcher or educator set-up and run a PTP. The next step would be active learning, where the coach engages in hands-on learning and works to implement the PTP in a contrived scenario with other coaches in the workshop. In combination with discourse, the coach is able to first learn (discourse), then see (SLT observation), then do (active learning). If followed by a debrief session to address questions and to ensure positive and negative consequences of the behavior are reiterated, this learning sequence may promote an effective long-term learning experience.

Mentorship

One aspect of coach learning that has been studied at a cross sectional level in PTP implementation, is the impact of role-modeling from other coaches and administrative support.(108) In this respect, coaches stated they would be more likely to engage in PTP use if he or she felt that other coaches that he or she considered experts in the field were also using PTPs. To create this social network and social norm, researcher-led mentorship may need to be established for a period of time. Researchers could connect similar leagues to each other to build a social network, or serve as a continued resource for advice and troubleshooting help.

Adult Learning

Other components to keep in mind during education strategizing are the differences between adult and child learners. Adult learning, or andragogy, may consider that adults tend to be more self-directed and incorporate life experiences and knowledge into learning.(120) This is particularly relevant for coaching education, where experience with specific sports, both playing and coaching, will heavily influence a coach's willingness and ability to implement a PTP. Incorporation of previous knowledge and experience can actually be a strength of coaching education, where coaches' can take ownership of their team warm-up while still learning important injury prevention techniques.

Persuasive Strategy – TED Format

TED, or Technology, Entertainment and Design, talks are a succinct, widespread method for approaching lecture presentations. These lectures are massively popular podcasts and are anecdotally effective in relaying a central message to the audience. Applying a TED talk format to future PTP education technologies could be one way of ensuring an interesting, meaningful central message while leaving ample time for hands-on learning and discussion, regardless of if you have 2-hours or 30-minutes with your group.(121)

In general, TED talks are anywhere from 10-18 minutes depending on the session specifications, but are never longer than 18 minutes. TED talks emphasize brevity in making a point unforgettable. Overall, the speaker must identify key, meaty points needed to justify an argument and must support this argument using meaningful examples without over-burdening the audience with statistics. In utilizing a needs-assessment, a PTP promoter will have a batch of important information that the audience wants to know and be able to formulate a TED talk format to streamline education efforts.

In conclusion, there are numerous theories, models, frameworks, and strategies to approach education and PTP dissemination. The last ten years of PTP implementation research has surged in delineating frameworks and describing the steps taken toward to implementation. This same effort needs to be put toward specifically describing educational techniques and strategies to promote coach education efforts and long-term behavior adoption.

Rationale for Dissertation

Despite strong evidence that PTPs can reduce injury risk, injury rate, and improve performance in youth athletes, fewer than 20% of coaches implement PTPs.(106, 110) Particularly at the community level, coaches are frequently volunteer parents and have a wide variety of sport knowledge and experience. Given the challenge of translating PTP use in this particular coach population, there is a need to improve training in order to efficiently educate and motivate coaches to use PTPs. Existing strategies have first focused on the efficacy of an educational workshop toward PTPs within the context of the Theory of Planned Behavior.(95) Coaches' training workshops can improve knowledge, attitudes, and intentions to implement a PTP; however, that intention does not necessarily translate into behavioral change.(95) Other studies

have examined coach barriers and facilitators to PTP adoption at an exploratory level to guide framework design, finding league administration oversight and colleague mentorship to be strong contributing factors to PTP use.(90, 106) A social-ecological model has been utilized in other physical activity interventions, showing success in engaging different layers within an organization's hierarchy.(122) Our current proposal will seek to use the social-ecological model to develop a greater understanding of the interplay between league directors, coaches, and parents, and how those interactions can be used to improve pre-season workshops. We will then use findings to drive a succinct, tailored education strategy. To our knowledge, no study has evaluated the impact of a tailored workshop on PTP intention to adopt, adoption, compliance and the subsequent impact on athlete outcomes.

Preliminary Studies

To promote early adoption of PTPs in youth sport, we have conducted efficacy trials with researcher-led PTPs for youth athletes, as well as collected preliminary effectiveness data with coach-led PTPs. Our current proposal will advance this line of research by evaluating education techniques and monitoring season-long compliance in community level youth coaches.

Acute Effects of PTPs in Youth Athletes

A common barrier to PTP implementation is the perception that PTPs make athletes too fatigued prior to sport. We examined the immediate effects of a static, dynamic, and PTP warm-up on performance measurements and jump-landing technique after a single session.(123) There were no differences between groups for performance measures and the PTP improved jump-landing technique. This refutes that PTPs impair acute performance and supports PTP use.

Influence of PTPs on Neuromuscular Control in Youth Athletes

We evaluated different implementation strategies in researcher-led PTPs to determine if feedback could be simplified when delivering PTP interventions. A cluster-randomized controlled trial with 29 youth soccer teams and approximately 400 participants showed that a simplified PTP was as effective as a traditional PTP. This can help to simplify coach training by focusing on the select key movement correction cues that impact movement training in youth athletes.

Pilot Study – Influence of a Coach’s Educational Workshop on PTP Effects

We hypothesized that coaches could successfully implement a PTP after attending an 60-minute educational workshop. Twelve coaches attended and demonstrated nearly 100% compliance with implementing the program effectively, as evidenced by their athletes improving landing technique (mean difference [post-pre]= -0.8 ± 0.2 , $p < 0.001$). We concluded that youth coaches can effectively implement a PTP after a workshop, but this was a small sample.

Summary of Preliminary Studies

The preliminary studies highlight the experience that our research team has to complete our proposed project. The foundational concepts outlined need to be used in concert to build an optimal PTP implementation dissemination strategy to promote coach-led PTPs and reduce athletic injuries long-term.

Summary and Approach

Despite strong evidence that PTPs can reduce injury risk, injury rate, and improve performance in youth athletes fewer than 20% of high school level basketball and soccer coaches implement PTPs.(106, 110) Particularly at the community level, coaches are frequently volunteer parents and have a wide variety of sport knowledge and experience. Given the challenge of translating

PTP use in this particular coach population, there is a need to improve training in order to efficiently educate and motivate coaches to use PTPs.

Existing strategies have first focused on the efficacy of an educational workshop toward PTPs within the context of the Theory of Planned Behavior.(95) Coaches' training workshops can improve knowledge, attitudes, and intentions to implement a PTP; however, that intention does not necessarily translate into behavioral change.(95) Other studies have examined coach barriers and facilitators to PTP adoption at an exploratory level to guide framework design, finding league administration oversight and colleague mentorship to be strong contributing factors to PTP use.(90, 106) A social-ecological model has been utilized in other physical activity interventions, showing success in engaging different layers within an organization's hierarchy.(122) This dissertation will seek to use the social-ecological model to develop a greater understanding of the interplay between league directors, coaches, and parents, and how those interactions can be used to improve pre-season workshops and ultimately athlete health outcomes.

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CHAPTER III: METHODS

Experimental Design

A randomized, controlled study design will be used to investigate: (1) knowledge, attitudes, and behaviors of key stakeholders (league directors, coaches, parents) regarding PTPs immediately following a workshop (2) key predictors of initial adoption of a PTP (3) influence of a PTP workshop on compliance throughout the season (4) impact of a PTP workshop on athlete injury risk (5) knowledge, attitudes, and behaviors of key stakeholders (league directors, coaches, parents) regarding PTPs immediately following a single season.

Participants and Procedures

We will recruit two youth soccer leagues in Connecticut that differ in competition level (ex. town recreation, travel, or elite) to participate during the Fall 2016 season. Leagues will be required to have at least 10 teams of athletes aged 8-14 years in order to be included in this study. Research personnel and the soccer leagues will identify key stakeholders (league directors (n=2 per league), coaches (n=10 per league), and parents (n=3 per league)).

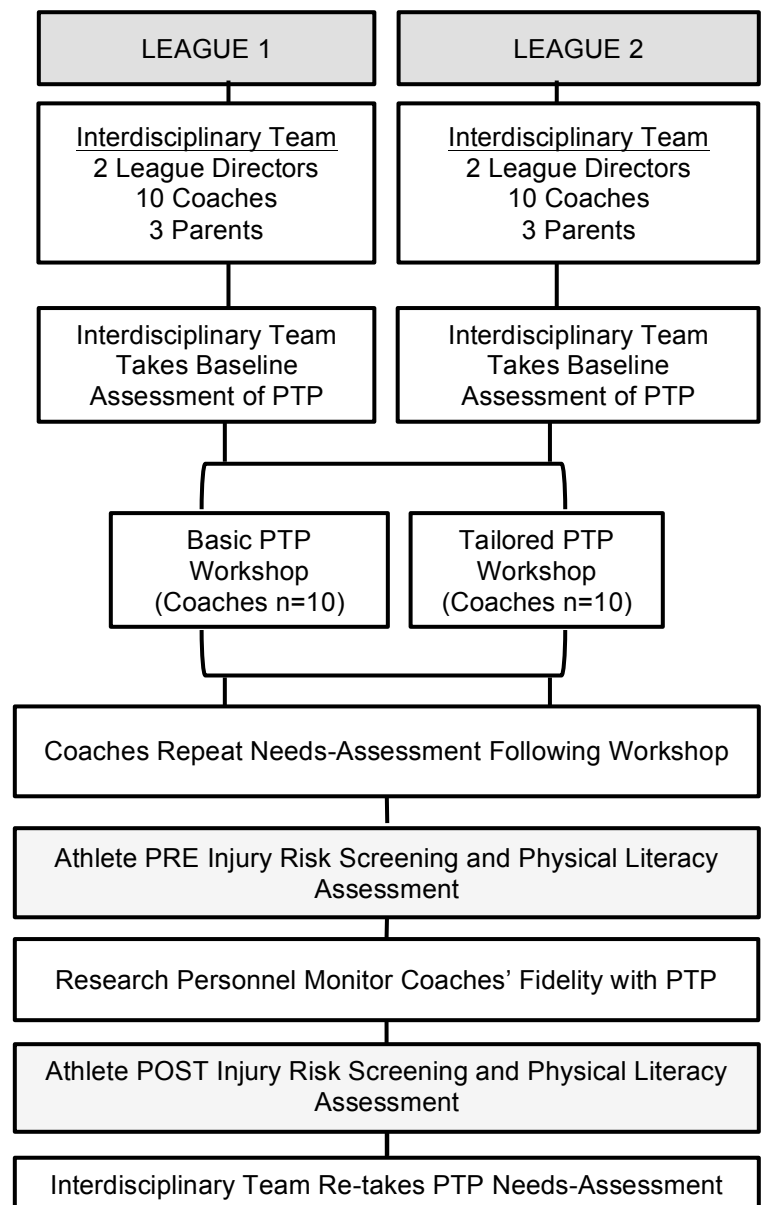


Figure 6: Flowchart of Study Components

Coaches (n=20) will be stratified by the age group and sex of the team he or she coaches and then randomized into one of two pre-season workshop groups: Basic or Tailored. Approximately 200 consented youth soccer athletes (n=100 females, n=100 males) between the ages 8-14 on teams of coaches who attend one of the workshops will complete a 10-15 minute assessment directly at their sport setting prior to the start of practice during the first week of the season (PRE) and again during the last week of the season (POST). The assessment will include an injury risk assessment (Landing Error Scoring System (LESS)) and a physical literacy battery (Figure 6).

Throughout the season, research assistants will oversee team compliance once every 1-2 weeks at the beginning of the team's practice in order to monitor initial adoption (within the first 2 weeks of the season), compliance, and fidelity with the prescribed PTP.

Outcome Variables

Knowledge, Attitudes, and Behaviors

Within each league, coaches will complete a baseline needs-assessment. This needs-assessment will be mixed-model of open-ended and Likert scale questions to assess behavioral determinants including attitudes, subjective norms, perceived behavioral control, intent, and perceived barriers and facilitators. This assessment will drive the design of the educational workshops.

Injury Risk: Landing Error Scoring System

Participants' injury risk will be evaluated during a standardized jump-landing test. Participants will jump from a 30-cm high box to a distance of 50% of their height away from the box, down to the ground, and immediately rebound for a maximal vertical jump on the landing. Subjects will not receive feedback or coaching on jump technique. Subjects will be given as many practice

trials as needed to perform the task successfully. A successful jump is characterized as: (1) jumping off of the box with both feet at the same time (2) jump forward and down as opposed to up and forward off the box (3) landing with both feet in the marked off area (4) completing the task in a fluid motion.



Figure 7: Jump Landing Task

Jump trials will be recorded from the front and side of the subject using a two standard digital cameras. The LESS is a valid and reliable clinical movement assessment used to identify high-risk movement patterns during a jump-landing task.(1, 2) LESS scores are based on observable jump-landing errors and can be utilized in a field setting, where a greater number of movement errors and a higher score is indicative of a higher risk of sustaining a lower extremity injury. A prospective study with 761 youth soccer athletes evaluated the predictive value of the LESS on ACL injury.(1)

Workshop

Coaches will be randomized into one of two workshop groups: Generalized or Tailored. Both Generalized and Tailored workshops will last approximately 60-minutes. Online resources with interactive video tutorials demonstrating each exercise will be available to all coaches regardless of group. The video tutorials will include real-time demonstration, examples of good and bad form, guided instruction indicating where the coach should focus corrections during each exercise, and end with knowledge quizzes to ensure learning. Printable resources with the PTP in detailed and abbreviated format will be made available. Materials emphasizing the effectiveness of PTP implementation will also be available with links to more detailed information for interested users.

Coaches will repeat the needs-assessment on PTP following either workshop to evaluate the immediate impact of the workshop on behavioral determinants and intent to implement the PTP.

Generalized Workshop Group: The Generalized workshop will be a standard training workshop that addresses common implementation barriers for the coaching population in general. The Basic Workshop will consist of: (1) education regarding pertinent PTP information, such as PTP effect on injury risk, performance, and long term consequences of injury (2) hands-on training on implementing a 10-minute exercise-based PTP as a team warm-up, including peer-to-peer demonstration and skills practice and (3) a question and answer session to address concerns or questions.

Tailored Workshop Group: The Tailored Workshop would use information garnered from a needs-assessment to establish priorities and streamline education to focus on specific components of interest.

Data Reduction and Analyses

Knowledge, Attitudes, and Behaviors

Likert scale questions from the Knowledge, Attitudes, and Behaviors questionnaires will be coded and analyzed using quantitative analysis methods. Open-ended questions will be read by two separate implementation experts and triangulated for themes. Descriptive analyses will determine common behavioral determinants and perceived barriers and facilitators to drive workshop design.

Injury Risk: Landing Error Scoring System

LESS change scores will be calculated (PRE – POST). A between-subject ANOVA will evaluate

changes in injury risk between workshops (Tailored, Generalized)($\alpha < 0.05$).

We conservatively assume pre-season and post-season complete data on 80% of participants. Based on our published data on LESS score changes after a soccer injury prevention program, we expect a change between 0.98 – 1.76 with a standard deviation of 1.3 for our injury risk outcome measure.(2)

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APPENDICES

Survey Instrument for Knowledge, Attitudes, and Behaviors

DEMOGRAPHIC AND COACHING INFORMATION

Age: ☐ 18-24 ☐ 25-30 ☐ 31-35 ☐ 36+

I identify As: ☐ Male ☐ Female ☐ _____ (Fill In) ☐ Prefer Not to Disclose

1. How many years have you **COACHED** soccer? _____
2. Please list any coaching certification/licenses you currently hold and the organization granting this certification/license:

Certification/License	Organization

3. How many years, if any, did you/ have you **PLAYED** soccer? _____
4. Have you ever had an injury that caused you to miss soccer training or matches while **PLAYING**?

Yes ☐ No ☐

5. While playing a sport, have you ever torn or sprained your anterior cruciate ligament (ACL)?

Yes ☐ No ☐

6. While playing a sport, have you ever torn or sprained any knee ligaments besides the ACL?

Yes ☐ No ☐

7. Have you ever injured a non-ligament structure associated with the knee (e.g. cartilage, meniscus, etc.)?

Yes ☐ No ☐

8. While playing a sport, have you ever sprained either ankle that caused you to miss more than 1 day of physical activity?

Yes ☐ No ☐

9. Have you ever undergone rehabilitation as a result of injury?

Yes ☐ No ☐

a. If yes, how long was your rehabilitation? _____

10. Have you ever **personally** performed/participated in ACL/Lower Extremity preventive training program while playing soccer?

Yes ☐ No ☐

CURRENT TEAM INFORMATION

11. What sex/age group do you currently coach or have you most recently coached?

<input type="checkbox"/> U8 Girls	<input type="checkbox"/> U9 Girls	<input type="checkbox"/> U10 Girls	<input type="checkbox"/> U11Girls	<input type="checkbox"/> U12Girls	<input type="checkbox"/> U13Girls	<input type="checkbox"/> U14Girls
<input type="checkbox"/> U8 Boys	<input type="checkbox"/> U9 Boys	<input type="checkbox"/> U10 Boys	<input type="checkbox"/> U11 Boys	<input type="checkbox"/> U12 Boys	<input type="checkbox"/> U13 Boys	<input type="checkbox"/> U14Boys
<input type="checkbox"/> Other (Please list sex and age group): _____						

12. Have you ever **required your soccer team** to perform an ACL/Lower Extremity injury prevention program?

Yes ☐

No ☐

a. If YES: What programs have you used? (name or describe):

PREVENTIVE TRAINING PROGRAMS

13. Please mark the box that best represents how you feel about each of the following statements:

<i>Attitudes toward Preventive Training Programs</i>	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
Training/practice sessions are important for improving performance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower extremity injury prevention is important in training sessions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is important for players to attend training/practice if they want to play in games.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am comfortable with my team doing an ACL IPP daily at the beginning of practice.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I feel ACL IPPs can effectively substitute for my team's warm-up.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I can change my team's landing and cutting technique by teaching them an ACL IPP.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My team will have improved agility after completing an ACL IPP.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My team will sustain fewer injuries after completing an ACL IPP.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Injuries are an unavoidable part of the game at the level I coach.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower extremity injuries negatively influence game performance and end of season results.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Lower extremity injuries are not a problem for my team.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is important for coaches to have current knowledge of lower extremity injury prevention strategies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

It is important for players to have current knowledge of lower extremity injury prevention strategies.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would implement specific training if it was proven to prevent lower extremity injuries.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would implement specific training if it was proven to improve player performance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would implement specific training if it was proven to improve player performance and prevent lower extremity injuries.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Attitudes Toward Potential Barriers	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
My team's practices are not long enough to devote time to an injury prevention program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
There is no training available to teach me how to implement a program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The activities included in these programs are not relevant or beneficial to my athletes.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I already have my athletes perform the same types of activities that are included in these programs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I do not believe that using an injury prevention program will actually reduce the number of injuries on my team.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
It is the responsibility of the sports medicine staff to implement injury prevention programs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I do not want to change the warm-up and practice activities that I am currently using.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
My student-athletes do not want to complete these types of injury prevention programs.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Subjective Norms	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
If I implemented an ACL IPP for my team, my team would feel comfortable with me leading it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Perceived Behavioral Control	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
If I implemented an ACL IPP for my team, I would feel comfortable leading it if I was provided instructions.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If I implemented an ACL IPP for my team, I would need help from experts in order to lead the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
If I implemented an ACL IPP for my team, I would feel comfortable leading it if I went through training.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am comfortable teaching my soccer team to change direction safely while playing soccer.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am comfortable teaching my team to land safely from a jump.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am comfortable teaching my team an ACL IPP.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

I have enough knowledge to lead the injury prevention program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I have enough experience to lead the injury prevention program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I am prepared to lead the injury prevention program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Behavioral Intention	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
I plan to implement an ACL IPP with my soccer team next season.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform an ACL IPP if the program required 10 min of practice time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform an ACL IPP if the program required 15 min of practice time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform an ACL IPP if the program required 20 min of practice time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform an ACL IPP if the program required 30 min of practice time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if I could lead the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if a player could lead the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if an athletic trainer could lead the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if the program included ball exercises.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if other teams in my league/club were also doing the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
I would be willing to have my team perform a lower extremity injury prevention warm-up program if my team was the only team in my league/club doing the program.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14. On a scale of 1-10, with 1 being “not likely at all” and 10 being “completely likely”, how likely are you to implement a preventive training program *this season*.

☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10

Not likely at all > Slightly Likely > Moderately Likely > Very Likely > Completely Likely

15. What would need to happen for your likelihood of implementing a preventive training program to increase one degree? (For example: If your level response for Question 14 as a “6” – what would it take for you to feel like you were a “7”?)

PLAY Documents



Physical Literacy Assessment for Youth

Your Name _____

Gender: M F Age: _____

I am most active in (check all that apply): ☐ summer ☐ winter ☐ active in both

How good are you at doing sports and activities?	Never tried	Not so good	OK	Very good	Excellent
1. In the gym?					
2. In and on the water?					
3. On the ice?					
4. On snow?					
5. Outdoors?					
6. On the playground?					
What do you think about doing sports and activities?	Not true at all	Not usually true	True	Very true	
7. It doesn't take me long to learn new skills, sports or activities					
8. I think I have enough skills to participate in all the sports and activities I want					
9. I think being active is important for my health and well-being					
10. I think being active makes me happier					
11. I think I can take part in any sport/physical activity that I choose					
12. My body allows me to participate in any activity I choose					
13. I worry about trying a new sport or activity					
14. I understand the words that coaches and PE teachers use					
15. I'm confident when doing physical activities					
16. I can't wait to try new activities or sports					
17. I'm usually the best in my class at doing an activity					
18. I don't really need to practice my skills, I'm naturally good					
19. Reading and writing are very important	Do you agree or disagree with this statement?				
	Strongly disagree	Disagree	Agree	Strongly agree	
In school					
At home with family					
With friends					
20. Math and numbers are very important	Do you agree or disagree with this statement?				
	Strongly disagree	Disagree	Agree	Strongly agree	
In school					
At home with family					
With friends					
21. Movement, activities and sports are very important	Do you agree or disagree with this statement?				
	Strongly disagree	Disagree	Agree	Strongly agree	
In school					
At home with family					
With friends					
22. My fitness is good enough to let me do all the activities I choose	Disagree	Agree			

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MANUSCRIPT 1: The Effect of a Tailored Educational Workshop on Youth Coaches' Attitudes, Knowledge, and Behaviors Regarding Preventive Training Programs

ABSTRACT

Objectives: Evaluate differences between a Tailored coaches' education workshop on coaches' attitudes, subjective norms, perceived behavioral control, and behavioral intention to adopt a preventive training program compared to a Generalized workshop. A secondary purpose was to determine how coach perceptions of facilitators and barriers to preventive training programs change following an education workshop and a single sport season.

Design: Cluster-randomized control trial.

Methods: Mixed methods approach. Youth soccer and basketball coaches volunteered to participate. Coaches were randomized by league into a Tailored or General workshop. Pre-workshop surveys were used to prioritize content of the Tailored workshop. Generalized workshops followed standardized content. We evaluated coaches' attitudes, subjective norms, perceived behavior control, and behavioral intention to adopt a PTP using a pre- and post-workshop survey consisting of Likert-scale and open-ended questions.

Results: There were no significant differences between workshop groups on attitudes, subjective norms, perceived behavioral control, or behavioral intention to adopt. Following a workshop, coaches increased in reported having enough knowledge and enough experience to implement a preventive training program. Open-ended responses indicated that at post-workshop, coaches wanted more time to refine implementation skills and also wanted some level of flexibility with exercise choices. Coaches wanted shorter programs (<10 minutes) but also wanted to incorporate more ball skills and sport-specific drills.

Conclusions: A generalized workshop design was as effective as a tailored workshop in increasing some aspect of coach injury prevention behavior.

Word Count: 231 / 250 words

Keywords: Injury Prevention; Athletes; Education; Adolescent; Sports

INTRODUCTION

Lower extremity sport-related injuries have short- and long-term health consequences. For example, anterior cruciate ligament (ACL) injuries can lead to time loss from sport, increased risk of subsequent injury, and early onset of knee osteoarthritis (OA).(1, 2) Athletes are at an increased risk of ACL injury between the ages of 14 and 25.(1, 3) Injury prevention efforts should target youth athletes prior to this high-risk age range in order to prevent primary injury and the negative sequelae.

Preventive training programs (PTPs) that focus on improving neuromuscular control and are used as a dynamic warm-up can reduce lower extremity injury rates by 65-85%.(4-6) However, injury reduction with PTPs is dependent on the level of compliance and fidelity of the program implementation.(7, 8) For youth athletes, coaches represent the best option for consistent, long-term delivery of PTPs and coach-administered PTPs have been shown to effectively reduce injury risk(9) and injury rate(10) in high school and youth sport. Despite strong evidence that PTPs can reduce injuries, as well as improve performance in youth athletes,(11-13) fewer than 20% of youth coaches implement PTPs.(14-16) Particularly at the community level, coaches are frequently volunteer parents and have a wide variety of sport knowledge and experience. Given the challenge of promoting PTP implementation in this particular coach population, there is a need to improve training to efficiently educate and motivate coaches to use PTPs. Previous work with coach education demonstrates that intention to adopt can be improved through educational workshops but this change in intention does not necessarily translate into actual behavior of implementation and compliance with PTPs.(17) Future dissemination strategies may be more effective if organization administration is involved and the needs of the coaches are considered in educational efforts.

While current PTP research is largely nonspecific about the exact components of an educational workshop, studies(17-19) suggest the following objectives: review PTP effectiveness evidence, describe the relationship between PTPs and existing organizational goals, provide practical methods for PTP implementation, and improve self-efficacy through hands-on practice and expert feedback. Interventions with content tailored to an individual's needs, beliefs, and characteristics may be more personally relevant and motivating to promote

health behavior.(20-22) A tailored approach would conduct a needs-assessment to determine which information would be most motivating for each person within a specific population of coaches being trained, for instance a single soccer league, and then design the educational training based on the findings.(23) While this may seem unrealistic for widespread dissemination, growth in automated algorithms and technology may help to streamline this process in the future. This approach has been successfully utilized in health and wellness strategies as well as in medical school curricula.(23, 24) However, in order to disseminate knowledge to the widest audience of youth coaches more frequently, a generalized workshop may be a more relevant and efficient implementation strategy. To our knowledge, no study has evaluated the impact of a tailored workshop strategy compared to a generalized workshop on PTP behavioral drivers.

Overall, this study sought to examine the knowledge and attitudes related to preventive training programs in coaches of youth soccer or basketball athletes. The primary purpose was to evaluate the differences between a Generalized coaches' education workshop and a tailored coaches' education workshop on coaches' attitudes, subjective norms, perceived behavioral control, and behavioral intention to adopt a PTP. . A secondary purpose was to determine how coach perceptions of facilitators and barriers to PTP change following: (1) an education workshop and (2) a single sport season. The following open-ended research questions guided the secondary purpose:

- What resource(s) would you need in order to implement training preparation for sport this season?
- What is/are your biggest motivating factor(s) for implementing PTP with your team?
- If you implemented PTP this season, what types of difficulties did you encounter?
- If you did not implement PTP this season, why not?

We hypothesized that a tailored coaches' workshop would result in a greater degree of change in coaches' attitudes, subjective norms, perceived behavioral control, and behavioral intention to adopt a PTP, compared to a generalized workshop, but that a generalized workshop would still result in positive changes. We took an inductive approach to the open-ended questions and thereby did not have hypotheses prior to data collection.

METHODS

Youth soccer and basketball organizations with athletes between the ages of 8-14 years and within 50 miles of the university were contacted via email (n=69 organizations) to participate in our study. Organization administrators who replied with interest met with research personnel for a primary meeting to discuss mutual goals, planning logistics and to schedule the coaches' educational workshop. A total number of 12 organizations (Soccer: 7 organizations, n=44 coaches; Basketball: 5 organizations, n=14 coaches) consented to participate in this study. Approval for this study was completed by the University's Institutional Review Board.

Previous approaches to coach education have been targeted in nature, focusing on general behavior determinants found to be relevant for typical coaches. However, coach populations can vary tremendously, from coaching experience, parental status, what age and competition level the person is coaching, etc. All of these factors can impact a coaches' level of buy-in and thereby the effectiveness of the workshop to change PTP implementation behaviors. A tailored approach to pre-season education workshops may be more effective to improve coaches' knowledge, attitudes, and behaviors regarding PTP implementation.

Organizations were randomized into one of two pre-season workshop groups: Generalized or Tailored so that all coaches

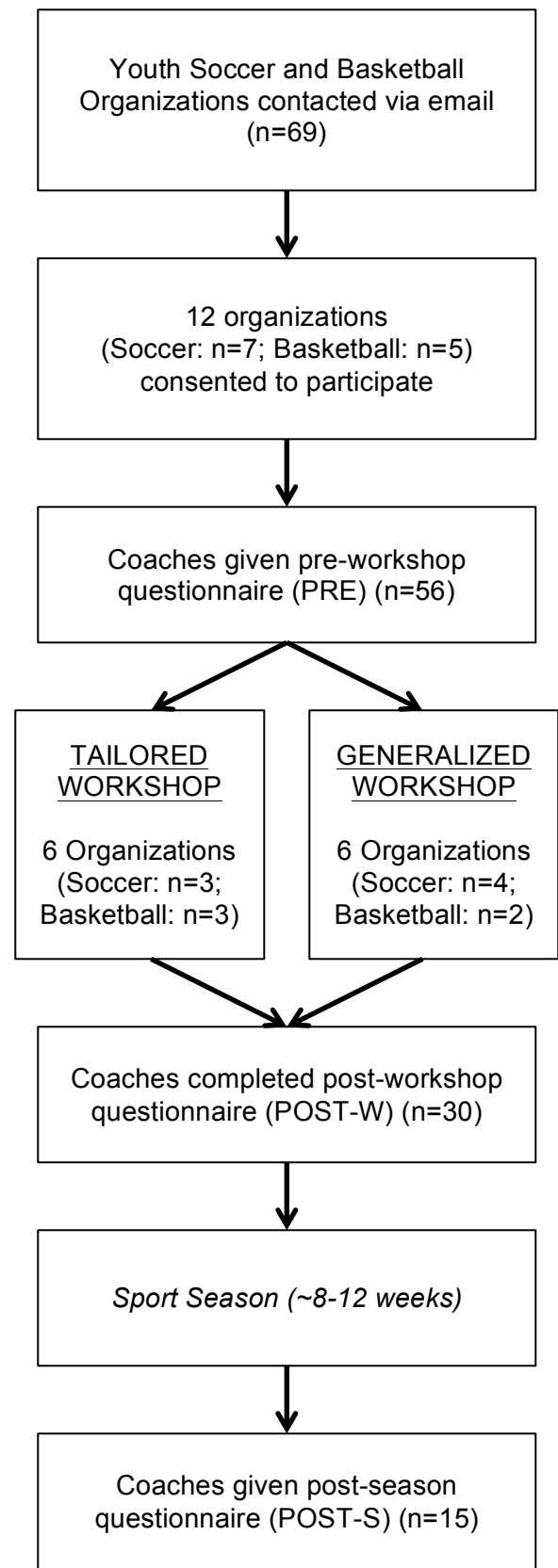


Figure 1: Flowchart of Study Procedures

within a given organization received the same workshop education strategy. Research assistants were assigned to a type of workshop (Tailored: (LD, SS); General: (EB, JB)) and trained on administering an educational workshop that followed their assigned strategy. To ensure that the specific education strategy was employed at each workshop, an independent researcher (HR) attended all workshops but did not serve as the primary educator in an effort to prevent cross contamination or bias.

One educational workshop was implemented per organization. Both Tailored and Generalized workshops lasted between 45-70 minutes depending on the number of coaches in attendance and availability of time. For instance, some organizations chose to include the educational workshop as a component of an existing coaches' meeting or equipment day, which limited time to conduct the workshop. Other organizations chose to conduct the workshop on an independent day to allow for more time for questions and practice.

The research team created a 10-minute PTP, which was utilized for training purposes. The PTP contained flexibility, agility, core, strength, balance, and plyometric exercises and was based off of previous PTPs that have reduced injury risk and improved performance in youth athletes (DiStefano). The same PTP was discussed during both workshop designs. However, research assistants made specific mention that there were multiple options for PTPs, such as the F11+, but that we would be going through a standard warm-up of our research team's design. Each workshop emphasized key components of PTPs that would be important to include (i.e. agility, balance, etc.).

The Generalized workshop was a standard training workshop that addressed common implementation barriers for the coaches in general. The Generalized Workshop consisted of: (1) education regarding PTP effect on injury risk/rate, performance, and long term consequences of injury (2) hands-on training on implementing a 10-minute exercise-based PTP as a team warm-up, including peer-to-peer demonstration and skills practice and (3) a question and answer session to address concerns or questions.

The Tailored Workshop used information garnered from a pre-workshop questionnaire to establish priorities and streamline education to focus on specific components of interest. While the TAIL workshop also contained an educational portion, as well as hands on demonstration, the educational portion was geared to the specific interests and questions vocalized by the coaches in attendance. If the organization completed pre-workshop questionnaires prior to the workshop, the responses were reviewed by research staff and strengths, weaknesses, and questions that appeared in at least 50% of the participants were pulled as focus areas for the workshop. If the organization was unable to complete pre-workshop questionnaires prior to the day of the workshop, questionnaires were completed day-of, prior to the start of the workshop. The research assistant leading the workshop then took a few minutes in the beginning to verbally discuss with the coaches which elements of the preventive training program were most important to them (injury prevention, sport performance, etc.) and what the coaches perceived to be their biggest barriers (time, understanding, hands on training, etc.). The research assistant then focused the content of the workshop toward those elements.

Online resources with interactive video tutorials demonstrating each exercise were available to all coaches following the workshop regardless of group (<http://trainingpreparationforsport.weebly.com>). The online resource contained video demonstrations, examples of good and bad form, cues for exercises, and downloadable hand-outs of the PTP and educational materials.

The PRE and POST-W questionnaires were a mixed-model of open-ended and Likert scale questions to assess behavioral determinants including attitudes, subjective norms, perceived behavioral control, intent to adopt a PTP, and perceived barriers and facilitators.

Open-ended questions were first administered to content experts and qualitative researchers who verified content of the questions. The Likert scale questions were previously utilized in a study examining coach behavioral drivers for PTP implementation (Frank). Pilot testers then took the complete questionnaire to provide feedback. Questions that were unclear were reworded or removed from the questionnaire.

	Tailored	General
Workshop Duration	45-70 minutes	45-70 minutes
Lecture Component: Creating a shared understanding of PTP	Driven by pre-workshop questionnaire responses and the acute questions/concerns of the coaches in attendance of the workshop	Pre-written education flow based on previous literature on PTP workshops. Education included: what is a PTP, effectiveness of PTP on injury risk, injury rate, and performance
Hands-On Training: Demonstration, Practice, and Expert Feedback	How to implement a predesigned 10-min PTP	How to implement a predesigned 10-min PTP

Table 1: Characteristic Differences Between Tailored and General Workshops

All coaches were asked to complete the pre-workshop questionnaire (PRE) prior the workshop. For organizations assigned to TAIL, coach responses were reviewed to identify both assets and weaknesses regarding PTP knowledge and implementation to drive the workshop design. Post-workshop questionnaires (POST-W) were administered after the workshop. PRE and POST-W questionnaires were identical.

At the end of the season, post-season questionnaires (POST-S) were given to coaches to assess if the coach implemented the PTP throughout the season and, if so, how frequently and what exercises. If the coach did not implement a PTP during the season we evaluated what barriers influenced the coaches' behavior through open-ended questions.

Likert scale data were pre-coded and entered into a Microsoft Excel spreadsheet (Microsoft Office 2011 for Macintosh, Microsoft, Inc.) Survey data were analyzed using SPSS version 21.0 for Macintosh (IBM Corporation). Survey data were not normally distributed. To evaluate group differences between workshops (Tailored, General) on the coach behavioral determinants Likert scale questions we used a non-parametric Mann-Whitney U test with an a priori alpha level of $P < 0.05$. If there are no group differences between coach behavioral determinants we will collapse Tailored and General groups and perform Wilcoxon-Sign Rank Tests to evaluate overall group changes regardless of education strategy with an a priori alpha level of $P < 0.05$.

To evaluate if there were differences between workshops (Tailored, General) on coach PTP implementation (Yes/No from POST-S), we ran a chi-square analysis with an a priori alpha level of $P < 0.05$. To assess if there were group differences between coach PTP implementation (Yes/No from POST-S) and length of workshop we ran a one-way ANOVA group (Yes/No PTP implementation) by workshop time (in minutes) with an a priori alpha level of $P < 0.05$.

To determine how coach perceptions of facilitators and barriers to TPS changed following an educational workshop and after a single sport season, we identified dominant themes from our open-ended responses. We employed a general inductive process and multiple-analyst triangulation for data credibility. All open-ended responses were entered into a Microsoft Excel spreadsheet. Two researchers (HR, JB) independently read through all open-ended responses in their entirety. After multiple readings of the responses, the researchers identified key phrases. Key phrases were coded and clustered into themes. For a theme to be established, key phrases had to be cited by at least 50% of the study's participants. The two researchers met and came to a consensus on themes, meaning an agreement of the label assigned and the supportive data from the responses. If there was a discrepancy between researchers on a key phrase or theme, a third researcher (SM) served as an objective deciding vote. General descriptives were calculated for each theme.

RESULTS

There were no significant differences between workshop type (Tailored, General) on Likert scale questions from PRE to POST ($P>0.05$) so coaches were collapsed into a single group to evaluate the overall effects of any educational workshop on coach behavioral drivers. Coach demographics are displayed in Table 2. There were no significant differences between workshop type (Tailored, General) and coach demographics ($P>0.05$). There were no significant differences between workshop group (Tailored, General) on self-reported PTP implementation (Yes/NO) from the POST-S.

		Workshop Group							
		Tailored n=26 coaches				General n=31 coaches			
		Soccer n=21		Basketball n=5		Soccer n=23		Basketball n=8	
		Male n=18	Female n=3	Male n=4	Female n=1	Male n=21	Female n=2	Male n=7	Female n=1
Previous Experience implementing a PTP?	Yes	n=3	n=0	n=3	n=0	n=5	n=0	n=1	n=0
	No	n=15	n=3	n=1	n=1	n=16	n=2	n=6	n=1
Years of coaching experience? (mean±SD)		5±5	3±3	6±8	4±0	2±3	4±0	5±8	8±0
Years of playing experience? (mean±SD)		15.65± 13.70	10.0± 8.0	25.33± 23.59	12.0±0	11.76± 11.04	11.50± 4.95	15.0± 11.1	30.0± 0

Table 2: Coach Demographics

Regardless of education strategy, at POST-W, coaches' perceived behavioral control increased, as coaches more strongly agreed that they were *comfortable teaching their team a PTP* ($Z=-2.45$, $P=0.01$). Additionally, following the workshop, coaches reported that they *had enough knowledge to lead a PTP* ($Z=-4.19$, $P=0.10$), *had enough experience to lead a PTP* ($Z=-3.96$, $P<0.01$), and *were prepared to lead a PTP* ($Z=-3.79$, $P<0.01$). The frequencies of PRE and POST-W survey responses are reported in Tables 3a – 3d (Full merged table in Appendices).

From the post-workshop questionnaire, a few key themes emerged per question (Table 3). When asked what resources the coach would need to implement PTP this season coaches reported: (1) knowledge and skill refinement and (2) program flexibility and implementation changes. The coaches stated that the biggest

motivating factor(s) for utilizing PTP were: (1) Injury Prevention/Player Safety and (2) Player Performance Benefit.

Attitude	Strong Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree	
	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W
Training/practice sessions are important for improving performance	42 (79.25%)	21 (70.00%)	10 (18.87%)	8 (26.67%)	--	--	--	--	1 (1.89%)	1 (1.89%)
Lower extremity injury prevention is important in training sessions	29 (54.72%)	17 (56.67%)	20 (37.74%)	12 (40.00%)	3 (5.66%)	--	--	--	1 (1.89%)	1 (1.89%)
It is important for players to attend training/practice if he/she wants to play in games	35 (66.04%)	20 (66.67%)	13 (24.53%)	7 (23.33%)	4 (7.55%)	2 (6.67%)	--	--	1 (1.89%)	1 (1.89%)
Injuries are an unavoidable part of the game at the level I coach	3 (5.88%)	2 (6.67%)	20 (39.22%)	9 (30%)	15 (29.41%)	9 (30%)	9 (17.65%)	10 (33.33%)	4 (7.84%)	--
LE injuries negatively influence game performance and end of season results	18 (34.62%)	14 (46.67%)	24 (46.15%)	14 (46.67%)	10 (19.23%)	2 (6.67%)	--	--	--	--
LE injuries are not a problem for my team	--	--	9 (16.98%)	8 (26.67%)	28 (52.83%)	15 (50.00%)	13 (24.53%)	6 (20.00%)	3 (5.66%)	1 (3.33%)
It is important for coaches to have current knowledge of lower extremity injury prevention strategies	29 (54.72%)	18 (60.00%)	21 (39.62%)	10 (33.33%)	2 (3.77%)	1 (3.33%)	--	--	1 (1.89%)	1 (3.33%)
It is important for players to have current knowledge of LE IP strategies	27 (50.94%)	17 (56.67%)	22 (41.51%)	13 (43.46%)	3 (5.66%)	--	1 (1.89%)	--	--	--

Table 3a: Pre and Post Likert Scale Questions – “Attitudes”

Subjective Norms	Strong Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree	
	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W
If I implemented PTP for my team, my team would feel comfortable with me leading it.	12 (23.53%)	10 (33.33%)	30 (58.82%)	16 (53.33%)	9 (17.65%)	4 (13.33%)	--	--	--	--

Table 3b: Pre and Post Likert Scale Questions – “Subjective Norms”

Perceived Behavioral Control	Strong Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree	
	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W
If I implemented a PTP for my team I would feel comfortable leading it if I was provided instructions	14 (26.92%)	9 (30%)	32 (61.54%)	20 (66.67%)	6 (11.54%)	1 (3.33%)	--	--	--	--
If I implemented a PTP for my team, I would need help from experts in order to lead the program	5 (9.80%)	4 (13.33%)	20 (39.22%)	11 (36.67%)	15 (29.41%)	7 (23.33%)	9 (17.65%)	7 (23.33%)	2 (3.92%)	1 (3.33%)
If I implemented a PTP for my team, I would feel comfortable leading it if I went through training	21 (40.38%)	12 (40.00%)	27 (51.92%)	14 (46.67%)	4 (7.69%)	4 (13.33%)	--	--	--	--
I am comfortable teaching my soccer team to change direction safely while playing soccer.	12 (23.53%)	4 (13.33%)	27 (52.94%)	20 (66.67%)	8 (15.69%)	5 (16.67%)	4 (7.84%)	1 (3.33%)	--	--
I am comfortable teaching my soccer team to land from a jump.	9 (17.31%)	4 (13.33%)	23 (44.23%)	22 (73.33%)	15 (28.85%)	4 (13.33%)	5 (9.62%)	--	--	--
I am comfortable teaching my team a PTP.	8 (15.69%)	5 (16.67%)	13 (25.49%)	18 (60.00%)	20 (39.22%)	6 (20.00%)	5 (9.80%)	1 (3.33%)	5 (9.80%)	--
I have enough knowledge to lead a PTP.	1 (1.92%)	5 (16.67%)	5 (9.62%)	14 (46.67%)	15 (28.85%)	7 (23.33%)	24 (46.15%)	4 (13.33%)	7 (13.46%)	--
I have enough experience to lead a PTP.	1 (1.92%)	3 (10.00%)	6 (11.54%)	12 (40.00%)	14 (26.92%)	10 (33.33%)	23 (44.23%)	5 (16.67%)	8 (15.38%)	--
I am prepared to lead a PTP.	2 (3.85%)	5 (16.67%)	7 (13.46%)	15 (50.00%)	18 (34.62%)	7 (23.33%)	19 (36.53%)	3 (10.00%)	6 (11.54%)	--

Table 3c: Pre and Post Likert Scale Questions – “Perceived Behavioral Control”

Behavioral Intention	Strong Agree		Agree		Neither Agree Nor Disagree		Disagree		Strongly Disagree	
	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W	PRE	POST-W
I would implement specific training if it were proven to prevent LE injuries	33 (62.26%)	14 (70.00%)	17 (32.08%)	5 (25.00%)	2 (3.77%)	1 (5.00%)	--	--	1 (1.89%)	--
I would implement specific training if it were proven to improve player performance	36 (67.92%)	14 (70.00%)	15 (28.30%)	6 (30.00%)	1 (1.89%)	--	--	--	1 (1.89%)	--
I would implement if it were proven to improve player performance and prevent LE injuries.	36 (67.92%)	17 (85.00%)	16 (30.19%)	3 (15.00%)	--	--	--	--	1 (1.89%)	--
I plan to implement a PTP with my soccer team next season. ⁷	7 (14.29%)	10 (33.33%)	19 (28.78%)	13 (43.33%)	23 (46.94%)	6 (20.00%)	--	--	--	1 (3.33%)
I would be willing to implement a PTP if it was 10 minutes in length.	11 (21.15%)	12 (40.00%)	33 (63.46%)	15 (50.00%)	7 (13.46%)	2 (6.67%)	1 (1.92%)	--	--	1 (3.33%)
I would be willing to implement a PTP if it was 15 minutes in length.	7 (13.46%)	5 (16.67%)	23 (44.23%)	14 (46.67%)	15 (28.85%)	2 (6.67%)	7 (13.46%)	8 (26.67%)	--	1 (3.33%)
I would be willing to implement a PTP if it was 20 minutes in length.	5 (9.62%)	--	11 (21.15%)	5 (16.67%)	14 (26.92%)	8 (26.67%)	20 (38.46%)	16 (53.33%)	2 (9.62%)	1 (3.33%)
I would be willing to have my team perform a PTP if a player could lead the warm-up	6 (11.76%)	9 (30.00%)	31 (60.78%)	14 (46.67%)	11 (21.57%)	4 (13.33%)	2 (5.88%)	2 (6.67%)	--	1 (3.33%)
I would be willing to have my team perform a PTP if an athletic trainer could lead the warm-up.	8 (15.69%)	8 (28.57%)	24 (47.06%)	7 (25.00%)	15 (29.41%)	12 (42.86%)	3 (5.88%)	1 (3.57%)	1 (1.96%)	--
I would be willing to have my team perform a PTP if the program included ball exercises	16 (31.37%)	14 (46.67%)	25 (49.02%)	9 (30.00%)	9 (17.65%)	5 (16.67%)	1 (1.96%)	2 (6.67%)	--	--
I would be willing to have my team perform a PTP if other teams in my league/club were also doing the program.	9 (18.00%)	5 (17.24%)	20 (40.00%)	6 (20.69%)	18 (36.00%)	15 (51.72%)	2 (4.00%)	3 (10.34%)	1 (2.00%)	--
I would be willing to have my team perform a PTP if my team was the only team in my team/club doing the program.	9 (17.65%)	9 (31.03%)	25 (49.02%)	11 (37.93%)	16 (31.37%)	8 (27.59%)	1 (1.96%)	1 (3.45%)	--	--

Table 3d: Pre and Post Likert Scale Questions – “Behavioral Intention”

We also asked coaches if there was anything else we should know regarding their views on PTP and coach education. Coaches reported on: (1) training priorities, where PTPs were not a current priority for the coaches’ team or the league overall and (2) the worth of the intervention, where coaches viewed PTPs as a valuable component of training regardless of age group being coached.

For the post-season questionnaire, a few additional key themes emerged from the questions (Table 4a-4e).

We asked coaches what types of difficulties, if any, they encountered and coaches reported: (1) athlete buy-in and (2) teaching proper technique. We also asked for suggestions for future workshops to which coaches suggested: (1) Additional physical help, where coaches wanted more time spent on demonstrations or in-

person practice and (2) Reference materials, where coaches wanted resource materials to reference independently.

Theme	Operational Definition	% of Responders Within This Theme	# of People / Total # of Responders	Supportive Quotes
Knowledge and Skill Refinement	Additional practice, specific knowledge, or reference materials.	52.4%	11 / 21	<p>“More confidence / mechanical understanding of the techniques.”</p> <p>“It would take repetition to help me feel comfortable doing it.”</p> <p>“I would need to review online materials prior to implementing TPS.”</p>
Program Flexibility and Implementation Changes	Flexibility with the program duration, types of exercises included, and implementation guidance.	52.4%	11 / 21	<p>“The time potential required is expensive to expend with limited training time. Best to blend TPS with “real-play” exercises to maximize foot skills and passing, dribbling, etc.”</p> <p>“More exercises with the ball and/or shorter warm-up duration.”</p>

Table 4a: Open Response (POST-W), “What resources would you need to implement a preventive training program this season?”

Theme	Operational Definition	% of Responders Within This Theme (# of People / Total # of Responders)	Supportive Quotes
Injury Prevention / Player Safety	Reducing player injuries and/or increasing player safety.	92.9% (26 / 28)	<p>“Teaching girls which are much more prone to ACL!!! Scary!!”</p> <p>“Injury prevention”</p> <p>“Safety and long term enjoyment of the sport for my players.”</p>
Player Performance Benefit	Improving aspects of athlete performance	50% (14 / 28)	<p>“Improving girls performance potential”</p> <p>“Increase performance, teach healthy training”</p> <p>“Athletic enhancement”</p>

Table 4b: Open Response (POSTW), “What is/are your biggest motivating factor(s) to adopt/use a preventive training program?”

Theme	Operational Definition	% of Responders Within This Theme (# of People / Total # of Responders)	Supportive Quotes
Training Priorities	TPS is not a current priority for the coaches' team or the league overall.	66.7% (4 / 6)	We haven't had too many injuries at this point as the boys are 10 and under. Having youth teams stretch is not a big concern for most coaches.
Worthwhile Intervention	TPS is a valuable component of training regardless of age group.	66.7% (4/6)	[I have] been using FIFA11+ for 3 years now. Start training 15 minutes earlier to accommodate TPS but not lose technical/tactical training time. It is a good habit to get the kids into. Most club coaches move up with their teams. They eventually should be in the position to use stretching techniques.

Table 4c: Open Response (POST-W), "Is there anything else we should know about regarding your views on training preparation for sport, coach education/training, etc.?"

Theme	Operational Definition	% of Responders Within This Theme (# of People / Total # of Responders)	Supportive Quotes
Athlete Buy-In	A coach's perception that the team exhibited a lack of compliance or did not take TPS seriously.	50% (5 / 10)	Attention span of young players Getting the kids to take it seriously. They rush through some of the motions. Kids are kids, they rush while doing exercise, and most of the time didn't take it seriously.
Teaching Proper Technique	Difficulty monitoring or teaching proper form to maximize exercise fidelity.	50% (5 / 10)	Teaching a new skill set that the players are not used to is a challenging task. Young boys sometimes don't really care how true to form they are doing things so I wonder if the effectiveness was somewhat reduced by poor form.

Table 4d: Open Response (POST-S), "If you implemented a preventive training program this season, what types of difficulties, if any, did you encounter?"

Theme	Operational Definition	% of Responders Within This Theme (# of People / Total # of Responders)	Supportive Quotes
Physical Help	More time spent on demonstrations or in-person help	87.5% (7 / 8)	Having a trainer come to a couple practices to instruct the proper way could be beneficial for the kids and the coach.
Reference Materials	Resource materials to reference independently at a later time	62.5% (5 / 8)	<p>More info on stats etc. on how it helps with injury resistance and player performance, and more info on how to implement it as part of overall physical periodization</p> <p>...If you could have a few players to demonstrate in front of coaches they would take it a bit more seriously.</p> <p>I'd love to have the players involved in the training getting the first hand knowledge too.</p>

Table 4e: Open Responses (POST-S), "Do you have any suggestions for future workshops?"

DISCUSSION

This study advances preventive training program implementation research by describing the effect of different education workshop strategies on youth athlete coaches' behavior determinants for PTP implementation, as well as facilitators and barriers to implementation before and after a single sport season. The results of this study suggest that a generalized workshop strategy may be just as effective as a tailored workshop to increase coaches' perceived behavioral control to implement PTP. This is important for widespread dissemination, as standardized workshop content and online reference materials can be readily available, which could exponentially improve the reach and buy-in of implementation intervention efforts.

Previous public health efforts to tailor messaging for skin cancer prevention behaviors in adults found that personalized messaging was more effective at changing health behavior in general.²⁰ This study found no significant differences between workshop education strategies. However, we personalized messaging at the organization level, not the individual level, and youth recreational leagues have a heterogeneous composition of coaches' demographics (age, experience levels, etc.) as well as motivational interests (Table 4a-4e). Additionally, other tailored messaging strategies for health professionals have personalized curriculum over the course of a given semester or year²⁴ but our workshop was only 45-75 minutes in length, so the Tailored and General workshops may not have been different enough to cause large group differences. The messaging may not have been tailored enough to individuals to cause a difference between education strategies, or the General workshop may have been sufficient to interest the largest amount of coaches. Overall these results improve future PTP education dissemination for youth soccer and basketball coaches, because a succinct generalizable workshop is just as effective as a personalized workshop. This means that a generalized workshop could be distributed electronically to reach the largest amount of coaches or a health care professional, such as an athletic trainer, could implement a single workshop across multiple organizations. The reach of implementation intervention efforts has the potential to dramatically increase to a variety of populations, sports, and areas of the country.

Following either workshop (Tailored, General) coaches reported that they had enough knowledge and experience to lead PTPs and reported feeling prepared to lead a PTP. At PRE, only 11.54% of coaches reported Strongly Agree or Agree for the response, I have enough knowledge to lead a PTP, but POST, over 63.34% of coaches responded as either Strongly Agree or Agree. A similar trend was found for I have enough experience to lead a PTP from PRE to POST-W. Most optimistically, for the prompt I plan to implement a PTP this season, coaches jumped from 43.07% responding Strongly Agree or Agree at PRE to 76.66% at POST. This is very promising for future implementation efforts, as this indicates that coaches left the pre-season workshop with the intention to implement. However, Frank et al.¹⁷ found that coach intention to implement a PTP did not lead to initial adoption in the first 2 weeks of the season. Future initiatives should investigate what barriers may be contributing to this disconnect.

While coaches answered the Likert-scale questions indicating that they had enough knowledge and experience to implement PTP, our open-ended analyses found that following the workshop coaches wanted additional practice time or time to review resources (Table 4a-4e). Specifically, coaches wanted more repetitions correcting form while youth athletes perform the exercises (Table 4a-4e). Previous research examining ways to improve coaching education suggested the inclusion the coaches' athletes as models for the warm-up during the workshop.²⁵ Within our study, two soccer organizations and one basketball organization specifically requested to have athletes attend the workshop. However, youth recreational sports rely on volunteers for coaches. Volunteer coach engagement was low prior to the season starting and it was challenging to find a day when most coaches within an organization could attend the workshop. Therefore, it added an additional scheduling complication to invite athletes. While three organizations within our study were able to have athletes attend, this may not be feasible for all organizations. An alternative solution may be to have more research assistants attend to serve as examples or to dedicate a larger proportion of the workshop to hands on training and practice. In the military setting, online resources also contained multiple-choice video questions where implementation leaders could test their knowledge on movement errors. This may be a more feasible way to give coaches additional practice and it could be done on their own schedules at their own pace.

Post-season surveys further indicated that coaches had perceived a lack of athlete buy-in and had difficulty monitoring correct form during the warm-up throughout the season. This supports the POST-W results that coaches needed more repetitions correcting athlete form. However, there is a balance between having a thorough workshop that provides enough experience for coaches and having a efficient workshop that is short enough to encourage attendance for this volunteer coach population. Our workshops were structured so that the first half followed suggested formatting to create a shared understanding of PTPs among coaches within a given organization – review PTP effectiveness evidence, describe relationship between PTPs and existing organizational goals, and provide practical methods for PTP implementation.^{17,18} In a study by Frank et al.¹⁷ the workshop was lecture-based in nature due to time constraints and the study found that the workshop increased behavioral intention to implement PTPs but that the intention did not necessarily translate into initial adoption and compliance of PTPs. Perhaps the true self efficacy and behavior drivers lie in the hands-on training and future workshops should look at concentrating time and efforts into the hands-on practice components.

Previous research into coaches' attitudes regarding PTPs found that coaches wanted more sport-specific drills in the PTP, such as ball exercises,^{26,27} and that coaches did not see the relative advantage in performing a PTP over other warm-up or training strategies.¹⁴ Similar to O'Brien et al.²⁸, many of our coaches wanted to modify the suggested program. Our coaches wanted to incorporate more sport-specific ball exercises and also wanted a shorter program. This persistent desire for modification underscores the need to evaluate the effectiveness of coach-approved PTPs on injury risk and sport performance. Similarly, while it was a small subset of coaches, we found that 4 coaches reported that PTPs did not align with their training priorities, as the coaches did not see injuries as a problem for their teams and did not want to spend the practice time performing a PTP (Table 4a-4e). One league in particular suggested to coaches that athletes under the age of 11 did not need a warm-up and needed more time practicing ball touches. This is an example of a lack of support or understanding from the top-down and served as a major barrier to implementation for teams within that organization. Youth athletes may be the optimal target population for PTP interventions to improve neuromuscular control and movement biomechanics prior to and throughout periods of maturation and growth,

but coaches of youth athletes may not understand the relative advantage of using a PTP rather than warming up exclusively with ball-handling drills. However, in another organization, one coach reported that it was important to build the warm-up habit at younger ages because many coaches within his league moved up with their teams (Table 4a-4e). Emphasizing to coaches the need to establish behavior change and create a normative culture of PTP implementation earlier on, particularly coaches who may move up with their teams, may increase buy-in and adoption of PTPs for younger age groups.

One major limitation of this study was the attrition rate for the questionnaires. Because the coaches were volunteer in nature, the engagement and participation waned as the season progressed. Particularly at post season, coaches became far less likely to respond to electronic correspondence and in-person check ins were more burdensome as coaches wanted to spend as much daylight as possible with their teams. Future research should look into a larger scale approach to the pre-season workshop to increase post-season participation, as well as investigate workshop designs that have a larger focus on hands-on training.

CONCLUSION

Our study supports that a generalized pre-season education workshop was as effective as a tailored pre-season education workshop to increase youth athlete coaches' perceived knowledge and feeling prepared to implement a PTP during the season. We also described coach-perceived barriers and facilitators to PTP implementation following an educational workshop and a single sport season. These results could increase the reach of preventive training program implementation efforts by simplifying the education content and utilizing web-based and electronic resources to disseminate knowledge, as well as addressing common barrier and facilitator themes throughout the pre-season workshop.

PRACTICAL IMPLICATIONS

- A tailored workshop that used a baseline needs-assessment to prioritize education content was just as effective as a generalized workshop in increasing coaches' knowledge and experience implementing a preventive training program.
- While coaches cited "injury prevention and player safety" as the primary motivating factor for attending the pre-season workshop, some coaches stated that they perceived injuries were not a problem for their teams. Therefore other motivating factors, such as performance enhancement or general athlete development, may need to be emphasized throughout workshops.
- Web-based resource materials, such as knowledge quizzes and video examples may further improve coach confidence with implementing PTPs.

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MANUSCRIPT 2: Application of a Preventive Training Program Implementation Framework to Youth Soccer and Basketball Organizations

ABSTRACT

Objectives: The primary purpose of this study was to evaluate the application of one implementation framework, the 7-Step framework in American youth soccer and basketball organizations.

Design: Descriptive.

Methods: Youth soccer and basketball organizations were contacted to participate in a pre-season coaches' education workshop on implementing preventive training programs. We used the 7-Step framework to guide implementation between all organizations. For each organization, we retrospectively evaluated level of completion of Steps 1-5 within Padua's 7-Step framework. Each step had an overall theme and was then broken down into subcomponents.

Results: Sixty-two youth soccer (n=40) and basketball (n=22) organizations were invited to participate in the larger study. Overall, twelve organizations completed all of Steps 1-4 and Step 5a – 5d. No organization completed all components of Steps 1-5.

Conclusions: This study provides insight into the injury prevention dissemination and implementation experience of different organizations in youth sport settings. The challenges we faced in the first steps establishing administrative support and forming an interdisciplinary team mirror the body of knowledge's general lack of reporting information on the initial adoption of PTPs. In order to promote successful adoption and implementation of PTPs, future research needs to clearly describe methodologies, as well as discuss barriers and solutions to implementation efforts.

Word Count: 205 / 250 words

Keywords: Injury Prevention; Athletes; Education; Adolescent; Sports

INTRODUCTION

Lower extremity sport-related injuries, such as anterior cruciate ligament (ACL) tears, lead to short- and long-term health and financial consequences.^{1,2} Injury prevention efforts should be focused on youth athletes in order to reduce primary injuries because previous injury history is the number one risk factor for sustaining an injury.³ Fortunately, preventive training programs (PTPs) utilized as a warm-up prior to athletic activity that incorporate balance, agility, flexibility, strengthening, and plyometric exercises, as well as focus on improving neuromuscular control have been shown to reduce lower extremity musculoskeletal injury rates by 65-85%.⁴⁻⁶ Youth sport coaches represent the most viable long-term option for PTP delivery and coach-delivered PTPs can effectively reduce injury rates for their athletes.⁷ However, injury rate and injury risk reduction are dependent on PTP dosage and fidelity,^{8,9} and less than 20% of youth coaches utilize PTPs.¹⁰ Therefore, there is a need to improve the dissemination of PTP information so that youth coaches willingly adopt and implement PTPs.

Frameworks to guide PTP implementation and streamline reporting to improve replication and dissemination of efforts have been proposed.¹¹⁻¹³ One example, the Reach Efficacy Adoption Implementation Maintenance Framework (RE-AIM) was designed to improve the application of health interventions in real-world contexts.¹⁴ Each of the 5 domains (Reach, Efficacy, Adoption, Implementation, and Maintenance) provides context to consider when structuring implementation efforts. However, a review of the application of the RE-AIM framework¹² in PTP research found reporting gaps regarding adoption and maintenance of PTPs. A similar look at Padua's 7-Steps framework in youth sport interventions¹⁵ found that there was limited information reported regarding obtaining administrative support, and utilizing an interdisciplinary team. In order to increase translatability, implementation efforts need to clearly report methodologies, particularly with regard to initial adoption.

Health behavior frameworks can improve the organization of implementation efforts and help to more effectively disseminate strategies, but frameworks are theoretical in nature and youth sports are heterogeneous in athleticism, coaching experience, and other cultural factors. For example, recreational youth sport in the

United States relies primarily on volunteer coaches and the barriers and facilitators of completing step-wise implementation may vary considerably between organizations even within a specific age group and sport. Recent studies investigating the characteristic differences between coaches who do and do not implement PTPs found that coaches who utilized PTPs had more coaching experience¹⁶ and coaches who did not utilize PTPs felt that PTPs did not align with their team needs and were difficult to implement.¹⁰ No study has looked at how group characteristics of coaches within a given organization may impact the organization's overall participation with PTP implementation?

To our knowledge, no dissemination and implementation study has prospectively investigated the use of a framework across multiple organizations. This is a novel approach to explore how a theoretical framework translates into real-world settings. The primary purpose of this study was to evaluate the application of one implementation framework, the 7-Step framework,¹⁷ in American youth soccer and basketball organizations. We hypothesized that developing an interdisciplinary team (component within Padua Step 2) would be the most challenging factor of Padua's Steps 1-5 for leagues to complete. Evaluating the translation of a framework to multiple organizations within the same age groups and sports will advance dissemination and implementation efforts to expand the reach of interventions.

METHODS

Youth soccer and basketball organizations with athletes between the ages of 8-14 years and within 50 miles of the university were contacted via email (n=62 organizations) to participate in our study. Organizations were offered a free pre-season coaches' education workshop on preventive training program strategies. Approval for this study was completed by the University's Institutional Review Board.

Appraisal with the 7-Step model Dimension Items Checklist

Following the sport-season (10 ± 2 weeks), we utilized an operationalized dichotomous (yes/no) screening checklist that was previously developed (Sport Health 2017) to evaluate completion of each step in the Padua 7-Step framework. This review focused on Steps 1-5 of the framework, as the larger study did not evaluate PTP fidelity and thereby Steps 6 and 7 were ruled out.

The purpose of this screening was to reflect on and evaluate which components of an implementation framework may be most challenging or easy and why. Answering this big-picture question will help to profile future dissemination and implementation interventions for youth sport.

Step 1: Establish Administrative Support

Sport organizations were invited via email to participate in a free, brief pre-season education workshop delivered on site to their organization's coaches as part of the larger study. If an organization did not respond

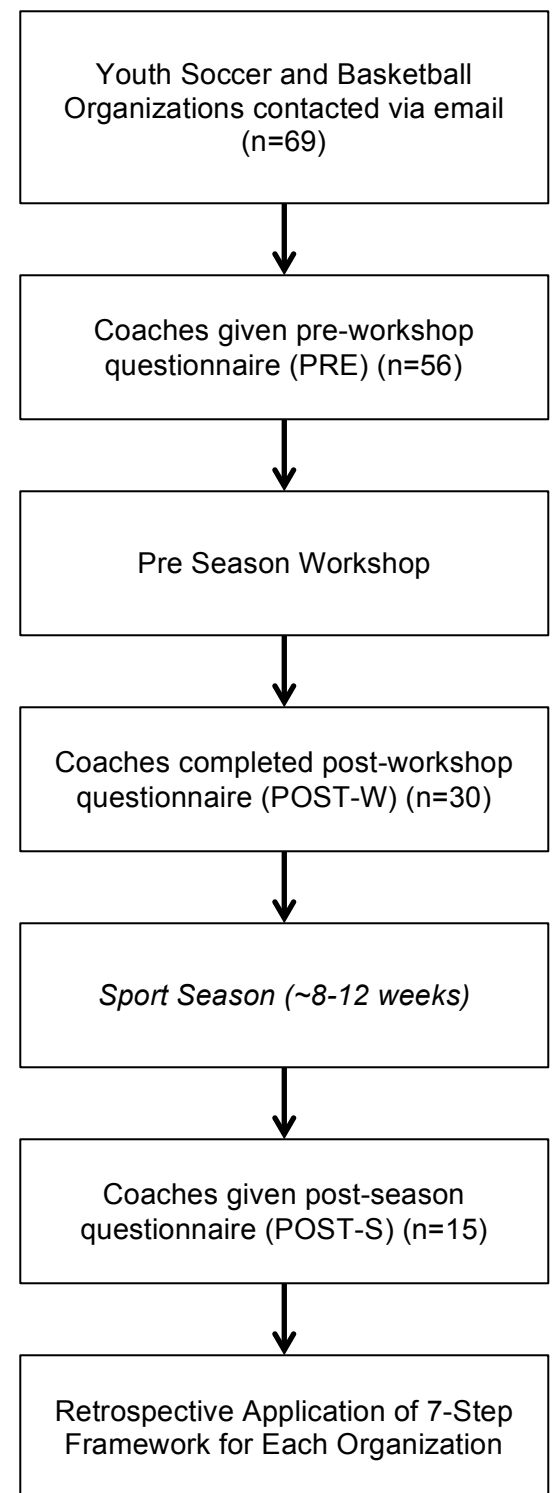


Figure 2: Flowchart of Study Procedures

to the initial email, the principle investigator (PI) sent follow-up emails at least two more times within a month of the initial email, a maximum of one email per week.

If an organization responded to the research team's communication efforts, the research team organized a preliminary meeting between the PI and at least one organization liaison. The organization liaison could be any league administrator, such as an Owner, President, Coaching Director, League Parent, etc. This varied based on the hierarchical structure of the organization during pre-season. At this meeting, the PI and liaison discussed: (1) what preventive training programs are and how PTPs compare to other warm-up strategies (2) the benefit of preventive training programs to reduce injury risk, reduce injury rate, and improve sport performance, specifically in a youth athlete population (2) the research study objectives and what procedures the organization could expect throughout the season. A secondary objective of this meeting was to identify potential dates to host the pre-season coaches' education workshop on preventive training programs for the respective organization.

Step 2: Develop an Interdisciplinary Team

If the organization volunteered to participate in the study, the PI worked with the organization to create an interdisciplinary team. The interdisciplinary team was either the initial liaison or, following the meeting, some organizations realized that there were other administrators within the organization who were better suited to carry out the communication, such as an active parent volunteer or a team coach.

Step 3: Identify Barriers and Solutions

Logistical barriers and solutions were identified during the preliminary meeting or throughout subsequent communication with the interdisciplinary team. These barriers included: number of coaches within the organization, location and venue availability to host the education workshop, what day and how long the workshop could feasibly be to promote coach attendance, etc. Once barriers were identified, the PI and interdisciplinary team worked to solve the issues.

Step 4: Develop an Evidence-Based PTP

The same preventive training program was taught during each and every organization's workshop (Appendix A). The PTP was developed based on efficacious warm-up strategies for youth soccer athletes.¹⁸⁻²⁰

During the hands-on training portion of the pre-season workshop, the research team discussed ways to make each exercise easier or more challenging. Coaches were asked to consider how the prescribed evidence-based PTP would work with their own teams and coaches encouraged to ask questions. Although the education workshop reviewed a specific evidence-based PTP, researchers discussed with coaches that there does not appear to be a one-size-fits-all or singular PTP that should be used. The workshop discussed the principles behind neuromuscular control and quality of movement during exercise as a way to encourage coaches to incorporate some PTP behaviors.

Step 5: Train the Trainers and Users

Coaches attended a 45-75 minute pre-season workshop on PTP implementation.

As part of the larger study, organizations were randomized into one of two pre-season educational workshop strategies. The "Generalized" workshop was a standard training workshop that addressed common implementation barriers for the coaches in general. The Generalized Workshop consisted of: (1) education regarding PTP effect on injury risk/rate, performance, and long term consequences of injury (2) hands-on training on implementing a 10-minute exercise-based PTP as a team warm-up, including peer-to-peer demonstration and skills practice and (3) a question and answer session to address concerns or questions.

The "Tailored" Workshop used information garnered from a pre-workshop questionnaire to establish priorities and streamline education to focus on specific components of interest. While the TAIL workshop also contained an educational portion, as well as hands on demonstration, the educational portion was geared to the specific interests and questions vocalized by the coaches in attendance. If the organization completed pre-workshop questionnaires prior to the workshop, the responses were reviewed by research staff and strengths,

weaknesses, and questions that appeared in at least 50% of the participants were pulled as focus areas for the workshop. If the organization was unable to complete pre-workshop questionnaires prior to the day of the workshop, questionnaires were completed day-of, prior to the start of the workshop. The research assistant leading the workshop then took a few minutes in the beginning to verbally discuss with the coaches which elements of the preventive training program were most important to them (injury prevention, sport performance, etc.) and what the coaches perceived to be their biggest barriers (time, understanding, hands on training, etc.). The research assistant then focused the content of the workshop toward those elements.

The goal of the larger study was to examine the knowledge and attitudes related to preventive training programs in coaches of youth soccer or basketball athletes (Root 2017). Coaches completed a pre-workshop (PRE-Q) and identical post-workshop (POST-W) questionnaire, as well as a post-season (POST-S) questionnaire (Appendix B). The questionnaires were a mixed-model of open-ended and Likert scale questions to assess behavioral determinants including attitudes, subjective norms, perceived behavioral control, intent to adopt a PTP, and perceived barriers and facilitators (Root 2017).

At the end of the season, post-season questionnaires (POST-S) were given to coaches to assess if the coach implemented the PTP throughout the season and, if so, how frequently and what exercises. If the coach did not implement a PTP during the season we evaluated what barriers influenced the coaches' behavior through open-ended questions.

Step 6: PTP Fidelity Control and Step 7: Exit Strategy

Step 6 and Step 7 did not align with the objectives of the larger initiative (Root 2017) and were therefore not evaluated within this study.

Data Analyses

One researcher (HJR) evaluated each of the steps for the 62 organizations and corroborated results with a second researcher (LJD). The principle investigator (HR) also conducted an observation evaluation to classify

different characteristics of organization implementation. Questions used to drive descriptions included: (1) Who were the key stakeholders for each organization? (2) What role did that stakeholder play in the organization? (3) What kinds of implementation problems were encountered throughout the study? (4) If applicable, how were those problems resolved? (5) What kinds of implementation successes were encountered throughout the study? (5) How can those successes be used to inform future dissemination efforts? Frequencies were calculated to evaluate the application of Padua's 7-Steps between different youth sport organizations.

RESULTS

Sixty-two youth soccer (n=40) and basketball (n=22) organizations were invited to participate in the larger study (Root 2017). For each organization, we retrospectively evaluated level of completion of Steps 1-5 within Padua's 7-Step framework (Figure 2)(Table1).

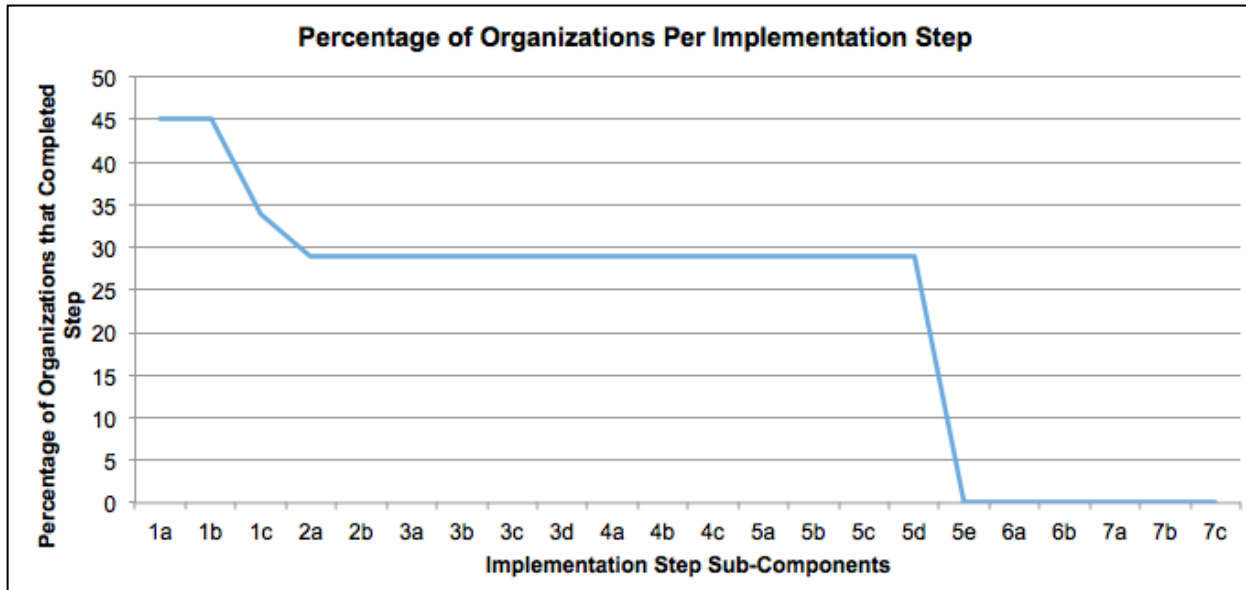


Figure 3: Percentage of Organizations that Successfully Completed Each Implementation Subcomponent

Each step had an overall theme and was then broken down into subcomponents (Table 1). Overall, twelve organizations completed all of Steps 1-4 and Step 5a – 5d. No organization completed all components of Steps 1-5.

Implementation Step	# of Organizations that Completed: n of yes / total (%)
Step 1. Establish Administrative Support	
1a. Did the research team explain the negative outcomes of injury? (<i>lack of athlete availability, decreased athletic performance, long-term disability, high re-injury risk</i>)	28 / 61 (45.9%)
1b. Did the research team explain the positive outcomes of injury prevention programming? (<i>reduce injury risk, enhance athletic performance increase athlete availability</i>)	28 / 61 (45.9%)
1c. Did the research team formally receive permission from the organization to implement the preventative training program?	21 / 61 (34.4%)
Step 2. Develop an Interdisciplinary Team	
2a. Did the research team involve key stakeholders (<i>coaches, organizational administrators, parents, athletes, sports medicine staff</i>) in the design of the PTP?	18 / 61 (29.5%)

2b. Did the research team involve key stakeholders (<i>coaches, organizational administrators, parents, athletes, sports medicine staff</i>) in the implementation plan of the PTP?	18 / 61 (29.5%)
Step 3. Identify Barriers & Solutions	
3a. Were logistical (<i>organizational infrastructure, locations, resource availability, capacity</i>) barriers and solutions identified?	18 / 61 (29.5%)
3b. Were time (<i>program & session duration</i>) barriers and solutions identified?	18 / 61 (29.5%)
3c. Were the organization's personnel (<i>number of staff available, staff's background / professional education</i>) barriers and solutions identified?	18 / 61 (29.5%)
3d. Were environmental (<i>training locations, surfaces, equipment availability</i>) barriers and solutions identified?	18 / 61 (29.5%)
Step 4. Develop an Evidence-Based Preventive Training Program	
4a. Is the program evidence-based?	18 / 61 (29.5%)
4b. Is the program solutions oriented? (<i>i.e. improve biomechanics, enhance performance, provide warm up, decrease muscle soreness</i>)	18 / 61 (29.5%)
4c. Is the program scalable? (<i>i.e. Do all components of the program need to be executed in order for it to be effective? Is program effectiveness maintained if intervention is adapted to meet the needs of the target population?</i>)	18 / 61 (29.5%)
Step 5. Train the Trainers & Users	
5a. Was the effectiveness of the preventative training program explained to the trainers & users?	12 / 61 (19.7%)
5b. Was the injury prevention program aligned with organizational goals (<i>player safety, reduce organization injury rates, enhance athlete athletic performance</i>)?	12 / 61 (19.7%)
5c. Were trainers' & users' knowledge, attitudes, and beliefs regarding injury prevention evaluated?	12 / 61 (19.7%)
5d. Were trainers & users self-efficacy assessed and addressed? (<i>i.e. trainers and users believe they are able to effectively teach and deliver the PTP</i>)	12 / 61 (19.7%)
5e. Were trainers & users provided with regular feedback on their delivery and execution of the preventative training program?	0 / 61 (0%)
Step 6. Preventative Training Program Fidelity Control	
6a. Was program implementation fidelity assessed?	<i>Not Evaluated</i>
6b. Was continuous quality improvement feedback provided based on program fidelity assessment findings?	<i>Not Evaluated</i>
Step 7. Exit Strategy	
7a. Were objective criteria for achieving high-fidelity implementation established?	<i>Not Evaluated</i>
7b. Was a goal-oriented exit strategy established? (<i>i.e. organization has achieved ≥90% compliance with markers of program implementation fidelity for at least 2 months</i>)	<i>Not Evaluated</i>
7c. Was implementation fidelity reassessed to ensure retention and maintenance after implementation support has been withdrawn for an extended period of time (<i>i.e. >6 months</i>) following initial training?	<i>Not Evaluated</i>

Table 1: 7-Step Operational Definitions

Step 1: Establish Administrative Support

Twenty-eight of the 62 organizations (45.2%) completed Step 1A and Step1B (Table 1). There was a drop off at Step1C and after the initial meeting between the liaison and PI. Only 21 out of the 62 organizations (33.9%) gave permission to implement the workshop for the preventive training programs.

Step 2: Develop an Interdisciplinary Team

Only 18 of the 62 organizations (29.0%) developed an interdisciplinary team with the research group. The interdisciplinary team makeup varied between organizations but was predominantly an organization administrator, such as a club President or Coaching Director, as well as an active team parent or team coach. The team helped to facilitate communication between the research staff and the other coaches and athletes within the organization.

Step 3: Identify Barriers and Solutions

Each of the 18 remaining organizations completed all of the components of Step 3.

Time

All pre-season education workshops lasted between 45-75 minutes. Organizations tried to plan proactively to maximize coach attendance to the workshop. However, the plan for this workshop differed. For example, some organizations chose to embed the workshop with other responsibilities, such as a uniform distribution or a meeting to schedule games, while others wanted the workshop to be a stand-alone event. We relied on the interdisciplinary team to know the best method to plan a workshop for their population of coaches. These plans however did not always yield high attendance.

For example, one league wanted the education workshop to take place on the same day as team uniform distribution. In this case, the organization had struggled to schedule a day for that worked for all of their coaches and stated that scheduling would be a major barrier for attendance. However, a different organization wanted the workshop to be held independently and not overlap with other meetings or pre-season tasks. In this case, the organization knew that more coaches would show up if the proposed duration of an event was shorter with a very specific agenda.

Organizational Infrastructure

The 18 organizations differed in administrative hierarchy and thereby handled workshop planning very differently. Our most common top-down structure was that of an organization administrator that also served a dual role as a volunteer coach. Only one soccer organization, the only elite-level organization evaluated, had administration independent of the coaching staff. This structure presented challenges with timely communication due to the heterogeneity of the roles, responsibilities, and time of the members of the interdisciplinary team. One organization had a proactive parent volunteer spearheading the workshop initiative and mobilized coaches through daily email reminders in the week leading up to the workshop. Another organization had paid coaches rather than volunteers and the organization owner facilitated reminders to coaches.

Environmental: Training Locations, Surfaces, and Equipment Availability

The organizations were located in different geographical locations within the state of Connecticut and towns differed in socio-economic status composition.

Step 4: Develop an Evidence-Based PTP

During the workshop we encouraged coaches to utilize any evidence-based PTP strategy that would work best for their team culture but distributed information regarding a specific PTP that our research team had developed for youth athletes. Only 14 coaches completed the POST-S questionnaire. Thirteen out of the 14 coaches who completed the POST-S (92.8%) reported utilizing any PTP during the season. Four of the 13 coaches (30.8%) reported implementing the workshop-specific PTP as instructed with no modifications to the program. Another four of the 13 coaches (30.8%) reported implementing the PTP but shortening the program due to time constraints. Three of the 13 coaches (23.1%) reported implementing a different PTP and 2 of the coaches (15.4%) reported adding exercises to the prescribed program. The 1 coach who completed the post-season questionnaire and did not implement any PTP strategies reported that there was not enough time in practice to use the program.

Step 5: Train the Trainers and Users

Twelve of the 62 organizations (19.4%) completed 4 out of 5 of the components within Step 5.

None of the organizations completed component 5e. Step 5e was to provide the coaches' with regular feedback on delivery and execution of preventive training program. This was not a measure of the larger study so no league was given regular, standardized feedback. Coaches were encouraged to reach out to the research staff if they had any questions and research staff were available by phone or email.

DISCUSSION

This was a retrospective study to evaluate the application of a framework following dissemination efforts of PTPs across youth sport organizations. Despite progress in reporting evidence-based PTP implementation strategies(1, 2)implementation sometimes fails.(3) While researchers have proposed frameworks to guide dissemination efforts,(4-6) the layers and complexities involved with widespread implementation can be challenging – what makes sense for one population may be unrealistic or ineffective in a different setting. In order to better understand the circumstances surrounding successful PTP adoption, we must identify which steps within a given framework may present the most challenges for youth sport organizations in the real world. No one has looked at the application of Padua's 7-Steps(6) at the youth level of American recreational sports. Comparing youth sport organization profiles within an implementation framework will streamline future interventions to increase the reach and effectiveness of preventive training programs.

Step 1: Establish Administrative Support

The first and largest barrier identified by this study was "Step 1: Establish Administrative Support". This study found that out of 62 organizations that were contacted, only 28 responded. A study by Donaldson et al.(7) experienced challenges planning an implementation strategy with community-Australian football because the volunteer culture of the leagues made pre-season planning and communication difficult. We had similar difficulties, particularly with making initial contact prior to the start of the season. Efforts were advertise the workshop to be as appealing and accommodating as possible. The workshop was described as a free, brief pre-season coaches' education workshop that would take place on a day and time and at a location that was most convenient for the majority of the coaches within the organization. Despite these efforts to offer a low maintenance training opportunity for coaches, multiple attempts to initiate communication, and the fact that our research group had existing professional relationships with many sport organizations in the area, we only saw a 45.2% response rate. Perhaps a more top-down approach, including mandates from state or national organizations, would improve the preliminary buy-in to beginning discussions to plan a coaches' workshop.

Step 2: Develop an Interdisciplinary Team

Of the 28 organizations that responded to the initial offer for the free, locally delivered pre-season coaches' education workshop, only 18 organizations continued and created interdisciplinary teams to collaborate on planning the coaches' workshop. The hierarchical structure within a given organization differed dramatically and thus the makeup of the interdisciplinary team was different between organizations. This heterogeneity carried over into organization barriers, where multiple organizations expressed that many coaches had not yet been confirmed with the season only weeks away. This challenge may not be present in higher-level athletics that likely have coaches determined farther in advance, so this presents unique challenges for dissemination of PTPs at the youth level. Youth sport and its volunteer cycle may only allow for very narrow windows of opportunity to establish contact and then administer training workshops. To overcome this potential barrier, dissemination efforts should begin 1-2 seasons prior and identify administration and staff who are confirmed to carry over into the season of interest. Similarly, it may be beneficial to engage different stakeholders to attend the workshop, such as parents who coach, parents who do not coach, coaches who do not have children on a team, organization administrators who coach, organization administrators who do not coach, athletes, etc. By creating an education workshop where there are likely different motivating factors and perspectives, the education workshop may have a more holistic approach to the benefits and reasons to implement PTPs, thus potentially increasing coach adoption and compliance. While previous research has not evaluated the impact of parents at workshops, one study by Steffen et al.(8) found it useful to include athletes as demonstrators within the workshop. Future research should look to include multiple stakeholders and evaluate the impact of their attendance on adoption and buy-in of PTP implementation.

Step 3: Identify Barriers and Solutions

One of the main barriers identified throughout the process was time. The research team made every effort to keep the workshop as efficient as possible, maintaining a 45-75 minute time limit depending on organization. Some organizations requested the pre-season workshop to coincide with another organization-specific event, such as uniform distribution, whereas other organizations wanted the pre-season workshop to be its own event. The research team relied on the interdisciplinary team to choose the best options for the coach personalities of each organization, but as previously stated, pre-season communication was difficult to facilitate

and we ran into several barriers. For example, one organization was proactive in scheduling the pre-season workshop and had high attendance for the current coaches; however, the organization scheduled so far in advance that several coaches had not yet been identified. In another instance, a basketball organization reported high levels of interest among coaches, but pre-season took place around winter holidays (late November - late December) and the workshop had low attendance due to weather and other holiday commitments. Each organization will have its own culture and time constraints,(9) so once communication is established, flexibility and the capacity to potentially offer multiple workshops may better accommodate coaches' schedules.

Step 4: Develop an Evidence-Based PTP

During the coaches' workshop, research staff taught an evidence-based PTP but emphasized the use of any evidence-based PTP. The types of exercises and duration of the PTP utilized had been shown to be efficacious in reducing injury risk in youth soccer athletes. We found that while 13 out of the 14 coaches who completed the POST-S (92.8%) reported utilizing any PTP during the season, only 4 of the 13 coaches (30.8%) reported implementing the workshop-specific PTP as instructed with no modifications to the program. Four out of the 13 of our coaches reported implementing the PTP but shortening the program due to time constraints. This corroborates results found by O'Brien et al.(10) where only 6% of coaches use the full FIFA11+ program and 22% of coaches use the program with modifications. Coaches can effectively reduce injury risk(11) and injury rate(12) of their athletes by implementing PTPs, but success is linked to program compliance and exercise fidelity.(13, 14) At the youth level, some of our coaches reported that injuries were not a problem for their athletes and that they wanted to spend more time practicing ball drills and sport-specific tasks than on the warm-up program.

Three of the 13 coaches (23.1%) reported implementing a different PTP, specifically the FIFA11+, however, we did not evaluate to what degree the coaches implemented the program. Two of 13 coaches (15.4%) reported adding arm exercises to the prescribed program, specifically arm circles forwards and backwards. The 1 coach who completed the post-season questionnaire and did not implement any PTP strategies reported

that there was not enough time in practice to use the program. The time limitation has been continuously reported as a barrier to implementation and the specific components of effective PTPs are inadequately reported.(15) These results support previous findings and future studies should continue to evaluate ways to address coaches' concerns, namely time and emphasizing more sport specific ball drills, while maintaining an effective strategy.

Step 5: Train the Trainers and Users

Twelve of the 62 organizations (19.4%) completed 4 out of 5 of the components within Step 5. Our research study covered PTP effectiveness to reduce injury risk, reduce injury rate, and improve performance within the workshop. We were able to evaluate if the PTP aligned with organization goals and the knowledge, attitudes, beliefs, and self-efficacy based on pre- and post-workshop questionnaire that was administered as a part of the larger study (Root 2017).

Coaches were encouraged to reach out to the research staff if they had any questions and staff was available by phone or email. However, few coaches reached out throughout the season. We believe that this was at least in part due to the persistent difficulty with communication between coaches and the research staff throughout the larger study. Future studies should ask coaches what their best and preferred method of contact may be in order to ensure clear, consistent communication.

Similar evaluations applying frameworks to implementation efforts(15, 16) found gaps in adoption and long-term maintenance of PTPs. A limitation of this study was that we were not able to consider Steps 6 and 7, which evaluate the fidelity and long-term maintenance of PTPs. However, our results on Steps 1-5 corroborate that initial adoption and establishing the administrative support of the organizations were the most challenging steps.

This study provides insight into the injury prevention dissemination and implementation experience of different organizations in youth sport settings. The challenges we faced in the first steps establishing administrative

support and forming an interdisciplinary team mirror the body of knowledge's general lack of reporting information on the initial adoption of PTPs. In order to promote successful adoption and implementation of PTPs, future research needs to clearly describe methodologies, as well as discuss barriers and solutions to implementation efforts.

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MANUSCRIPT 3: Influence of Pre-Season Coaches' Education Workshop on Athlete Movement Technique

ABSTRACT

Objectives: The purpose of this study was to evaluate changes in neuromuscular control between adolescent basketball and soccer athletes whose coach attended either a Generalized or Tailored pre-season education workshop on PTP implementation.

Design: Cluster randomized control trial.

Methods: Youth soccer and basketball organizations were contacted to participate in a pre-season coaches' education workshop on implementing preventive training programs. Coaches were randomized by league into a Tailored or General workshop. Pre-workshop surveys were used to prioritize content of the Tailored workshop. Generalized workshops followed standardized content. Athletes completed a PRE and POST season baseline assessment of movement technique. The movement technique assessment included a jump-landing task that was evaluated using the Landing Error Scoring System (LESS). A single rater, blinded to team, graded all videos for PRE and POST. Each of the three trials was averaged together for one composite score at PRE and POST.

Results: Seventy-seven athletes on 9 teams across 6 different organizations (Coaches' Workshops: Generalized=5 teams from 4 organizations, Tailored=4 teams from 2 organizations) completed both PRE and POST testing sessions. There were no significant differences between workshop and LESS scores at POST ($P>0.05$). Regardless of workshop LESS scores improved over time ((Mean \pm SD [95%CI]) Generalized PRE: 5.46 ± 0.10 [4.84, 6.08], Generalized POST: 4.62 ± 0.10 [4.00, 5.25], Tailored PRE: 5.99 ± 0.09 [5.40, 6.59], Tailored POST: 5.66 ± 0.09 [5.06, 6.25])($P=0.03$).

Conclusions: In conclusion, regardless of coaches' educational workshop strategy, athletes improved movement technique from PRE to POST. Future studies should look to evaluate the content of pre-season coach education workshops in conjunction with fidelity of program delivery, as well as explore implementation with other popular sports at the youth level in order to improve the reach and applicability of intervention efforts.

Word Count: 331 / 250 words

Keywords: Injury Prevention; Athletes; Education; Adolescent; Sports

INTRODUCTION

Youth participation in sport can provide the foundation for positive long-term physical⁽¹⁾ and mental health.⁽²⁾ Unfortunately sport-related injury can lead to attrition from sport⁽³⁾ and over 1.24 million kids are seen in the emergency room for sport-related injuries each year.⁽⁴⁾ Specifically, athletes are at the highest risk for sustaining a sport-related anterior cruciate ligament (ACL) injury between the ages of 11 and 17.⁽⁵⁾ As previous injury is a major risk factor for sustaining a musculoskeletal injury,⁽⁶⁾ primary prevention efforts should focus on youth sport prior to this high-risk age range and mitigate long-term sequelae that may negatively impact the health system overall.

Evidence-based preventive training programs (PTPs) used as a pre-participation warm-up for sport have been shown to reduce injury risk,⁽⁷⁾ as well as injury rates.⁽⁸⁾ The effectiveness of PTPs on injury reduction is directly related to program compliance and exercise fidelity,⁽⁹⁾ where players with high levels of compliance have a lower rate of injury compared to athletes with low levels of compliance or athletes who do not perform a PTP (Hagglund 2013). Coaches are the best option to ensure long-term adoption and consistent PTP implementation, but less than 20% of high school level coaches reported utilizing PTPs.⁽¹⁰⁾

One way to increase coaches' awareness and knowledge regarding PTPs is to implement pre-season educational workshops for coaches; however previous research has shown that increasing knowledge may not directly translate into coaches' adopting PTPs with their teams.⁽¹¹⁾ In other health behavior research, tailored messaging that is specific to an individual's needs and interests is more personally relevant and increases the likelihood of adopting a certain behavior.⁽¹²⁻¹⁴⁾ Perhaps pre-season educational workshops for coaches with content that is tailored to an organization's needs, beliefs, and characteristics may increase buy-in of the coaches to adopt a PTP.

Further, proving that there is a direct benefit to athletes, such as a decreased risk of injury, may increase a coaches' likelihood of implementing a PTP. Injury rate tracking is challenging in youth sport, as there is typically no central healthcare provider, such as an athletic trainer, within a given team, and coach-reported or

athlete-reported injuries can present challenges with recall.(15, 16) Intermediate measures of injury risk, such as movement technique, are frequently used to understand the effect of a PTP in this population.(17-20) Athlete movement technique could be a surrogate endpoint of the education workshop, where perhaps coaches who had a better experience in the pre-season education workshop are more likely to implement PTPs with high fidelity and compliance, and thereby their athletes would see the most improvement on movement technique. One study by Pryor et al.(7) found that following a pre-season workshop, coaches implemented PTPs and athlete injury risk decreased from pre- to post-season evaluation. However, these results were specific to a single soccer organization and it is unknown if the results would apply across other soccer organizations or other sports.

The purpose of this study was to evaluate changes in neuromuscular control between adolescent basketball and soccer athletes whose coach attended either a Generalized or Tailored pre-season education workshop on PTP implementation. We hypothesized that athletes whose coach attended a Tailored workshop would see greater improvements in movement technique.

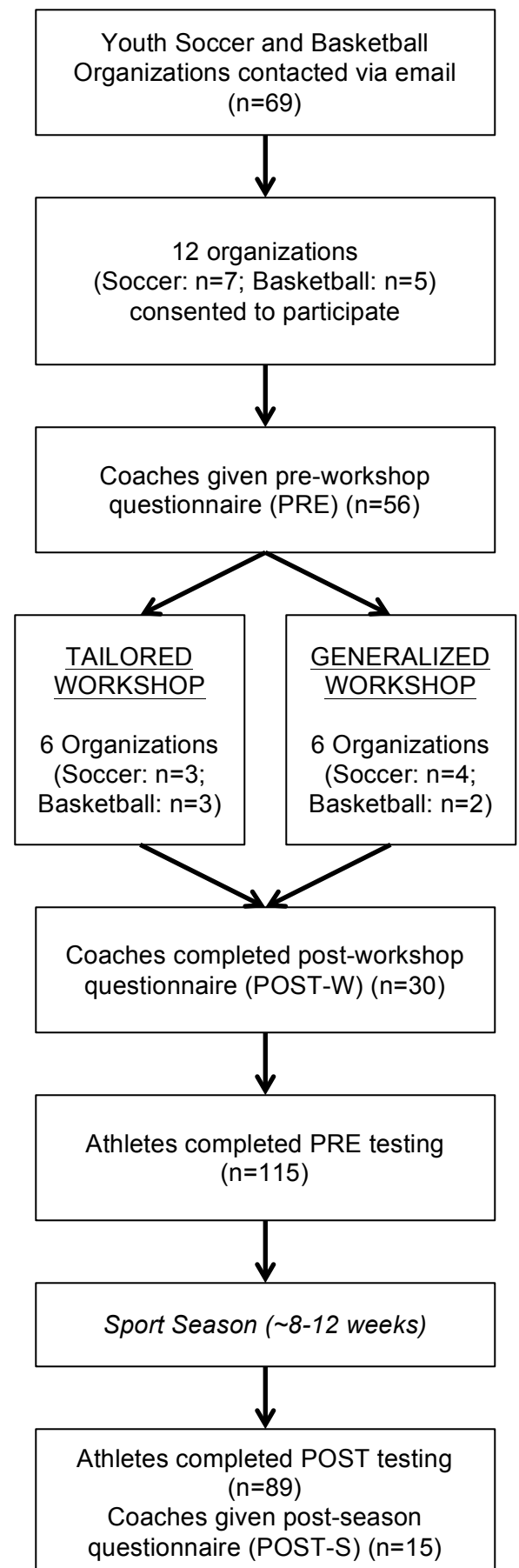
METHODS

This study was a part of a larger initiative (Root 2017)(Figure 1). Youth soccer and basketball organizations with athletes between the ages of 8-14 years and within 50 miles of the university were contacted via email (n=69 organizations) to participate in our study. Organization administrators who replied with interest met with research personnel for a primary meeting to discuss mutual goals, planning logistics and to schedule the coaches' educational workshop. A total number of 12 organizations (Soccer: 7 organizations, n=44 coaches; Basketball: 5 organizations, n=14 coaches) consented to participate in this study. Approval for this study was completed by the University's Institutional Review Board.

Coaches' Workshop

Organizations were randomized into one of two pre-season workshop groups: Generalized or Tailored so that all coaches within a given organization received the same workshop education strategy. One educational workshop was implemented per organization. Both Tailored and Generalized workshops lasted between 45-70 minutes depending on the number of coaches in attendance and availability of time. Full descriptions of the workshops are detailed in Root 2017.

The research group implemented pre-season PTP training workshops for coaches. One educational workshop was



implemented per sport organization. Workshops lasted between 45-70 minutes depending on the number of coaches in attendance and organization availability of time. For instance, some organizations chose to include the educational workshop as a component of an existing coaches' meeting or equipment day, which limited time to conduct the workshop. Other organizations chose to conduct the workshop on an independent day to allow for more time for questions and practice. The workshops had a lecture component, where the research team discussed PTPs and their impact on athlete injury risk, injury rate and sport performance to establish a shared understanding of PTPs and how PTPs may benefit their athletes. Workshops also had a hands-on component where coaches were taught how to implement a PTP that was created by the research team. The hands-on component included peer demonstration and time to practice leading PTPs.

Online resources with interactive video tutorials demonstrating each exercise were available to all coaches following the workshop regardless of group (<http://trainingpreparationforsport.weebly.com>). The online resource contained video demonstrations, examples of good and bad form, cues for exercises, and downloadable hand-outs of the PTP and educational materials.

Preventive Training Program

The research team created a 10-minute PTP, which was utilized for training purposes. The PTP contained flexibility, agility, core, strength, balance, and plyometric exercises and was based off of previous PTPs that have reduced injury risk and improved performance in youth athletes.(19) The same PTP was discussed during both workshop designs. However, research assistants made specific mention that there were multiple options for PTPs, such as the F11+, but that a standard warm-up of our research team's design would be specifically presented as an example for hands-on opportunities. Each workshop emphasized key components of PTPs that are important to include (i.e. agility, balance, etc.) according to the latest evidence regarding PTP effectiveness.(21)

Athlete Assessment

Coaches who attended a pre-season workshop were invited to have their athletes participate in pre- and post-season injury risk assessments. Athletes completed two test sessions, one during the first week of the season (PRE) and one during the last week of the season (POST). Test sessions lasted approximately 20 minutes per team and took place at the location of and prior to each team's practice.

Jump Landing Task

Participants stood on a box 30-cm high and jumped off the box forward towards a marked line a distance of approximately half the participant's body height away from the box. Participants were instructed to immediately perform a vertical jump for maximum vertical height upon landing. Participants performed as many practice jumps as needed to complete a successful trial. A successful trial was defined as the participant: (1) leaving the box with both feet at the same time (2) jumping straight down to the line (3) immediately rebounding as high up in the air as possible upon landing and (4) completing the task in a smooth motion. Three successful trials were recorded per participant.

Two digital video cameras recorded the jump-landing task from the front and side of the participant. A single rater analyzed the videos at a later date for high-risk movement technique using the Landing Error Scoring System (LESS). The LESS is a valid and reliable clinical movement assessment tool to identify biomechanical risk factors for ACL and other lower extremity injuries (CITE). A lower LESS score indicates good technique, and a lower risk of injury. Specifically, a LESS score less than 5 predicts a lower risk of ACL injury in youth soccer athletes.(20)

Post-Season Questionnaire

At the end of the season, post-season questionnaires (POST-S) were given to coaches. Coaches self-reported if they did or did not implement a PTP throughout the season and, if so, how frequently and what exercises.

Data Analyses

The purpose of this study was to evaluate changes in neuromuscular control across a season between adolescent basketball and soccer athletes whose coach attended either a Generalized or Tailored pre-season

education workshop on PTP implementation. We used a mixed model analysis of variance (ANOVA) to evaluate differences in neuromuscular control (average total LESS score) over time (PRE, POST) between educational workshops (Generalized, Tailored). We evaluated organization as a possible covariate, as educational workshops were delivered at the organization level.

We divided athletes into high and low risk categories based on LESS score at PRE, with a cut point of 5 based on previous research indicating that a LESS score <5 was indicative of a decreased risk of sustaining an ACL injury (HIGH: >5 ; LOW: <5). To determine the effect of the PTP with reducing risk based on the LESS, we selected participants who were HIGH risk at PRE and used chi-square analyses to evaluate differences in risk categorization (HIGH, LOW) at POST between workshop types (Generalized, Tailored).

All data were analyzed using SPSS Version 21.0 with an a priori alpha level of $p < 0.05$.

RESULTS

Of the 12 organizations who participated in a pre-season coaches' educational workshop, 6 organizations completed PRE and POST athlete testing. One hundred and fifteen participants on 9 different teams across 6 different organizations (Coaches' Workshops: Generalized=5 teams from 4 organizations, Tailored=4 teams from 2 organizations) volunteered to participate in this study (Table 1). Of the 115 athletes who completed PRE, 77 athletes completed both PRE and POST testing sessions.

Table 1. Athlete Demographic Information

	Soccer		Basketball	
	Male	Female	Male	Female
Sample size	39	63	7	6
Height, cm (mean±SD)	140.7±1.5	154.1±1.3	174.7±3.4	137.2±2.7
Weight, kg (mean±SD)	44.9±3.3	45.6±1.5	65.3±5.0	47.0±4.5
Age, years (mean±SD)	10±2	10±2	12±1	11±1

Organization did not affect the statistical model for continuous LESS items ($P>0.05$) so it was not included in the model as a covariate. There were no significant differences in LESS scores between workshops (Generalized, Tailored) between time points ($P>0.05$)(Table 2). However, regardless of workshop, LESS scores improved over time ($P=0.03$)(Table 2).

Table 2. LESS Score Descriptives by Workshop Over Time

	PRE		POST	
Workshop	Mean±SD	95% Confidence Interval	Mean±SD	95% Confidence Interval
Generalized Overall	5.46±0.10	[4.84, 6.08]	4.62±0.10	[4.00, 5.25]
Team 3	6.59±0.50	[5.43, 7.75]	5.96±0.62	[4.53, 7.39]
Team 4	6.03±0.53	[4.84, 7.23]	5.68±0.73	[4.03, 7.34]
Team 7	5.63±0.47	[4.56, 6.70]	5.02±0.47	[3.95, 6.08]
Team 9	3.50±0.50	[2.85, 9.85]	4.17±0.17	[2.05, 6.28]
Team 10	4.93±0.55	[3.40, 6.47]	4.07±0.44	[2.85, 5.29]
Tailored Overall	5.99±0.09	[5.40, 6.59]	5.66±0.09	[5.06, 6.25]
Team 1	4.38±0.72	[2.82, 5.95]	2.38±0.56	[1.17, 3.60]
Team 5	5.97±0.59	[4.67, 7.27]	5.89±0.42	[4.97, 6.81]
Team 6	7.03±0.32	[6.30, 7.77]	6.73±0.58	[5.43, 8.03]
Team 8	5.73±0.37	[4.70, 6.76]	6.53±0.89	[4.07, 8.99]

There were 45 participants who were categorized as HIGH risk at PRE, based on the LESS score. There was no significant difference in risk category (HIGH, LOW) at POST between workshop groups (Generalized, Tailored) at POST ($P>0.05$)(Figure 2).

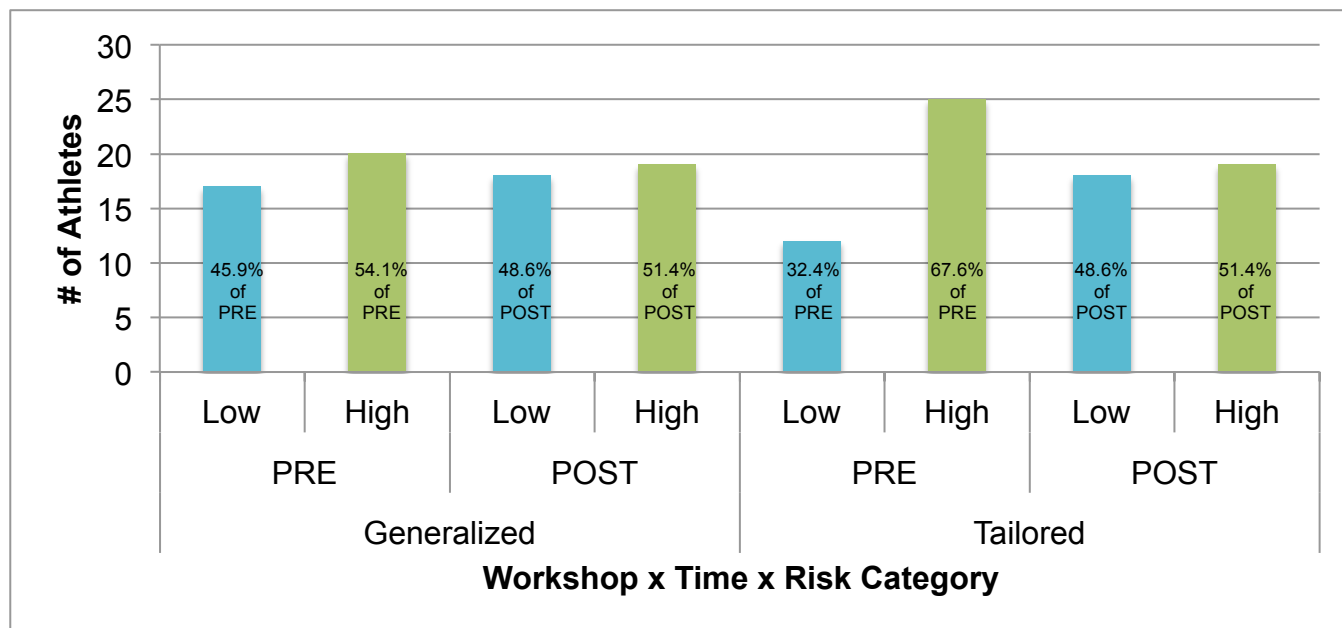


Figure 5. Number of Athletes within Each Risk Category Across Time By Workshop

DISCUSSION

The purpose of this study was to evaluate changes in neuromuscular control between adolescent basketball and soccer athletes whose coach attended either a Generalized or Tailored pre-season education workshop on PTP implementation. Our most important finding was that regardless of educational workshop design, an educational workshop can effectively prepare coaches to implement a PTP with their youth sport teams. Athletes significantly improved movement technique, which is associated with injury risk, from pre- to post-season. A recent study by Pryor et al.(7) also found that following a pre-season education workshop, coaches of youth soccer athletes were able to effectively implement a PTP over the course of a season and athletes improved their movement technique, which is related to injury risk in youth soccer athletes.(20) However, Pryor et al.(7) only evaluated one coaches' workshop and one youth soccer organization. Our study supports and adds to this knowledge by incorporating different educational techniques across multiple sport organizations, thus improving the applicability of coach workshops and increasing the dissemination potential of PTP education.

The present study included 6 different youth soccer and basketball organizations. O'Brien et al.(22) surveyed youth soccer coaches, fitness coaches, and physiotherapists at a professional youth soccer academy and found that there were challenges specific to individual soccer teams. Our study implemented one of two educational strategies per organization. The Generalized workshop was a standard training workshop that addressed common implementation barriers for a coaching population in general. Information in this workshop included: (1) education regarding PTP effect on injury risk/rate, performance, and long term consequences of injury (2) hands-on training on implementing a 10-minute exercise-based PTP as a team warm-up, including peer-to-peer demonstration and skills practice and (3) a question and answer session to address concerns or questions. The Tailored workshop used information on perceived barriers, facilitators, and motivating factors from the coaches' pre-questionnaire to establish priorities and streamline education to focus on specific components of interest. While the Tailored workshop also contained an educational portion, as well as hands-on demonstration, the educational portion was geared to the specific interests and questions vocalized by the coaches in attendance. Previous health behavior literature has found that personalized, tailored health

messaging can increase the likelihood and success of a health behavior change.(12-14, 23) One initiative aimed at prevention of skin cancer through improved behaviors found that tailored risk communications had improved adherence to protective behaviors compared to generic communications.(12) The different educational workshop designs within this study were intended to evaluate if tailored education would be more effective to increase coaches' behavior drivers for PTP implementation through addressing an organization's specific needs. We saw no difference in athlete outcomes between workshop groups. This indicates that a Tailored workshop may be unnecessary and more generalized content can effectively promote PTP usage through which we see improved athlete movement technique over the course of a season. With advances in online education tools and resources this could dramatically increase the reach of implementation interventions by providing access to educational workshops to anyone even those living in remote areas or those who do not have access to health care professionals to run an in-person workshop.

Most studies looking at coach-led PTPs have focused on female soccer athletes.(24-28) Further, within a recent meta-analysis showing that coaches can effectively implement PTPs, only one study evaluated athletes younger than high school ages and no study looked at basketball athletes. As basketball is a common sport for youth athletes to play,(29) basketball may be an additional opportunity to increase the reach of PTP dissemination efforts. We found no significant differences in LESS scores over time between sports. While we have a small number of basketball athletes (n=13), our findings further support that coaches can effectively implement PTPs(30) but adds to the literature by including both middle-school aged athletes as well as basketball athletes. One study by LaBella et al.(31) included high school basketball athletes and evaluated the impact of coach-led PTPs on athlete injury rate. LaBella et al.(31) found that coach-led PTPs decreased lower extremity injury rate. While our results evaluate movement technique as a proxy outcome related to injury risk, both studies indicate benefits of PTPs for basketball athletes. These results are encouraging for future research, as implementation efforts may successfully expand pre-season education workshops to basketball coaches.

Additionally, typically athletes with higher scores at PRE who have the most room to improve see the greatest change over time. Of the 74 athletes who completed PRE and POST testing, 45 participants (58.44%) were categorized as HIGH risk at PRE, based on the LESS score. Thirteen of the 45 participants (28.89%) improved risk category from HIGH to LOW from PRE to POST. This finding makes sense as the LESS is a summation of multiple injury risk factors dichotomized as yes/no for either present or absent. Athletes may have started too high to make such a dramatic change in movement technique to move below the 5 cut off point. Interestingly, we had a small subsample of elite level soccer athletes playing for a premier team who improved their team average by nearly 2 points from PRE (total LESS score(mean±SD): 4.38±2.59) to POST (total LESS score(mean±SD): 2.38±2.02). This was a surprising finding because the team had low LESS scores at PRE and showed huge improvements. These athletes had less room to improve but still saw a decrease in overall LESS scores. However, the organization that saw these improvements was the only elite organization included in our study and the coach reported (1) previous experience implementing a PTP and (2) implementing a PTP during the current season at least 3 times per week. These results corroborate that workshop design did not significantly influence an athlete's ability to improve movement technique but also show that while populations who baseline at a HIGH risk may have more room to change, any group of athletes can benefit from PTP implementation.

One of the major limitations of this study was that we did not have a control group and all athletes who completed PRE and POST testing were on teams of coaches who self-reported implementing any PTP during the season. We also did not measure program fidelity and relied on coach self-report at the end of the season to determine which coaches implemented a PTP throughout the season. Several studies have indicated that fidelity control and specific feedback to program delivers is an extremely component to successful coach training and high quality PTP dosage for athletes.(11, 32) However, previous literature has shown that athletes who perform a PTP with low compliance or do not perform a PTP at all do not see changes in injury rate(33) or injury risk.(19) Therefore, we feel that having a control group would not significantly change our results.

In conclusion, regardless of coaches' educational workshop strategy, athletes improved movement technique, which may indicate a reduced risk of injury over the course of a sport season. Future studies should look to evaluate the content of pre-season coach education workshops in conjunction with fidelity of program delivery, as well as explore implementation with other popular sports at the youth level in order to improve the reach and applicability of intervention efforts.

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