



Contents lists available at ScienceDirect

# Journal of Science and Medicine in Sport

journal homepage: [www.elsevier.com/locate/jsams](http://www.elsevier.com/locate/jsams)



## Original research

# High levels of coach intent to integrate a ACL injury prevention program into training does not translate to effective implementation

Barnett S. Frank\*, Johna Register-Mihalik, Darin A. Padua

The Department of Exercise & Sport Science, The University of North Carolina at Chapel Hill, USA

## ARTICLE INFO

### Article history:

Received 4 December 2013  
Received in revised form 30 May 2014  
Accepted 15 June 2014  
Available online xxx

### Keywords:

Athletic injuries  
Anterior cruciate ligament  
Primary prevention  
Physical education and training  
Compliance

## ABSTRACT

**Objectives:** Evaluate the effect of an anterior cruciate ligament injury prevention program coaching workshop on elite-level youth soccer coaches' behavioral determinants to implement an injury prevention program and describe coaches' subsequent injury prevention program implementation compliance.

**Design:** Descriptive study.

**Methods:** We evaluated a soccer club's coaches' behavioral determinants regarding injury prevention programming implementation before and after a coaching workshop using pre- and post-workshop surveys. We then described the club's coaches' subsequent adoption of and implementation compliance with the injury prevention programming during the following season.

**Results:** The injury prevention workshop increased coaches' attitudes toward conducting a program at the beginning of practice ( $p < 0.05$ ), substituting the program for a warm-up prior to practice ( $p < 0.05$ ), and improving player cutting and landing technique by implementing the program ( $p < 0.05$ ). The injury prevention program workshop increased coaches' perceived behavioral control; feeling more comfortable in their ability to teach their team a program ( $p < 0.05$ ), and more confident leading a program if given instructions ( $p < 0.05$ ). The injury prevention program workshop increased coaches' intent to implement a program the next season ( $p < 0.05$ ), to implement a program for 15 min ( $p < 0.05$ ), and 20 min ( $p < 0.05$ ) prior to the start of a training session. Only 53% of the club's teams implemented the injury prevention program, with implementers demonstrating high variability in program fidelity.

**Conclusions:** Coaching workshops can effectively increase coach attitudes, perceived behavioral control, and intent to implement an injury prevention program. However, high levels of behavioral determinants do not appear to translate to high levels of implementation compliance.

© 2014 Sports Medicine Australia. Published by Elsevier Ltd. All rights reserved.

## 1. Introduction

In the United States, children's sport-related injuries are responsible for 20% of all emergency department visits in children aged 6–19, representing a healthcare system cost of \$935 million in 2012.<sup>1</sup> While there are numerous serious sport injuries that result in time loss from sport, perhaps one of the most severe and debilitating is anterior cruciate ligament (ACL) injury.<sup>2</sup> Injuries involving the ACL are particularly problematic due to negative long-term consequences, such as an early-onset of osteoarthritis.<sup>1</sup> Thus, musculoskeletal injury prevention efforts in youth sports should target minimizing ACL injury.<sup>3</sup>

Numerous efficacious sport injury prevention policies and programs exist, spanning prevention and management of concussion and neck injury<sup>4,5</sup> to prevention of lower extremity injuries.<sup>6</sup> Specific to ACL injury, there is a 65–85% reduction in injuries when athletes participate in ACL injury prevention programs (IPP).<sup>1,6</sup> ACL IPPs have proven highly efficacious at reducing injury risk in adult and adolescent male and female soccer athletes,<sup>7,8</sup> as well as other field or court team sports such as basketball<sup>8</sup> and team handball.<sup>6,9</sup> While ACL IPPs have proved efficacious, their level of adoption and compliance is low.<sup>10–12</sup> Current epidemiological evidence suggests programs are not effectively deployed in the “real-world,”<sup>13–15</sup> as knee injury rates are projected to rise in the upcoming years.<sup>16</sup> The effectiveness of ACL IPPs is ultimately limited by the program's adoption and implementation in real-world settings.<sup>17</sup> Thus, understanding behavioral and environmental factors associated with coaches' real-world compliance for implementing a ACL IPP is critical for long-term effectiveness of a

\* Corresponding author.

E-mail addresses: [bsfrank@unc.edu](mailto:bsfrank@unc.edu), [bsfrank@email.unc.edu](mailto:bsfrank@email.unc.edu) (B.S. Frank).

ACLIPP, as compliance has been identified as a primary determinant of successful ACL IPPs.<sup>18</sup>

The Theory of Planned Behavior (TPB) suggests that *intent* is the strongest predictor of behavior.<sup>19</sup> Additionally, the TPB addresses *attitudes, subjective norms and perceived behavioral control* around intentions to perform a specific behavior<sup>19</sup> such as implementing an ACL IPP. In order to identify appropriate methods to increase the effectiveness of ACL IPPs in the real world, we must first be capable of developing systematic approaches for implementing ACL IPPs, leveraging theoretical frameworks such as the RE-AIM Sports Setting Matrix (RE-AIM SSM)<sup>17</sup> (Supplement A) and Implementation Drivers<sup>20,21</sup> (Fig. 1.) that promote adoption of and implementation compliance with efficacious ACL IPPs.<sup>22,23</sup> The RE-AIM SSM facilitates evaluation of the *reach, effectiveness, adoption, implementation, and maintenance* of a sports injury prevention program.<sup>17</sup> We aimed to structure the implementation and evaluation of the ACL IPP in the club setting using the constructs of the RE-AIM SSM.

Thus the primary purpose of this study was to evaluate the immediate effects of a ACL IPP workshop and a ACL IPP implementation packet on a club's coaches behavioral determinants of *attitude, subjective norms, perceived behavioral control, and behavioral intention* regarding ACL IPP implementation. The secondary purpose of this study was to evaluate a soccer club's acute *adoption* of the ACL IPP and the club's *implementation compliance* with the programming during the first two weeks of the league's soccer season.

## 2. Methods

We structured all elements of the application of our intervention within the RE-AIM SSM with an aim to *reach* all coaches of female elite teams within a youth soccer club. The planning of the intervention was coordinated with the club's administrators, including the director of coaching, chief operating officer, and sports medicine staff. Through collaboration with the club administrators, the research team worked to map an efficient method of ACL IPP deployment within the club during the Fall 2011 season (Fig. 1). The research team and the club administrators began discussions of implementing the ACL IPP four months prior to the start of the Fall 2011 season. Initial discussions assessed the needs of the club in regards to being able to deploy the ACL IPP within the elite-level female teams. The research team outlined an implementation plan (Fig. 1) that was presented to the club administrators. The research team, club administrators, and club's sports medicine staff held planning meetings twice per month during the two months leading up to the Fall 2011 season to optimize the implementation plan and further align with the elite-level female teams' objectives. At the conclusion of the final planning meeting a verbal agreement between the research team and club administrators was reached regarding the final implementation plan. Collaboration between the club administrators and research team resulted in the development of a workshop to be delivered during the first coaches' meeting. In addition, the club adopted a policy for all teams to implement the ACL IPP during two of the four mandatory team practice sessions per week and that all teams utilize implementation assistance from the research team members during the first two weeks of the season.

The club administrators asked that at the club's annual meeting the researchers introduce the concept of the ACL IPP to coaches, team managers, and parents, and then further describe the program to coaches during the first club meeting prior to the start of the Fall 2011 season. The club administrators asked that the structure of the workshop assume an informational session format due to time constraints. Initially the research team proposed that the workshop be delivered in an interactive format with research team members

walking the coaches through field set-up, conducting the ACL IPP, and teaching coaches how to provide appropriate cuing. While the research team envisioned an interactive workshop session to be ideal, the club administrators committed to only be able to devote 30–40 min of the coaches meeting to the workshop presentation. All coaches and athletes provided informed written consent prior to participation and all data were recorded anonymously. Ethics approval was obtained from The Institutional Review Board at (The University of North Carolina at Chapel Hill IRB 11–1376).

Prior to the start of the workshop, coaches were administered a Likert scale survey to assess behavioral determinants within the TPB,<sup>19</sup> assessing 34 coaches' (30 males, age = 34.6 ± 9.1 years) *attitudes, subjective norms, perceived behavioral control, and intent* (Table 1.) to implement a ACL IPP with their teams during the Fall 2011 season. The workshop provided the coaches with background information regarding the impact of injury on team success,<sup>24</sup> importance of movement quality as a foundation for functional athletic activity, and evidence surrounding the *effectiveness* of ACL IPPs in reducing injury and improving athletic performance.<sup>6,25</sup> After presentation of the ACL IPP background, the workshop then provided coaches with instruction for on-field set-up and described the exercise elements of the program (Supplement B). The coaches were then directed to the ACL IPP's online materials, including demonstration videos for each exercise and videos of the composite program. The online materials also provided coaches with downloadable copies of on-field instructional cards describing field set-up, and exercise instructions. During the workshop, coaches were also provided with laminated on-field instruction cards and were informed they would be given assistance from research team members during the first two weeks of the Fall 2011 season to help deliver the ACL IPP.

Following the workshop, coaches completed a post-workshop survey to assess the effect of the workshop on coaches' behavioral determinants regarding implementation of a ACL IPP with their teams during the Fall 2011 season. The post-workshop survey was identical to the pre-workshop survey except for the inclusion of two subjective questions to further assess coaches' perceived behavioral control regarding implementation of a ACL IPP during the upcoming season asking coaches if they "felt more comfortable leading a ACL IPP" and "were more comfortable with their team doing a ACL IPP," the frequency of "yes" or "no" dichotomous responses were recorded. At the conclusion of the workshop, after all coaches had completed the post-workshop survey, the club administrators informed the coaches that it would be club policy to implement the ACL IPP a minimum of two training sessions per week during the upcoming season as discussed during intervention planning.

During the first two weeks of the Fall 2011 season, the 34 coaches of 15 elite-level female soccer teams (under 14–under 18 teams) received reminders from the club administrators that it was club policy to implement the ACL IPP at least twice per week, and were provided with a schedule of the practice sessions that a research team member would be available to help implement the ACL IPP. Research team members were assigned to each club team in pairs, an intervention facilitator and an evaluator. The facilitator was to be visible and available to the coach if the coach indicated they needed assistance with implementing the ACL IPP with their team. The evaluator was present to assess the level and quality of implementation of the ACL IPP by the coach using a coach implementation evaluation template (Supplement C). Coaches were sent e-mail reminders at least 48 h prior to evaluation sessions to ensure they were completing the ACL IPP when evaluators were present. The evaluator assessed club adoption as a dichotomous variable evaluating if the program was executed or not, and coach implementation compliance via *Completeness* – *Number of exercises completed out of 16 total ACL IPP exercises,*

**Table 1**  
 Determinants of coach behaviors regarding implementation of a ACL IPP (n and % of responses).

	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
<b>Attitude</b>										
I am comfortable with my team doing a ACL IPP daily at the beginning of practice.*	–	–	–	–	2 (5.9%)	1 (2.9%)	23 (67.6%)	18 (52.9%)	9 (26.5%)	15 (44.1%)
I feel ACL IPPs can effectively substitute for my team's warm-up.*	–	–	3 (8.8%)	1 (2.9%)	9 (26.5%)	7 (20.6%)	17 (50.0%)	13 (38.2%)	5 (14.7%)	13 (38.2%)
I can change my team's lading and cutting technique by teaching them a ACL IPP.*	–	–	–	–	11 (32.4%)	2 (5.9%)	16 (47.1%)	21 (61.8%)	7 (20.6%)	11 (32.4%)
My team will have improved agility after completing a ACL IPP.	–	–	–	–	7 (20.6%)	5 (14.7%)	16 (47.1%)	16 (47.1%)	11 (32.4%)	13 (38.2%)
My team will sustain fewer injuries after completing a ACL IPP.	–	–	1 (2.9%)	–	7 (20.6%)	6 (17.6%)	15 (44.1%)	19 (55.9%)	11 (32.4%)	9 (26.5%)
Injuries are a unavoidable part of the game at the level I coach.	–	–	8 (23.5%)	9 (26.5%)	11 (32.4%)	9 (26.5%)	9 (26.5%)	8 (23.5%)	6 (17.6%)	8 (23.5%)
<b>Subjective norms</b>										
If I implemented a ACL IPP for my team, my team would feel comfortable with me leading it.	–	–	–	–	2 (5.9%)	1 (2.9%)	14 (41.2%)	14 (41.2%)	18 (52.9%)	19 (55.9%)
<b>Perceived behavioral control</b>										
If I implemented a ACL IPP for my team, I would feel comfortable leading it if I was provided instructions.*	–	–	–	–	3 (8.8%)	1 (2.9%)	15 (44.1%)	14 (41.2%)	16 (47.1%)	19 (55.9%)
If I implemented a ACL IPP for my team, I would need help from experts in order to lead the program.	1 (2.9%)	1 (2.9%)	13 (38.2%)	12 (35.3%)	9 (26.5%)	9 (26.5%)	7 (20.6%)	10 (29.4%)	4 (11.8%)	2 (5.9%)
If I implemented a ACL IPP for my team, I would feel comfortable leading it if I went through training.	–	–	1 (2.9%)	2 (5.9%)	6 (17.6%)	–	13 (38.2%)	16 (47.1)	14 (41.2%)	16 (47.1%)
I am comfortable teaching my soccer team to change direction safely while playing soccer.	–	–	1 (2.9%)	1 (2.9%)	5 (14.7%)	2 (5.9%)	19 (55.9%)	22 (64.7%)	9 (26.5%)	9 (26.5%)
I am comfortable teaching my team a ACL IPP.*	–	–	–	–	7 (20.6%)	–	21 (61.8%)	21 (61.8%)	6 (17.6%)	13 (38.2)
<b>Behavioral intention</b>										
I plan to implement a ACL IPP with my soccer team next season.*	–	–	–	–	14 (41.2%)	4 (11.8%)	12 (35.3%)	12 (35.3%)	8 (23.5%)	18 (52.9%)
I would be willing to have my team perform a ACL IPP if the program required 10 min of practice time.	–	–	–	–	–	–	14 (41.2%)	11 (32.4%)	20 (58.8%)	23 (67.6%)
I would be willing to have my team perform a ACL IPP if the program required 15 min of practice time.*	–	–	1 (2.9%)	1 (2.9%)	1 (2.9%)	1 (2.9%)	19 (55.9%)	12 (35.3%)	13 (38.2%)	20 (58.8%)
I would be willing to have my team perform a ACL IPP if the program required 20 min of practice time.*	–	–	4 (11.8%)	3 (8.8%)	11 (32.45)	8 (23.5%)	15 (44.1%)	16 (47.1%)	4 (11.8%)	7 (20.6%)
I would be willing to have my team perform a ACL IPP if the program required 30 min of practice time.	4 (11.8%)	3 (8.8%)	7 (20.6%)	8 (23.5%)	16 (47.1%)	16 (47.1%)	5 (14.7%)	6 (17.6%)	2 (5.9%)	1 (2.9%)

\* Significant (p < 0.05) positive change in response to a question from the pre- to the post-workshop questionnaire.

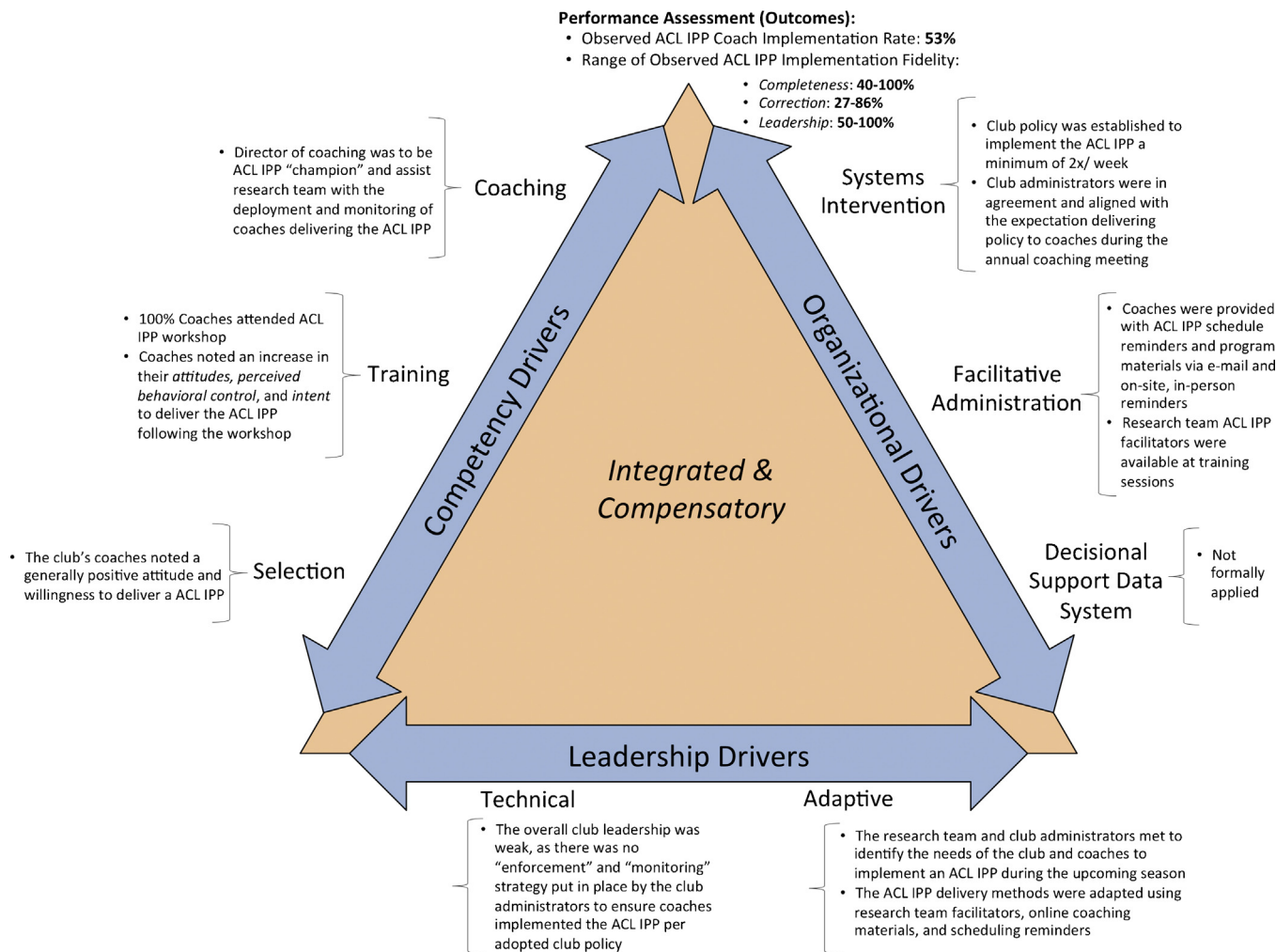


Fig. 1. Implementation Drivers Framework<sup>20,21</sup> as applied to a ACL injury prevention program with resultant observed study outcomes.

**Correction** – The rate at which club coaches provided cuing to athletes who were observed to execute an exercise incorrectly – 0 to maximum # of exercises performed (up to 16) – 1 if correction equal or exceed errors, 0 if errors exceed corrections, and **Leadership** – Assessed domains of: proper field set-up, athlete arrangement, leading of team with correct form, appropriate exercise cueing, appropriate correction of errors, exercises performed in correct order scores. Detailed description of implementation compliance scoring is presented in Supplement C. Each team was evaluated once during the first two weeks of the Fall 2011 season.

Likert scale data from the workshop surveys 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 test the null hypothesis that there was no effect of a coaching workshop on the club’s coaches behavioral determinants of implementing a ACL IPP we used a non-parametric Wilcoxon signed-rank test. We compared the club’s coaches’ pre- to post-workshop survey responses with a priori alpha-level <0.05 to detect significant changes in a coach’s response after exposure to the workshop presentation. Adoption and implementation data were compiled from program implementation evaluation forms into a Microsoft Excel spreadsheet to report descriptive adoption and implementation compliance statistics.

### 3. Results

Following the workshop, coach *attitudes* were more positive toward conducting a ACL IPP at the beginning of practice ( $Z = -2.33, p < 0.05$ ), substituting a ACL IPP for a warm-up prior to practice ( $Z = -2.69, p < 0.05$ ), and improving player’s cutting and landing technique by implementing a ACL IPP ( $Z = -3.36, p < 0.05$ ). After the workshop, coaches’ *perceived behavioral control* increased, feeling more comfortable in their ability to teach their team a ACL IPP ( $Z = -3.07, p < 0.05$ ) as well as more confident they could lead a ACL IPP if given instructions ( $Z = -2.24, p < 0.05$ ). The workshop increased coaches’ *intent* to implement a ACL IPP during the Fall 2011 season ( $Z = -3.54, p < 0.05$ ). Following the workshop, coaches were more inclined to implement a ACL IPP for 15 min ( $Z = -2.65, p < 0.05$ ) and 20 min ( $Z = -3.530, p < 0.05$ ) prior to the start of a training session, but did not change their intent to implement a ACL IPP for a 10 or 30 min duration prior to a training session. The frequencies for pre- and post-workshop survey responses are summarized in Table 1.

During the post-workshop survey a majority of coaches reported they were “more comfortable with their team implementing a ACL IPP” ( $n = 33, 97.1%$ ) and they were “more comfortable leading a ACL IPP” ( $n = 34, 100%$ ), suggesting coaches had a high level of perceived behavioral control to implement a ACL IPP at the beginning of the Fall 2011 soccer season.

**Table 2**  
Counts and descriptive statistics (Mean, Standard Deviation (SD), and Range) of implementation compliance in teams ( $n = 8$ ) that adopted a ACL IPP.

Team #	1	2	3	4	5	6	7	8	Mean	SD	Range
Completeness <sup>a</sup>	15/16 (94%)	16/16 (100%)	15/16 (94%)	6/16 (40%)	6/16 (40%)	16/16 (100%)	16/16 (100%)	14/16 (88%)	82%	25%	40–100%
Correction <sup>b</sup>	4/15 (27%)	16/16 (100%)	13/15 (87%)	6/6 (100%)	6/6 (100%)	13/16 (81%)	16/16 (100%)	12/14 (86%)	85%	23%	27–86%
Leadership <sup>c</sup>	6/12 (50%)	12/12 (100%)	12/12 (83%)	9/12 (75%)	9/12 (75%)	11/12 (92%)	8/12 (67%)	7/12 (58%)	75%	16%	50–100%

<sup>a</sup> Number of exercises completed out of 16.

<sup>b</sup> Correction rate: (0 to maximum # of exercises performed (up to 16)) – 1 if correction equal or exceed errors, 0 if errors exceed corrections.

<sup>c</sup> Leadership score based on domains of: proper field set-up, athlete arrangement, leading of team with correct form, appropriate exercise cueing, appropriate correction of errors, exercises performed in correct order.

The immediate adoption of the program was 53%, with eight of the 15 teams adopting the ACL IPP during their scheduled evaluation session. ACL IPP adopters demonstrated high variability in implementation compliance. Implementation compliance measures are reported in Table 2 for the teams that implemented the ACL IPP ( $n = 8$ ).

#### 4. Discussion

Our study describes the planning, immediate adoption, and subsequent implementation of a ACL IPP in an elite female youth soccer club in a real world context using the RE-AIM Sports Setting Matrix (RE-AIM SSM). Our study is the first to evaluate the acute effects of a coaching workshop on a single club's coaches' behavioral determinants of implementing a ACL IPP and describe subsequent levels of implementation and fidelity. The results of our study suggest that an educational coaching workshop can effectively promote a positive attitude, strengthen perceived behavior control, and increase intent to implement a ACL IPP in elite youth soccer coaches. Interestingly, our findings suggest that a coaching workshop effectively increases intent to implement a ACL IPP; however, the subsequent adoption rate was relatively low (53%) despite the established club policy to implement the ACL IPP twice per week. These findings highlight a lack of translation between policy and practice. Previously identified efficacious IPPs have reported higher adoption rates, but interestingly have reported similarly high variability in implementation compliance.<sup>8</sup> Collectively, the findings of our study indicate that competency drivers, technical assistance, and intent alone do not translate to high rates of adoption and implementation compliance of a ACL IPP in the elite soccer club sport setting. Furthermore, the results of this study suggest that positive attitudes and beliefs regarding injury prevention programming do not precipitate changes in injury prevention behaviors of sport coaches.

Our prospective findings are in agreement with a majority of retrospective studies that have evaluated coach knowledge, attitudes, and beliefs regarding ACL IPPs. Specifically, our observation of a generally positive coach attitude toward ACL IPP agrees with findings from studies that have evaluated coaches' beliefs regarding the efficacy of lower extremity injury prevention programs in netball<sup>26,27</sup> and soccer.<sup>27</sup> Previous literature suggests that coaches agree ACL IPPs can improve athletic performance and effectively decrease lower extremity injury risk.<sup>10,26,27</sup> An important finding of our study is that coaches demonstrated relatively high levels of attitude, subjective norms, perceived behavioral control and behavioral intention prior to the workshop. The observed initial high levels of behavioral determinants informs individuals planning ACL IPPs they may not need to design their interventions to further promote attitude, subjective norms, perceived behavioral control and behavioral intention, but rather focus their efforts on reducing barriers to facilitating adoption and implementation compliance at the individual coach level. Moreover, our results are consistent with findings of studies in other countries, suggesting the population of sport coaches demonstrate relatively positive attitudes and beliefs regarding lower extremity injury prevention.<sup>28</sup> However, the lack of translation of high levels of intent and positive attitudes toward

injury prevention to adoption and implementation of programming persists as a global issue.<sup>15</sup>

Interestingly, we observed positive increases in coach attitudes toward the effectiveness of ACL IPPs in reducing injury and improving athletic performance. Our finding is important, considering the perceived performance enhancing benefits and reduction in injury rates are consistently reported by coaches as important factors underlying coaches' implementation of ACL IPPs.<sup>10,22</sup> Our results suggest that an educational workshop can amplify a positive attitude toward the benefits of ACL IPPs, which may decrease the perceived barriers to implementing a ACL IPP.<sup>19</sup> Additionally, we observed an increase in the coach's perceived behavioral control to implement ACL IPPs in the upcoming season. Specifically, coaches demonstrated an increase in their "comfort teaching their team a ACL IPP" and felt more comfortable implementing a ACL IPP if they "were provided instructions" after the workshop. The effect of increasing a coach's perceived behavioral control to implement a program is important, as this behavioral determinant has been identified to translate to a heightened level of intent to change behavior.<sup>19</sup> Furthermore, previous findings report coaches identify instructional materials as helpful and facilitative in their efforts to implement ACL IPPs.<sup>10,26,27</sup>

Within the TPB, behavioral intent is identified as the strongest predictor of behavior change.<sup>19</sup> Following the workshop, 88.2% of coaches indicated that they agreed or strongly agreed with the statement "I plan to implement a ACL IPP with my soccer team next season." During the observational period following the workshop, only 53% of teams implemented the ACL IPP. Thus, our results demonstrate that a ACL IPP workshop can significantly increase a coach's intent to implement a ACL IPP in the future; however, this does not translate to high levels of program compliance. Thus, our findings suggest that factors other than behavioral intent may be important to thoroughly describe coaches' ACL IPP implementation behavior.

We observed a large range of variability in the implementation compliance (Table 2.) amongst those coaches who did implement the ACL IPP. These findings are worrisome, considering our intervention achieved a 100% reach to coaches of elite-level teams, a majority of coaches "agreed" (pre: 50%, post: 38.2%)—"strongly agreed" (pre: 14.7%, post: 38.%) ACL IPPs could effectively substitute for their team's warm-up, and that the club adopted a policy to implement programming during at least two training sessions per week. Furthermore, coaches were provided with ACL IPP resources, including print materials, an instructional website, and technical assistance with facilitative administration<sup>20,21</sup> through reminder e-mails to implement the ACL IPP. Although our findings of a low-level of compliance with implementation may be disappointing, they are supported by previous research using similar implementation strategies to those described in the current study. Myklebust et al. reported similar levels of variability in program "buy-in" from coaches implementing a ACL IPP in a large controlled trial in team-handball athletes.<sup>9,14</sup> And most recently, Joy et al. reported only 10.2% (14/136) coaches of female soccer athletes implemented ACL IPPs with "best practices."<sup>10</sup> The results of our study suggest that educating coaches through a coaching workshop, provided ACL IPP

implementation toolkit, and implementation assistance is not sufficient to drive behavior change in youth sport coaches. Future research is necessary to explore additional elements that are necessary to increase implementation compliance with ACL IPPs in youth sport.

Conversely, multiple studies have reported relatively higher levels of compliance with ACL IPP ranging from 77<sup>28</sup> to 80%.<sup>8</sup> A potential source of incongruence in our observation of low compliance with implementation compared to previous studies is that a research team evaluator recorded our data (observed behaviors), and other methodologies have included retrospective coach self-reports of program implementation. Self-reports of compliance with implementation have been identified to possess limited validity.<sup>15,28</sup> Additionally, our implementation compliance measures were cross-sectional, only including one observation session, whereas other compliance evaluations completed by independent research team members have been repeated throughout a season, and implicate higher levels of compliance with implementation.<sup>29</sup> While a majority of studies document self-reported implementation compliance, they do not consistently report objective measures of implementation compliance. In order to adequately assess the implementation of a ACL IPP, the degree to which the program was implemented as it was intended should also be considered, as real world implementation with poor compliance with recommended parameters may limit program effectiveness.<sup>20,22</sup> Thus it is important researchers further evaluate ACL IPP implementation compliance, and not limit implementation evaluation to simple dichotomous assessment of program execution that is more representative of adoption. Regardless of the disparity in implementation compliance reporting methods, evidence suggests that compliance with recommended implementation is the primary factor responsible for effectively reducing injury rates, and improving performance in athletes.<sup>8,15,29</sup> Thus, it is imperative researchers aim to thoroughly describe and evaluate implementation of ACL IPPs to promote IPP effectiveness in the real world.

Our study and implementation methods are not without limitations. We are unable to objectively describe the effects of our intervention on modifying club coaches' warm-up behaviors prior to the introduction of our recommended ACL IPP warm-up. We did not formally evaluate coach warm-up behaviors prior to the coaches' workshop. While we did not formally evaluate coach warm-up behavior, anecdotal observation prior to the coaches' workshop revealed a lack of structured warm-ups that did not represent current recommendations for ACL IPPs.

We aimed to evaluate our intervention within the RE-AIM SSM and attempted to facilitate implementation via constructs of the Implementation Drivers framework. However, we were unable to fully apply all elements of the Implementation Drivers framework at all stakeholder levels (Fig. 1). We were also not able to fully evaluate our implementation efforts over time to report *maintenance* of the ACL IPP. While we acknowledge limitations in our methodology, it is important to note the club adopted the ACL IPP at a policy level, yet there was limited implementation at the coach level, thus there was limited effectiveness in our strategy to promote implementation of the ACL IPP in the end-user. The disparity between established policy and program implementation compliance suggests future multi-level implementation efforts must consider synergistic promotion of interventions between levels of influence,<sup>21</sup> and that a single theoretical model construct such as *intent* as in the TPB may not sufficiently explain or predict behavior. Furthermore, this lack of implementation, despite policy level mandates, highlights the need for policy enforcement and supervision on a regular basis. Additionally, future research should continue to combine multiple theories and constructs to optimally promote adoption and implementation compliance of sport IPPs.<sup>30</sup>

Policy development and training are important elements of multi-level intervention implementation success.<sup>21</sup> The field of implementation science readily acknowledges there is commonly a gap between policy and practice.<sup>21</sup> Similar to our findings, previous reports of policy development and training not translating to high levels of sport injury prevention program adoption and implementation compliance has been reported when teaching safe tackling technique in rugby<sup>5</sup> and preventing lower extremity injury in soccer.<sup>7</sup> Thus it is clear that there is a need to move beyond policy development and training, focusing research efforts on understanding and promoting the removal of barriers to sport injury IPP adoption and implementation compliance for coaches, athletes, and sports medicine professionals to promote safe youth sport participation in the real world.

## 5. Conclusion

There is a gap between coaches' determinants of behavior regarding a ACL IPP and their consequent implementation compliance in a real-world environment. Coaches that adopt ACL IPPs demonstrate high levels of variability in implementation compliance, potentially limiting program effectiveness. Future research should investigate what factors will drive higher rates of implementation compliance in those who are adopters of ACL IPPs such as parent and athlete involvement, and "buy-in" to the program. Despite high levels of intention to implement the IPP, barriers exist in real-world implementation. The persistent pursuit of high-leverage drivers of ACL IPP implementation should be better established through effectiveness research in real-world contexts.

## Practical implications

1. Sporting organizations invested in implementing ACL IPPs will need to consider synergistic, multi-level implementation strategies to better integrate IPPs into their operations.
2. Clinicians working with coaches to deploy ACL IPPs in youth sport organizations should not simply provide coaches with IPP resources alone. It is likely repeated face-to-face instruction is warranted to promote implementation compliance.
3. Clinicians can leverage ACL IPP workshops to increase coaches' knowledge, attitudes, and beliefs, regarding ACL IPPs.
4. To ensure high adoption rates and compliance with intended implementation of ACL IPPs, sporting organizations with established ACL IPP implementation policies will need to consider adopting policy enforcement and monitoring.

## Acknowledgements

The researchers would like to thank the research assistants who contributed to the data collection and implementation facilitation during the study. This study was financially supported by The North Carolina Injury Prevention Research Center.

## Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.jsams.2014.06.008](https://doi.org/10.1016/j.jsams.2014.06.008).

## References

1. Ferguson RW, Green A, Hansen LM. *Game Changers: Stats, Stories and What Communities are Doing to Protect Young Athletes*, Washington, DC, Safe Kids Worldwide, 2013 <http://www.safekids.org/research-report/game-changers-stats-stories-and-what-communities-are-doing-protect-young-athletes>, Accessed 27 September 2013.

2. Shultz SJ, Schmitz, Benjaminse A et al. ACL Research Retreat VI: an update on ACL injury risk and prevention. *J Athl Train* 2012; 47:591–603. <http://dx.doi.org/10.4085/1062-6050-47.5.13>.
3. Hootman JM, Dick R, Agel J. Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. *J Athl Train* 2007; 42:311–319.
4. Finch CF, McCrory P, Ewing MT et al. Concussion guidelines need to move from only expert content to also include implementation and dissemination strategies. *Br J Sports Med* 2013; 47:12–14. <http://dx.doi.org/10.1136/bjsports-2012-091796>.
5. Viljoen W, Patricios J, BokSmart – implementing a national rugby safety programme. *Br J Sports Med* 2012; 46:692–693. <http://dx.doi.org/10.1136/bjsports-2012-091278>.
6. Sadoghi P, Keudell von A, Vavken P. Effectiveness of anterior cruciate ligament injury prevention training programs. *J Bone Joint Surg Am* 2012; 94:769–776. <http://dx.doi.org/10.2106/JBJS.K.00467>.
7. Junge A, Lamprecht M, Stamm H et al. Countrywide campaign to prevent soccer injuries in Swiss amateur players. *Am J Sports Med* 2011; 39:57–63. <http://dx.doi.org/10.1177/0363546510377424>.
8. LaBella CR, Huxford MR, Grissom J et al. Effect of neuromuscular warm-up on injuries in female soccer and basketball athletes in urban public high schools: cluster randomized controlled trial. *Arch Pediatr Adolesc Med* 2011; 165:1033–1040. <http://dx.doi.org/10.1001/archpediatrics.2011.168>.
9. Myklebust G, Engebretsen L, Braekken IH et al. Prevention of anterior cruciate ligament injuries in female team handball players: a prospective intervention study over three seasons. *Clin J Sports Med* 2003; 13:71–78.
10. Joy EA, Taylor JR, Novak MA et al. Factors influencing the implementation of anterior cruciate ligament injury prevention strategies by girls soccer coaches. *J Strength Cond Res* 2013; 27:2263–2269. <http://dx.doi.org/10.1519/JSC.0b013e31827ef12e>.
11. Keats MR, Emery CA, Finch CF. Are we having fun yet? Fostering adherence to injury preventive exercise recommendations in young athletes. *Sports Med* 2012; 42:175–184. <http://dx.doi.org/10.2165/11597050-000000000-00000>.
12. White PE, Newton JD, Makdissi M et al. Knowledge about sports-related concussion: is the message getting through to coaches and trainers? *Br J Sports Med* 2014; 48:119–124. <http://dx.doi.org/10.1136/bjsports-2013-092785>.
13. Sugimoto D, Myer GD, Bush HM et al. Compliance with neuromuscular training and anterior cruciate ligament injury risk reduction in female athletes: a meta-analysis. *J Athl Train* 2012; 47:714–723. <http://dx.doi.org/10.4085/1062-6050-47.6.10>.
14. Myklebust G, Skjølberg A, Bahr R. ACL injury incidence in female handball 10 years after the Norwegian ACL prevention study: important lessons learned. *Br J Sports Med* 2013; 47:476–479. <http://dx.doi.org/10.1136/bjsports-2012-091862>.
15. Renström P. Eight clinical conundrums relating to anterior cruciate ligament (ACL) injury in sport: recent evidence and a personal reflection. *Br J Sports Med* 2013; 47:367–372. <http://dx.doi.org/10.1136/bjsports-2012-091623>.
16. Swenson DM, Collins CL, Best TM et al. Epidemiology of knee injuries among U.S. high school athletes, 2005/2006–2010/2011. *Med Sci Sports Exerc* 2013; 45:462–469. <http://dx.doi.org/10.1249/MSS.0b013e318277acca>.
17. Finch CF, Donaldson A. A sports setting matrix for understanding the implementation context for community sport. *Br J Sports Med* 2010; 44:973–978. <http://dx.doi.org/10.1136/bjsm.2008.056069>.
18. Häggglund M, Atroshi I, Wagner P et al. Superior compliance with a neuromuscular training programme is associated with fewer ACL injuries and fewer acute knee injuries in female adolescent football players: secondary analysis of an RCT. *Br J Sports Med* 2013; 47:974–979. <http://dx.doi.org/10.1136/bjsports-2013-092644>.
19. Ajzen I. The theory of planned behavior. *Organizational behavior and human decision processes. Organ Behav Hum* 1991; 50:179–211.
20. Donaldson A, Finch CF. Applying implementation science to sports injury prevention. *Br J Sports Med* 2013; 47:473–475. <http://dx.doi.org/10.1136/bjsports-2013-092323>.
21. Fixsen DL. *Implementation Research: A Synthesis of the Literature*, Tampa, FL, Florida Mental Health Institute, 2005. p. 1–125.
22. White PE, Otago L, Saunders N et al. Ensuring implementation success: how should coach injury prevention education be improved if we want coaches to deliver safety programmes during training sessions? *Br J Sports Med* 2014; 48:402–403. <http://dx.doi.org/10.1136/bjsports-2012-091987>.
23. Donaldson A, Finch CF. Planning for implementation and translation: seek first to understand the end-users' perspectives. *Br J Sports Med* 2012; 46:306–307. <http://dx.doi.org/10.1136/bjsports-2011-090461>.
24. Häggglund M, Waldén M, Magnusson H et al. Injuries affect team performance negatively in professional football: an 11-year follow-up of the UEFA Champions League injury study. *Br J Sports Med* 2013; 47:738–742. <http://dx.doi.org/10.1136/bjsports-2013-092215>.
25. Distefano LJ, Padua DA, Blackburn JT et al. Integrated injury prevention program improves balance and vertical jump height in children. *J Strength Cond Res* 2010; 24:332–342. <http://dx.doi.org/10.1519/JSC.0b013e3181cc2225>.
26. Saunders N, Otago L, Romiti M et al. Coaches' perspectives on implementing an evidence-informed injury prevention programme in junior community netball. *Br J Sports Med* 2010; 44:1128–1132. <http://dx.doi.org/10.1136/bjsm.2009.069039>.
27. Gianotti S, Hume PA, Tunstall H. Efficacy of injury prevention related coach education within netball and soccer. *J Sci Med Sport* 2010; 13:32–35. <http://dx.doi.org/10.1016/j.jsams.2008.07.010>.
28. Soligard T, Nilstad A, Steffen K et al. Compliance with a comprehensive warm-up programme to prevent injuries in youth football. *Br J Sports Med* 2010; 44:787–793. <http://dx.doi.org/10.1136/bjsm.2009.070672>.
29. Steffen K, Emery CA, Romiti M et al. High adherence to a neuromuscular injury prevention programme (FIFA 11+) improves functional balance and reduces injury risk in Canadian youth female football players: a cluster randomised trial. *Br J Sports Med* 2013; 47:794–802. <http://dx.doi.org/10.1136/bjsports-2012-091886>.
30. McGlashan AJ, Finch CF. The extent to which behavioural and social sciences theories and models are used in sport injury prevention research. *Sports Med* 2010; 40(10):841–858. <http://dx.doi.org/10.2165/11534960-000000000-00000>.