



Use of Social or Behavioral Theories in Exercise-Related Injury Prevention Program Research: A Systematic Review

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Abstract

Background The use of social or behavioral theories within exercise-related injury prevention program (ERIPP) research may lead to a better understanding of why adherence to the programs is low and inform the development of interventions to improve program adherence. There is a need to determine which theories have been used within the literature and at what level theory was used to further the field.

Objective To determine which social or behavioral science theories have been incorporated within ERIPP research and assess the level at which the theories were used. The key question guiding the search was “What social or behavioral theories have been used within ERIPP research?”

Methods A systematic review of the literature was completed with an appraisal of bias risk using a custom critical appraisal tool. An electronic search of EBSCOhost (Academic Search Complete, CINAHL, Medline, Psychology and Behavioral Sciences Collection) and PubMed was completed from inception to October 2018. Studies investigating attitudes towards ERIPP participation with the use of a social or behavioral theoretical model or framework were eligible for inclusion.

Results The electronic search returned 7482 results and two articles were identified through a hand search, which resulted in ten articles meeting inclusion criteria. Four different behavioral or social theoretical models or frameworks were identified including the health action process approach model, health belief model, self-determination theory, and theory of planned behavior. Six studies utilized the theory at a B level meaning a theoretical construct was measured while four utilized the theory at the C level meaning the theory was tested. The mean critical appraisal score was 78%, indicating a majority of the studies were higher quality.

Conclusion There has been an increase in the use of theory within literature that is specific to ERIPP participation. Additionally, the use of theory has shifted from guiding program design to the measurement of theoretical constructs and testing of the theoretical models.

Key Points

There has been an increase in the use of behavioral and social theoretical model use within literature that is specific to exercise-related injury prevention program use.

The two most commonly used theoretical models were the theory of planned behavior and the health belief model.

The use of theory has expanded beyond program design to measuring specific theoretical constructs and testing the theories.

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1 Introduction

Musculoskeletal injuries are common among those who participate in physical activity [1–4]. These injuries have several short-term consequences such as functional limitations, time loss from participation in occupational and recreational activity, and economic burden [5, 6]. Along with the immediate ramifications of musculoskeletal injuries, there are also long-term consequences such as a decreased health-related quality of life and early development of osteoarthritis, which can affect people over their lifespan [7–9]. In addition to the consequences to the injured individual, there are additional consequences to the entire social circle of the individual including parents, friends, teammates, coaches, etc. Due to the negative impact of musculoskeletal injuries, an increased emphasis has been placed on the prevention of these injuries.

Exercise-related injury prevention programs (ERIPPs) have been developed to include specific exercises used to prevent the occurrence of musculoskeletal injuries, which occur due to participation in sport or exercise within physically active populations. ERIPPs contain specific exercises that often target strength, range of motion, balance, and agility to address contributing factors associated with musculoskeletal injuries. Fortunately, multiple studies have concluded that ERIPPs can effectively reduce the incidence of musculoskeletal injuries [10]. However, one of the barriers that influences ERIPP effectiveness is willingness of the user to complete the recommended exercises [11]. One of the suggested reasons for poor uptake is the absence of an implementation strategy addressing the behavioral change that must occur [12]. The reasons for poor ERIPP adherence are not well understood; however, overcoming this barrier is critical to achieving a greater reduction in injury risk for those participating in physical activity.

In order to change adoption and adherence rates, there needs to be a change in behavior. This change in behavior may involve multiple stakeholders such as the user, coach, family members, and team-mates. Additionally, the individual delivering the program and the delivery strategy may influence whether the individual adopts the program [12]. The benefit of utilizing a behavioral or social science theory is that the constructs of the theories cover multiple factors and levels. For example, the theory of planned behavior takes the attitudes and perceptions of important individuals to the user into consideration. The important individuals could include coaches, family members, peers, etc. The use of social or behavioral theoretical models within ERIPP research may aid researchers in identifying which factors need to be addressed to change the behavior.

Incorporating behavioral and social science theories and models into ERIPP research may expand the underlying

issues associated with poor adherence from the user's perspectives. Additionally, there is an opportunity to expand the use of the theory to other stakeholders such as coaches, implementers, or family members, and gain their perspectives. These theories provide a systematic way to better understand the reasons for lack of uptake, which may lead to the development of appropriate implementation strategies [13]. Behavioral and social science theories have been used to better understand participation in other preventative health behaviors such as vaccine uptake, mammography screenings, and bicycle helmet use [14–16]. There is a possibility that the same theoretical models can be applied within ERIPP research to enhance ERIPP delivery and improve adherence [17]. This is supported by previous investigators who have advocated for the need and usefulness of using social and behavioral theories within ERIPP research [12, 17–21]. Theoretical models can be used to identify potential social and behavioral factors that may need to be addressed to improve adherence. The factors identified may then be addressed in an intervention that could be delivered in conjunction with the ERIPP.

A systematic review published in 2010 examined the use of theoretical models within sport-related injury prevention research [17]. The search identified 100 articles related to injury prevention in sport. Most studies used theory to provide insight for program design and were focused on protective equipment [17]. The type of injury prevention that best aligned with ERIPPs was termed “specialized exercise.” Strikingly, none of the studies within this category used social or behavioral theories in any capacity. ERIPP research has been more prominent since the publication of the aforementioned systematic review, and there is a possibility that the inclusion of theoretical models within ERIPP research has expanded. There is a need to determine which theoretical models are incorporated within ERIPP research to make additional progress in the field and aid clinicians and researchers in choosing which theoretical model to incorporate. This is a critical first step in potentially improving adherence with the use of social or behavioral theories. The level of theory use is important when clinicians and researchers begin transitioning the information gained into clinical practice. There is a need to investigate the level of theory use within the current literature related to ERIPP participation. Therefore, the purposes of this systematic review were to determine which behavioral or social sciences theories have been incorporated within ERIPP research, and assess the level at which theories were used in ERIPP research (scale design, testing theoretical construct, etc).

2 Methods

A systematic search was completed using the following databases: EBSCOhost (Academic Search Complete, CINAHL, Psychology and Behavioral Sciences Collection,

Table 1 Search terms and results

Step	Search terms	Boolean operator	EBSCOhost	PubMed
1	Sport Exercise Physical activity	OR	1,471,139	575,662
2	Prevent* Prophylactic	OR	1,833,546	2,071,469
3	Theoretical model Theoretical framework Theory of planned behavior Health belief model Social cognitive theory Self-efficacy Refined ecological model Diffusion of innovation theory Precede-proceed model Ottawa charter	OR	222,715	1,706,847
1 + 2 + 3		AND	1846	6418
Duplicates			782	
Total identified			7482	

SPORTDiscus) and PubMed. The search was limited to articles published prior to October 2018, human subjects, and English language. The keywords included were “theoretical model,” “theoretical framework,” “theory of planned behavior,” “health belief model,” “social cognitive theory,” “self-efficacy,” “refined ecological model,” “diffusion of innovation theory,” “precede-proceed model,” “Ottawa charter,” “prevent*,” “prophylactic,” “exercise,” “recreation,” and “sport” (Table 1). The summary of the search strategy, number of papers identified, and number of papers excluded at each stage are included in Fig. 1. After the initial search was completed, all duplicate studies were removed. Studies were then excluded based on title and abstract by two reviewers (EHG, MCH). The remaining studies were reviewed by full text to determine inclusion by two reviewers (EHG, MCH).

The following inclusion criteria were used to screen studies for inclusion in the systematic review: (1) published in a peer-reviewed journal, (2) measured a behavioral component (attitude, perception, etc.) related to ERIPP participation, (3) ERIPP focused on balance, strength, range of motion, or agility exercises with the goal of preventing musculoskeletal injury in sport or exercise, (4) used a behavioral or social science theory or model to guide program design, assess perceptions, or assess changes in perceptions, and (5) utilized quantitative research methodology. The following exclusion criteria were applied: (1) published abstracts or conference proceedings, (2) gray literature including theses and dissertations, (3) systematic reviews or meta-analyses, (4) articles

written in a language other than English, and (5) studies performed on animals.

Once the final articles were retained, they were reviewed and the theoretical model used within each study was identified. Additionally, the use of the theoretical model was classified according to categories adapted from McGlashan et al. [17] and Trifiletti et al. [22]. The categories and a brief description can be found in Table 2. The categories represent increasing levels of theoretical application starting with using theory for program design (level A) and progressing to testing a theoretical model or framework (level C).

A custom critical appraisal tool was created to effectively evaluate the study design and methodology within the included studies. The construction of the tool was based on a previously utilized critical appraisal tool [23] and a critical appraisal tool designed to evaluate pre-post study designs [24]. The tool consisted of 14 items, which can be found in Table 3. The evaluator assigned “yes,” “no,” or “not applicable” to each item. Two raters independently critically appraised each article (EHG, RSM). The raters met to discuss the critical appraisal tool for each study and disagreements were resolved through discussion. Total scores (0–14) were calculated out of the total number of applicable items and then converted to percentages. Therefore, items that were not applicable to the study in consideration were not included. A “yes” response to an individual item was assigned 1 point while a “no” answer was assigned 0 points; thus, greater scores were indicative of higher quality studies. The studies were then dichotomized into limited quality (<60%) and higher quality (≥60%) [25–27].

Fig. 1 Results of the search for studies included in the systematic review

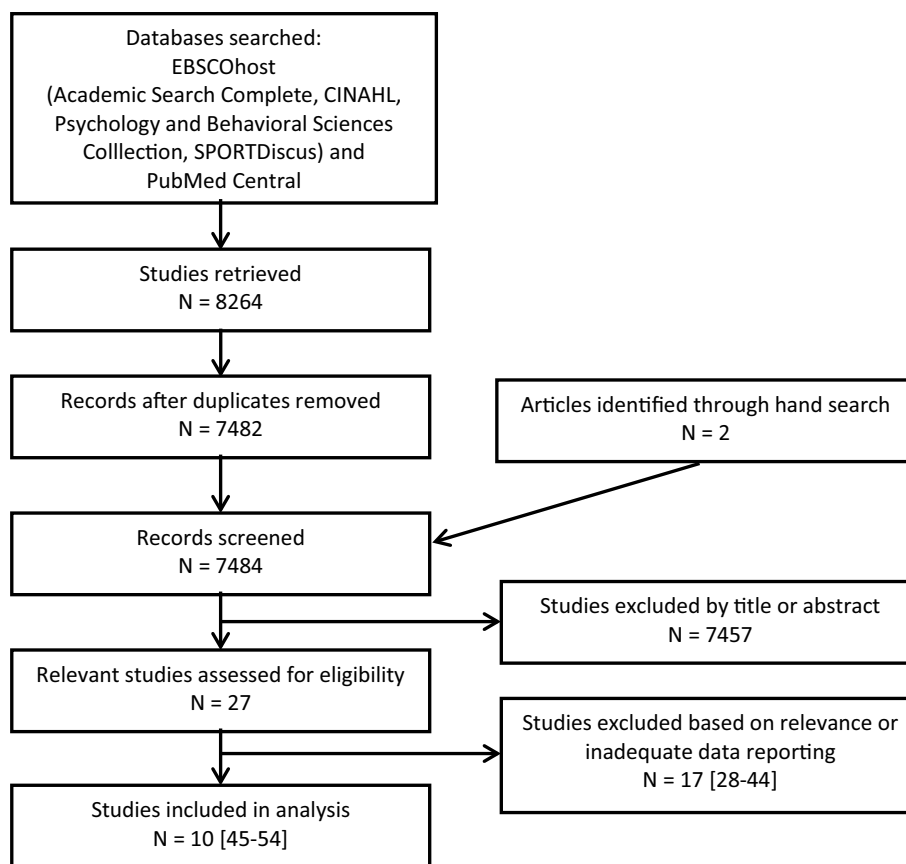


Table 2 Categorical classification of the use of theory

Category	Description
A	The health behavior theory was used for program design and/or implementation, and/or select program measures
B	Measurement of a theory or construct or model was undertaken (data were provided that described predisposing or enabling factors of player safety practices)
C	A theoretical construct or an extension of a theory was tested (whether the theory of planned behavior was helpful in understanding variations in attitudes)
Other	The use of the behavioral theory did not conform to any of the categories mentioned above

3 Results

The systematic search revealed 7482 articles for review and two articles were identified through hand searching. The full-text of 27 articles were reviewed to determine inclusion. Seventeen of those articles were excluded due to lack of theory or behavioral component or theoretical use that was not related to behavior [28–36], qualitative research methods [37–40], systematic review [41], abstract only [42], or ERIPP definition not matching the definition

Table 3 Critical appraisal tool

Question
1. Are the research objectives clearly stated?
2. Is the study design clearly described?
3. Were participant characteristics clearly described?
4. Was sampling methodology appropriately described?
5. Was sample size used justified?
6. Were the psychometric properties of the scale used previously established?
7. Was the scale used directly related to a behavioral or social theoretical model or framework?
8. Was the intervention clearly defined?
9. Were appropriate statistical methods used?
10. Was the loss to follow-up after baseline 20% or less? Were those lost to follow-up accounted for in analysis?
11. Did the statistical methods examine changes in outcome measures from before to after the intervention? Were statistical tests done that provided p values for the pre-to-post changes?
12. Were the main outcomes of the study clearly stated?
13. Were key findings supported by the results?
14. Were limitations of the study clearly described?

for this review [43, 44]. Ten articles that explored the use of theoretical models to better understand the use of

ERIPPs were included in the systematic review. The characteristics of the article, theoretical model used, level in which the theoretical model was implemented, and critical appraisal score are shown in Table 4. Seven studies [45–51] evaluated perceptions and attitudes within athletes or users, while five studies [49, 50, 52–54] investigated the attitudes and perceptions of coaches who were implementing an ERIPP. Seven studies [45–49, 53, 54] were cross-sectional and three studies [50–52] utilized a pre-test–post-test study design and evaluated the behavioral determinants before and after an intervention.

Most studies included within this systematic review used quantitative approaches to assess behavioral determinants of ERIPP participation, but one utilized mixed methods [51]. All studies used a survey to assess behavioral determinants of ERIPP participation or implementation. All of the surveys were directly informed by a social or behavioral theoretical model or framework.

3.1 Theories

Four different behavioral and social theoretical models or frameworks were used in the included articles. One study [45] used the self-determination theory, one study [49] used the health-action process-approach model, four studies [46, 47, 53, 54] used the health-belief model, and four studies used the theory of planned behavior [48, 50–52].

3.2 Level of Theory Implementation

Four studies utilized theory at the C level [45, 48, 49, 54], meaning the theoretical model or framework was tested. One study tested the self-determination theory related to ERIPP participation [45]. One additional study assessed the ability of the constructs of the theory of planned behavior to inform intention to participate in an ERIPP [48]. Jang et al. used the health belief model to assess high school coaches' attitudes towards injury prevention and determine which construct was most associated with intention to implement [54]. An additional study [49] investigated the ability of the health-action process-approach model constructs to inform intention to participate in an ERIPP within both coaches and athletes. Six studies [46, 47, 50–53] were categorized as category B, meaning the level of implementation involved measuring theoretical constructs related to ERIPP participation. Two of these studies measured the theoretical constructs before and after the implementation of an intervention aimed at improving behavioral determinants of ERIPP participation [50, 52]. An additional study measured the behavioral determinants of ERIPP participation before and after the users participated in an ERIPP [51]. The other studies only measured the theoretical constructs on one occasion [46, 47, 53]. None of the included studies were identified as

category A, meaning the theory was used exclusively for program design.

3.3 Program User Perceptions

Seven studies [45–51] assessed the perceptions of athletes or users towards ERIPP participation. One of the studies compared perceptions of ERIPP participation between those who had participated in an ERIPP and those who had not [46]. Those who participated in the ERIPP found the ERIPP to be more beneficial, less challenging, and more enjoyable than those who had not participated in the ERIPP. An additional study investigated the attitudes of users towards ERIPP participation before and after participation in an ERIPP [51]. The participants indicated they would be more likely to participate in an ERIPP if there was evidence to support the program reducing their risk of injury. Additionally, the participants reported they would be most comfortable with an athletic trainer leading the ERIPP rather than themselves, a teammate, or the coach. Overall, the perceptions of athletes towards ERIPP participation were positive. Most participants believed participating in an ERIPP would decrease the risk of lower extremity injury. However, in one study [49], athletes did not report a distinct intention to participate in an ERIPP.

3.4 Coaches Implementing Program Perceptions

Five studies [49, 50, 52–54] assessed the perceptions of coaches towards ERIPP implementation for their athletes. One study indicated that coaches, fitness coaches, and physiotherapists acknowledged there was a risk for lower extremity injury, and athletes should participate in an ERIPP [53]. An additional study indicated that only 45% of the high school coaches surveyed were using ERIPPs [54]. The same study found the most influential factor associated with intention to implement ERIPPs was perceived benefits within high school coaches [54]. One of the studies assessed changes in attitudes and implementation rates of coaches following an intervention [52]. Most coaches observed improvements in both athletic performance and reduced risk of injury.

3.5 Interventions

Two of the studies included within this systematic review assessed perceptions of ERIPPs before and after the implementation of an intervention. One study utilized an intervention to improve coaches' perceptions of ERIPP use [52]. The intervention consisted of information regarding the negative impact of lower extremity injury, importance

Table 4 Study details

Study/design	Theory used	Subject characteristics	Measurement tool	Methods	Main results	Level of theory use	Critical appraisal score
Chan and Hagger [45] Cross-sectional	SDT	533 elite athletes (international, national, or regional level athletes from 13 sports)	Adapted version of Health Care Climate Questionnaire, Basic Need Satisfaction in Sport Scale, Behavioral Regulation in Sport Questionnaire, Treatment Self-Regulation Questionnaire, Self-Reported Adherence of Sport Injury Prevention, adapted Manager Safety Attitude Questionnaire, General Causality Orientation Scale	The first questionnaire included scales measuring demographic variables, general causality orientation, basic need satisfaction in sport, sport motivation, and perceived autonomy support from coaches. The second questionnaire was administered approximately 1 week later and included measures of self-determined motivation, personal beliefs, and adherence with respect to injury prevention	Three paths were identified. Perceived autonomy support informed basic need satisfaction which informed self-determined motivation in sport which informed self-determined motivation for sport injury prevention. Self-determined motivation for sport injury prevention had significant positive associations with adherence, safety commitment, and injury priority and significant negative associations with fatalism concerning injury prevention, attitude toward safety violation, barriers to safety communication, and injury worry. Basic need satisfaction partially mediated the relationship between perceived autonomy support and self-determined motivation in sport. Self-determined motivation for sport injury prevention was a partial mediator of the effects of self-determined motivation in sport on all outcome variables	C	9/11 (82%)
Finch et al. [46] Cross-sectional	HBM	374 male football players aged 17–38 years	Questionnaire modeled on previous studies of risk and safety attitudes which broadly drew on HBM components; demographic questionnaire	Participants completed questionnaires aimed to assess their attitudes towards injury prevention programs one time during a training session	74.4% of participants agreed injury prevention programs would decrease their risk of injury and would be willing to participate in them; 64.1% agreed that training should be focused on improving athletic performance rather than injury prevention	B	8/11 (73%)
Finch et al. [47] Cross-sectional	HBM	Male football players who had participated in a cluster randomized controlled trial including an injury prevention program as one of the treatments	Post-season self-report survey derived from the HBM containing both open ended and Likert scale questions	All participants of a cluster randomized controlled trial which included one arm as participation in an injury prevention program and one arm with no participation in an injury prevention program were recruited to complete an end of the season questionnaire to assess attitudes and perceptions of injury prevention programs	Those who participated in the injury prevention program found it to be less challenging, more enjoyable, and beneficial than the program. Players suggested those who did not participate in the injury prevention program be shorter in duration, have a larger range of exercises, and for the benefits of the injury prevention program to be explained to the participants	B	9/12 (75%)

Table 4 (continued)

Study/design	Theory used	Subject characteristics	Measurement tool	Methods	Main results	Level of theory use	Critical appraisal score
Frank et al. [52] Pre-post study	TPB	34 soccer club coaches	Questionnaire to assess attitudes related to injury prevention programs based on the TPB	Attitudes towards injury prevention programs were evaluated before and after a coaching workshop. The workshop consisted of background information on the consequences of injury, importance of proper movement techniques, and evidence to support the effectiveness of injury prevention programs to reduce injury. Next, the coaches were taught how to implement the injury prevention program. At the end of the season, compliance of the coaches to implement the program was measured	After the workshop, coaches' attitudes towards injury prevention programs, thoughts about substituting an injury prevention program for a warm-up, and beliefs about improving player's cutting and landing techniques by implementing an injury prevention program were more positive. The coaches' intent to implement the injury prevention program also improved. However, only 53% of coaches implemented the injury prevention program	B	11/14 (79%)
Iversen and Friden [50] Pre-Post	TPB	113 female basketball players and 12 coaches from the high school level	Knowledge, attitudes, and practices (KAP) about ACL and injury prevention techniques, KOOS to assess knee function	Participants completed questionnaires and then participated in the intervention. The intervention consisted of 45 min of both didactic and skill presentations on the function of the ACL, risk factors associated with ACL injury, and risk reduction techniques. The skill portion of the intervention included demonstrations on proper landing technique and injury prevention exercises. The KAP and KOOS were re-administered at the end of the season	Players reported positive attitudes towards the use of the injury prevention programs (mean = 73.5/100) at baseline. The reported use of injury prevention programs at baseline was 58.4/100. Similarly, coaches had positive attitudes towards injury prevention programs at baseline (mean = 85.6). The average use of injury prevention programs within coaches was 61.1/100. After the intervention, attitudes towards injury prevention programs and use of injury prevention programs did not statistically significantly improve	B	11/14 (79%)
Jang et al. [54] Cross-sectional	HBM/TTM	185 coaches from 10 public high schools in Florida (5 of coaches had an athletic trainer at their high school and 5 did not)	Questionnaire designed based on the HBM and TTM	Coaches completed the questionnaire on one occasion	Only 45% of the coaches were currently implementing injury prevention programs with their teams. Perceived benefits were significantly associated with implementing injury prevention programs	C	10/11 (82%)

Table 4 (continued)

Study/design	Theory used	Subject characteristics	Measurement tool	Methods	Main results	Level of theory use	Critical appraisal score
Martinez et al. [51] Pre-post	TPB	76 female high school athletes who participated in field hockey, soccer, or volleyball	Injury prevention program attitude survey (IPPAS)	The participants completed the IPPAS and then participated in a season long injury prevention program. Compliance with the injury prevention program was measured throughout the season. At the conclusion of the injury prevention program, the IPPAS was repeated	Participants were likely to participate in the injury prevention program at both PRE and POST if data proved they would have less risk factors for injury, be less likely to suffer an ACL tear, and sustain less lower extremity injuries. Additionally, participants indicated that outside social influences such as other teams in their conference, colleges/universities, or their favorite athlete did not influence their likelihood to participate in an injury prevention program. Participants also indicated they would be most comfortable with an athletic trainer leading the injury prevention program rather than themselves, a team captain, or the coach	B	10/14 (71%)
McKay et al. [44] Cross-sectional	HAPA	10 coaches and 203 female soccer players competing at the under 14 or under 16 level	Bespoke questionnaire assessing demographics and HAPA constructs (self-efficacy, outcome expectancies, risk perceptions, behavioral intentions, barriers, and facilitators) in relation to the 11+ injury prevention program	All participants completed the questionnaires on one occasion prior to the start of the soccer season	For coaches, self-efficacy regarding understanding the program and using the program were significantly correlated to intention to implement the 11+. For players, player task self-efficacy and outcome expectancies had significant positive associations with intention to adopt the 11+ injury prevention program. Risk perceptions were not significantly associated with intention	C	9/11 (82%)

Table 4 (continued)

Study/design	Theory used	Subject characteristics	Measurement tool	Methods	Main results	Level of theory use	Critical appraisal score
O'Brien and Finch [53] Cross-sectional	HBM	18 soccer coaches, fitness coaches and physiotherapists working with elite male soccer teams	Survey guided by the RE-AIM and HBM to assess attitudes towards the 11+ injury prevention program. Open questions were included to assess barriers to and facilitators of implementing the 11+	Coaches, fitness coaches and physiotherapists associated with 4 elite soccer teams were asked to participate in an online survey. The survey was disseminated using Survey Monkey and the participants completed the survey on one occasion	Participants agreed players were highly susceptible to lower extremity injuries and that the injuries were serious. All respondents agreed that athletes should participate in injury prevention programs. Approximately 61% of the participants had heard of the 11+ program, but only 6% reported using the full program and 22% reported using a modified version of the program. Interestingly, 78% of the participants felt the 11+ needed improvement. The main barriers identified within implementing the 11+ related to program content or delivery and support of the program	B	8/11 (73%)
White et al. [48] Cross-sectional	TPB	287 female netball players	Questionnaire designed using the TPB to assess attitudes towards learning correct landing technique	Participants completed a baseline questionnaire on their attitudes and perceptions of learning proper landing technique prior to their coaches implementing the D2E injury prevention program	Participants had positive attitudes towards learning correct landing technique, perceived positive social pressure from significant others to learn correct landing technique, and perceived that they themselves had considerable control over whether they learned correct landing technique. Participants also had positive intentions to learn correct landing technique with 73.6% stating a strong intention. Significant associations were found for subjective norms and attitudes to intent to learn correct landing technique, but there was no association between perceived behavioral control and intent	C	9/11 (82%)

HBM health-belief model, *HAPA* health-action process-approach model, *SDT* self-determination theory, *TPB* theory of planned behavior, *A* theory design was used for program design and/or implementation, *B* theoretical construct(s) were measured, *C* theory was tested

of proper landing technique and movements, and evidence of the effectiveness of ERIPPs to prevent lower extremity injury. The coaches were also taught how to implement the ERIPP. The intervention effectively improved coaches' attitudes towards implementing an ERIPP, confidence in implementing an ERIPP, and intention to implement an ERIPP in the upcoming season. However, only 53% of coaches implemented the ERIPP.

An additional study utilized an intervention to improve knowledge, attitudes, and practice related to anterior cruciate ligament (ACL) injury and prevention [55]. The intervention consisted of anatomy and function related to the knee and ACL, risk factors associated with ACL injury, and prevention techniques for ACL injury. Additionally, participants were taught prevention techniques and the researchers assessed whether the exercises were completed properly. Following the intervention, athletes' attitudes towards ERIPPs improved, but not significantly. Participation rates in ERIPPs also did not significantly improve following the intervention.

3.6 Critical Appraisal

The mean percentage critical appraisal score was 80%. All ten studies were classified as high quality with scores of 71% [51], 73% [47, 53], 75% [46], 79% [50, 52], 82% [45, 48, 49], and 91% [54]. None of the studies provided justification for sample size. Six studies utilized scales to measure behavioral determinants of ERIPP participation for which the psychometric properties had not been previously established [46, 47, 49, 51–53]. Four studies did not clearly describe the characteristics of the participants used within the study [46, 48, 52, 53]. One article did not describe the sampling method [45].

4 Discussion

A previous systematic review published in 2010 indicated that none of the articles related to ERIPPs termed specialized exercise included social or behavioral theoretical models or frameworks at any level [17]. The most notable findings of the current systematic review were that a number of studies since 2010 have incorporated some form of behavioral or social science theory. The health belief model and theory of planned behavior were the two most common theoretical models utilized within ERIPP research and the level of use has shifted from mostly level A to mostly levels B and C. Therefore, the use of theory has expanded from simply guiding program design to assessing specific constructs of the theories and testing theories. The current systematic review identified ten articles that utilized theoretical models. None of the ten articles exclusively used the theoretical model for

program design. Six [46, 47, 50–53] of the included articles measured a specific theoretical construct, and four [45, 48, 49, 54] of the articles tested the application of the theoretical model. These results indicate that the incorporation of theoretical influence within ERIPP participation research is increasing. However, there is still limited use of behavioral or social theoretical model use. The use of theory is pertinent in gaining a better understanding of the reasons why adherence rates are low and informing the development of implementation strategies.

The systematic review also identified that theoretical models have been used for several different purposes related to ERIPP participation. Several studies used theoretical models to assess behavioral determinants of ERIPP participation within athletes or users, while others assessed behavioral determinants of ERIPP implementation within coaches. Athletes and coaches generally had positive attitudes towards ERIPP participation. Additionally, they believed the largest benefits of participating in an ERIPP would be improvements in athletic performance and a reduced risk of lower extremity musculoskeletal injury. The effectiveness of ERIPPs to reduce the risk of lower extremity musculoskeletal injuries is highly supported by many systematic reviews [10, 56, 57]. Additionally, several studies have identified improvements in athletic performance after participating in an ERIPP, including strength, speed, balance, and agility enhancements [58–61]. There is a potential that the expanded benefits beyond a reduction in lower extremity injury may need to be presented to both the user and implementer to improve adoption and adherence.

There was only one study that investigated the interaction between the constructs of the theoretical model or framework and actual adherence [45], while other studies investigated the interaction between the constructs and intention to either participate in or implement the ERIPP [48, 49, 51, 54]. Chan et al. found a significant association between self-determined motivation for sport injury prevention and adherence with ERIPPs [45]. Within users, one study found a significant association between subjective norms and intention to participate [42], while another found no significant relationship [51]. Additionally, significant associations between perceived benefits and attitudes with intention to participate were noted [48, 51]. Task self-efficacy or confidence in their ability to participate in an ERIPP and outcome expectancies had a significant association with intention to participate [49]. There is currently a lack of evidence to support whether intention to participate is associated with actual participation or adherence in users. One study found a lack of association between intention to implement and actual implementation rates within coaches [52]. Overall, it appears there is a relationship between constructs from social or behavioral theoretical models and intention to participate

in an ERIPP in users. Future research should examine the relationship between intention and participation in users.

One study included in the systematic review used a theoretical model to assess behavioral determinants of ERIPPs within athletes and compare the behavioral determinants between those who had participated in an ERIPP and those who had not [46]. The individuals who had participated in an ERIPP found the ERIPP to be more beneficial, less challenging, and more enjoyable than those who had not participated in an ERIPP. The results of this study indicate that previous use of an ERIPP may influence behavioral determinants of ERIPP participation [46]. Therefore, intervention strategies aimed at improving behavioral determinants of ERIPP participation and adherence to ERIPPs may need to be customized to meet the needs of individuals who have previously participated in an ERIPP and those who have not.

The final purpose of using a theoretical model within ERIPP research was to determine if an intervention was effective at improving attitudes towards ERIPPs and implementation rates. An intervention was focused towards improving knowledge and attitudes towards ERIPP implementation within soccer coaches as well as increase implementation of an ERIPP known as the 11+ [52]. The intervention improved coaches' attitudes and perceptions of ERIPP participation and implementation. However, only 53% of the coaches implemented the ERIPP. The results of this study [52] indicate that the intervention may need to involve both the coaches and the users. An additional study used an educational intervention to improve attitudes and participation rates in ERIPPs [50]. The changes in attitudes and participation rates were not statistically significant following the intervention. The results of this study indicate that intervention design may need to be based on a social or behavioral theory and the intervention may need to be individualized. The use of theory to guide the development of the intervention may also lead to enhanced effectiveness. Additionally, the intervention may need to be individualized to enhance the improvements in attitudes that can lead to improvements in implementation. Coaches are instrumental in the implementation of ERIPPs within the team setting. Further research needs to be done to investigate interventions targeted for coaches to improve implementation of ERIPPs.

The critical appraisal of the articles included within this systematic review revealed a few key factors. Many of the articles included in this systematic review failed to appropriately describe the characteristics of the participants included in the study [46, 48, 52, 53]. Before we can develop effective intervention strategies to improve participation, we must better understand the perceptions and attitudes of users and implementers towards ERIPP participation and implementation. There are specific demographic variables that may influence those perceptions, such as previous coaching

experience, previous number of years playing a sport, age, etc. When these variables are not clearly defined within the participants' demographics of studies, our understanding of these variables is limited. Additionally, over half of the articles used scales to assess behavioral determinants of ERIPP participation that did not have previously established psychometric properties [46, 47, 49, 51–53]. In order for clinicians and researchers to effectively utilize these scales to assess attitudes and perceptions of ERIPP participation, we must be sure the scales are assessing the intended behavioral determinants of ERIPP participation. However, it must be mentioned that there is a limitation to using scales to assess attitudes as the information is self-reported and may omit important information to the individual. The psychometric properties of several scales used to assess attitudes towards ERIPP participation have been confirmed [54, 62, 63], but further development and expansion of the scales' use to individuals who participate in different levels of physical activity or sport is warranted.

The two most commonly identified theoretical models were the health-belief model and theory of planned behavior. The health-belief model is commonly used to predict and better understand participation in preventative health behavior [64]. The health-belief model consists of six constructs that are thought to directly predict participation: perceived susceptibility, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. The theory of planned behavior is also used to better understand and predict participation in preventative health behaviors [65]. The model contains three constructs that are thought to indirectly predict participation through intention to participate. The three constructs are attitudes, perceived subjective norms, and perceived behavioral control. The specific use of these theories related to ERIPP participation research has previously been described [18–20, 47].

Most of the social or behavioral theoretical models used in this systematic review evaluated perceptions of the individual at the individual level. However, the health-belief model and theory of planned behavior do take some external influence into account. For example, within the health-belief model, the cues to action construct could include a recommendation by a coach or health professional or a team-mate sustaining an injury, which influenced the user to participate in an ERIPP [64]. Additionally, within the theory of planned behavior, the perceived subjective norms construct takes the attitudes and perceptions of the important individuals in the users' lives towards ERIPP participation into account [65]. Since there are many stakeholders rather than just the user him- or herself, it may be important to use theoretical models that consider outside influences as well as internal.

Using a social or behavioral theory may be beneficial when developing intervention strategies to improve adoption

of and adherence to ERIPPs. Two studies have investigated the use of interventions to improve attitudes and program adoption and adherence within coaches [52] and users [55]. Neither intervention used a theory to guide the design of the intervention and neither were successful at improving ERIPP participation or implementation. There is a potential that using a social or behavioral theory such as the health-belief model to inform the development of the intervention may lead to increased effectiveness. Users could be given questionnaires to assess attitudes towards ERIPP participation prior to the development of the intervention. For example, the most important factors to the users identified by the scales could be perceived benefits and perceived barriers. The intervention could then be specifically designed to include educational information on the benefits of the ERIPP including a reduction in injury and improvements in functional performance. Additionally, the users could be educated on the potential barriers of participating in the ERIPP and given strategies to overcome those barriers. The use of social or behavioral theories within ERIPP implementation interventions could lead to improvements in adoption and adherence.

Although a relatively limited number of ERIPP studies have used a social or behavioral theory, the information gleaned from these studies has provided insight into reasons for low adherence and factors to target to improve adherence. The most common social or behavioral theoretical models used in the studies included in this systematic review were the health-belief model and theory of planned behavior. Clinicians and researchers should consider utilizing these two models to better understand the behavioral determinants of ERIPP participation and to develop implementation strategies. There is a possibility that combining components of social or behavioral theories will provide more insight into all the unique factors that may play a role in ERIPP adoption and adherence [17, 19, 21]. Gabriel et al. [62] created the health-belief model scale and theory of planned behavior scale to assess attitudes towards ERIPP participation in physically active adults. These scales may be beneficial in continuing to assess attitudes towards ERIPP participation and begin testing the effectiveness of implementation interventions. Additionally, there may be a need to modify the instruments for individuals of different ages or those who participate in unique sport activities.

4.1 Limitations

There were several limitations associated with this systematic review. There is a potential that additional articles could be in the published literature that were not identified in the search. Some studies may have used behavioral or social theoretical models or frameworks, but this was not evident within the article. The definition used for ERIPPs could have excluded some pertinent articles. However, the intent of the systematic review was to investigate the use of theory within research related to

specific types of sports injury prevention. Therefore, future systematic reviews should investigate the use of theory in literature investigating other types of injury prevention related to sport such as protective equipment. The use of social or behavioral theories is important when implementing other forms of preventative measures and should be considered. Articles utilizing qualitative research methods were excluded from this review and this could have omitted relevant literature to the topic [37, 38, 66]. Additionally, the search criterion limited the articles to the English language; ERIPP use is prevalent in many other countries and there is a chance some articles may have been missed due to the language exclusion. Lastly, gray literature including theses and dissertations were excluded from the review, which could have left out important literature related to the topic [67].

5 Conclusion

The current systematic review has indicated that there has been an increase in the use of social or behavioral theories within ERIPP research. However, there is still a general lack of inclusion of behavioral and social theories within ERIPP research studies. Overall, there was a shift from using theory at a level for program design to assessing constructs within the theoretical model and testing theoretical models. One key factor identified within this systematic review was a lack of surveys in which the psychometric properties had been previously established. The first step in moving forward is to develop scales grounded in social or behavioral theories to assess the behavioral determinants of ERIPP participation and assess the psychometric properties of those scales. Once these scales are widely used to assess the behavioral determinants of ERIPP participation within different populations with varying previous experiences and demographic variables, the results can be used to inform the development of implementation strategies.

Compliance with Ethical Standards

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