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# Planning injury prevention training for youth handball players: application of the generalisable six-step intervention development process

Eva Ageberg ,<sup>1</sup> Sofia Bunke,<sup>2</sup> Per Nilsen,<sup>3</sup> Alex Donaldson<sup>4</sup><sup>1</sup>Department of Health Sciences, Lund University, Lund, Sweden<sup>2</sup>Department of Psychology, Lund University, Lund, Sweden<sup>3</sup>Department of Community Medicine, Division of Health and Medical Sciences, Linköping University, Linköping, Sweden<sup>4</sup>Centre for Sport and Social Impact, La Trobe University, Melbourne, Victoria, Australia**Correspondence to**

Dr Eva Ageberg, Health Sciences, Lund University, Lund 221 00, Sweden; eva.ageberg@med.lu.se

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**ABSTRACT**

**Background** Youth handball players are vulnerable to injuries. Because there is no available injury prevention training specifically developed for youth handball players targeting both upper and lower limbs or incorporating psychological aspects of injury, we undertook the 'Implementing injury Prevention training ROutines in TEams and Clubs in youth Team handball (I-PROTECT)' project. We used an ecological participatory design incorporating the perspectives of multiple stakeholders (health beneficiaries, programme deliverers and policy makers). The aim of this paper was to describe the process of developing the I-PROTECT model, featuring injury prevention training and an accompanying implementation strategy.

**Design** We used the generalisable six-step intervention development process, outlined to guide researchers when developing implementable, evidence-based sports injury prevention interventions, to develop the I-PROTECT model. The six-step process involves establishing a research-stakeholder collaborative partnership to (1) identify and synthesise research evidence and clinical experience; (2) consult with relevant experts; (3) engage end users to ensure their needs, capacity and values are considered; (4) test the feasibility and acceptability of the intervention; (5) evaluate the intervention against theory; and (6) obtain feedback from early implementers. Two community handball clubs in southern Sweden, offering organised training for youth male and female players, and the district handball federation, participate in the intervention development. Drafts of the I-PROTECT model will be developed and revised with key stakeholder advice and input throughout all six steps.

**Conclusion** The I-PROTECT model described will be an end user-driven intervention, including evidence-based, theory-informed and context-specific injury prevention training for youth handball, and an associated implementation strategy.

**BACKGROUND**

It is well recognised that sport participation in youth has beneficial effects on health from physiological, psychological and social perspectives. However, sport participation is also associated with an increased risk of injury.<sup>1</sup> Female and male players in team ball sports, for example, handball, soccer, floorball and basketball, are particularly vulnerable to acute and overuse musculoskeletal injury.<sup>1,2</sup> In Sweden, handball has the highest total injury incidence with approximately 50 injuries generating an insurance claim per 1000 athlete years, which

is about threefold higher than that observed in soccer.<sup>2</sup> The highest proportion of injuries among youth handball players are seen in the upper and lower limbs.<sup>2</sup> Moreover, the total incidence of injury in handball has increased by 14% for men and 23% for women over the past decade in Sweden.<sup>2</sup> Thus, there is a clear need for injury prevention in youth handball players. Although evidence-based injury prevention training is highly effective in reducing musculoskeletal injuries in youth,<sup>3-5</sup> this training has so far had limited public health impact because it is not widely or properly implemented or sustained. Research is needed to develop appropriate strategies to implement and evaluate injury prevention training programmes within real-world community sports settings.<sup>5-8</sup>

Available injury prevention programmes for handball players typically focus on senior players,<sup>9-12</sup> and those available for youth players target lower limb injuries only.<sup>13,14</sup> Because there are no available injury prevention programmes for youth players targeting both upper and lower limbs, or incorporating the psychological aspects of injury, we undertook the 'Implementing injury Prevention training ROutines in TEams and Clubs in youth Team handball (I-PROTECT)' project. The overall aim of I-PROTECT is to achieve widespread, sustained and high-fidelity use of evidence-based injury prevention training in youth handball through behaviour change at multiple levels within the sports delivery system. In I-PROTECT, we integrate behavioural and social science theories with medical and public health perspectives in a series of studies undertaken in close collaboration with stakeholders of the youth handball sports community. Specifically, the theory Health Action Process Approach (HAPA),<sup>15</sup> which includes strategies to convert intentions into the desired behaviour, is used as a theoretical framework in I-PROTECT to facilitate behaviour change. Also, the Reach, Effectiveness, Adoption, Implementation, and Maintenance Sport Setting Matrix (RE-AIM SSM) framework<sup>7</sup> will be applied to design and evaluate implementation outcomes. To enhance the implementation of injury prevention training,<sup>6</sup> it is important to incorporate the perspectives of relevant stakeholders at multiple levels.<sup>16</sup> The stakeholders in I-PROTECT include players (health beneficiaries), caregivers, coaches (programme deliverers), clubs and organisational administrators (policy makers).<sup>17</sup> Our first I-PROTECT study identified the facilitators, among stakeholders at multiple levels, that could



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help injury prevention training become part of regular training routines in youth handball.<sup>17</sup> In study 2, which is the focus of the present paper, we will develop the I-PROTECT model. While previous studies have generally developed and evaluated injury prevention training only, the I-PROTECT model will feature injury prevention training and an implementation strategy. Study 3 will be an implementation trial of the I-PROTECT model.

It is important to engage intervention end users at the individual and organisational levels to plan, develop and successfully implement injury prevention programmes.<sup>6,18</sup> End-user engagement will help understand the implementation context, that is, end users' perspectives, and create end-user motivation and ownership. Engaging end users may also help overcome identified barriers to implementing injury prevention programmes, that is, coaches' insufficient knowledge or lack of interest regarding programme content and delivery, and lack of support from the organisation.<sup>19–21</sup> Our first I-PROTECT study confirmed the importance of involving end users when developing injury prevention training, to achieve high levels of competence and self-efficacy among end users.<sup>17</sup> However, in previous studies of youth team sports, experts have developed the injury prevention programme, and end-user involvement has been poorly described.<sup>13,14,22</sup> Developing evidence-based injury prevention training incorporating end users' perspectives is complex, and following a structured process could guide researchers and ensure the implementation and outcomes are comprehensive and reproducible. To our knowledge, there is only one published description of the application of a systematic and pragmatic process to develop an injury prevention training programme in which end users were engaged: the development of FootyFirst for male, adult community Australian football players.<sup>23</sup>

## OBJECTIVE

The present paper aimed to describe the process of developing the I-PROTECT model. The I-PROTECT model will incorporate evaluated evidence-based, theory-informed and context-specific injury prevention training for youth handball, and an associated implementation strategy.

## METHODS

### Overview of the I-PROTECT project

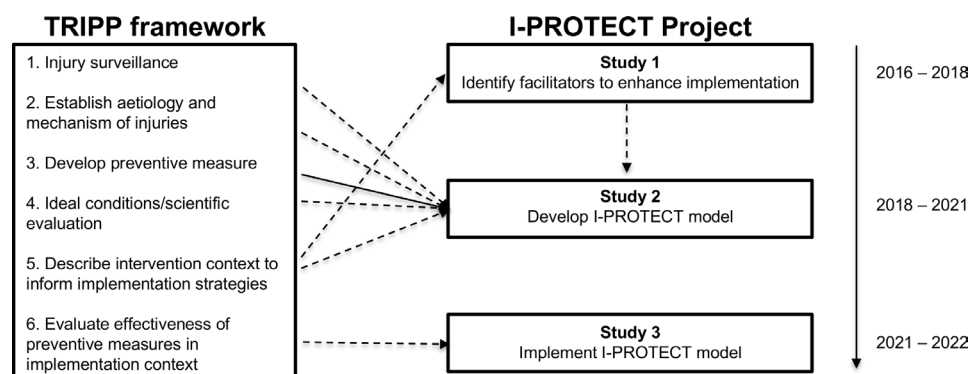
The I-PROTECT project has an ecological participatory design incorporating the perspectives of multiple stakeholders (youth players (ages 13–17 years), coaches, caregivers and administrators) (figure 1 in Ageberg *et al*<sup>17</sup>). The I-PROTECT project applies the Translating Research into Injury Prevention Practice (TRIPP) framework, developed specifically to inform sport

injury prevention research.<sup>24</sup> Although TRIPP describes a six-stage linear process, because of the existing epidemiological (stage 1) and risk factor (stage 2) research, we chose to begin the I-PROTECT project at stage 5 (understanding the implementation context). As such, I-PROTECT study 1 is aligned with TRIPP stage 5 through the consultation of end users in an ecological participatory study.<sup>17</sup>

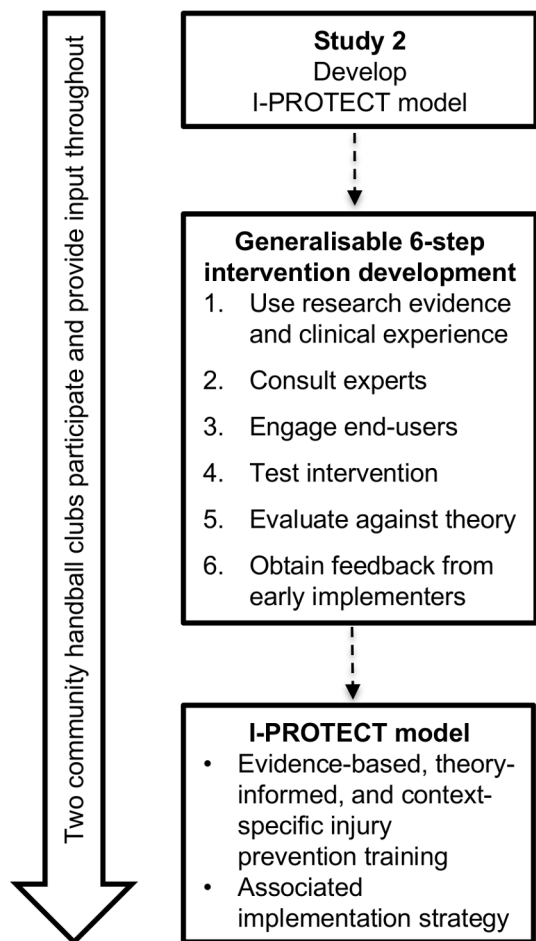
Study 2 is aligned with TRIPP stage 1 (injury surveillance) through to stage 5 using a review of the relevant literature, applying the expertise of the research team and consulting content and context experts. Content experts make sure current knowledge (evidence and theory) will be applied, and context experts (end users) make sure the exercises will be handball-specific and the implementation strategy is club-specific. The research team, together with the key stakeholders (ie, the planning group) make sure that the I-PROTECT model will take into account both content and context and, thus, be evidence-based, theory-informed and context-specific. Any disagreement between experts and end users will be solved in a consensus discussion within the planning group, and through this approach, we expect to reach agreement. Specifically, the product of study 2 will be the I-PROTECT model, which aligns directly with TRIPP stage 3 (develop preventive measure). Finally, I-PROTECT study 3 aligns with TRIPP stage 6 (evaluate effectiveness) (figure 1).

Evaluation of the I-PROTECT model (study 3) focuses on the effectiveness of the implementation of the injury prevention training. The behaviour change theory HAPA<sup>15</sup> is used in the I-PROTECT project to identify, facilitate and evaluate possible determinants of behaviour change among players, coaches, caregivers and club administrators. The HAPA theory distinguishes between preintenders, intenders and actors, and includes both motivational and volitional strategies. The RE-AIM SSM framework<sup>7</sup> will be applied to design and evaluate implementation outcomes at the individual and organisational levels.

This present paper focuses on the planning of the I-PROTECT model, which is specifically informed by a six-step process outlined to guide researchers in developing implementable, evidence-based sports injury prevention interventions<sup>23</sup> (figure 2). This process involves establishing a research–stakeholder collaborative partnership to (1) identify and synthesise the best available research evidence, and apply relevant clinical experience and knowledge of the implementation context to maximise the potential that the intervention will both ‘work’ to prevent injuries and be acceptable to end users; (2) consult with relevant experts to fill any gaps in the evidence and adapt the available evidence to the specific implementation context; (3) engage end users to ensure their



**Figure 1** The TRIPP framework applied to the I-PROTECT project. I-PROTECT, Implementing injury Prevention training Routines in TEams and Clubs in youth Team handball; TRIPP, Translating Research into Injury Prevention Practice.



**Figure 2** The I-PROTECT model informed by the generalisable six-step intervention development process with end-user involvement throughout.<sup>23</sup> I-PROTECT, Implementing injury Prevention training ROoutines in TEams and Clubs in youth Team handball.

needs, capacity and values are considered during the intervention development process; (4) test the feasibility and acceptability of the intervention with a small sample of potential end users to establish that all components can be delivered and completed as intended; (5) evaluate the intervention against theory to confirm that it is supported by sound principles and logic; and (6) obtain feedback from early implementers of the intervention to enable unforeseen content and implementation issues to be identified and rectified. Two community handball clubs in a city in southern Sweden, offering organised training for youth male and female players, and the district handball federation participate in the study.

**Development of the I-PROTECT model**

This paper describes the process used to develop the I-PROTECT model, applying the generalisable six-step intervention development process<sup>23</sup> (table 1). The methodological approaches include workshops, focus groups interviews and/or questionnaires (table 1). The outcomes of applying the different steps will be published separately, including details of the participants, methods and analyses.

**Step 1: using research evidence and clinical experience**

We will examine existing systematic reviews and more recent randomised controlled trials published in peer-reviewed literature to identify the physical (ie, physiological and/or biomechanical)<sup>4 5 12 13</sup> and psychological<sup>25</sup> principles of effective injury prevention training in youth team ball sports. We will also review the literature to identify key challenges to implementing injury prevention interventions in community youth team ball sports.<sup>21 26</sup> In addition, we will draw on the collective experience of the research team, including knowledge of existing injury prevention training programmes for team sports, particularly handball, expertise in implementation science and knowledge of the implementation context.<sup>17</sup>

**Table 1** Application of the generalisable six-step intervention development process<sup>23</sup> to develop the I-PROTECT model

Generalisable six-step intervention development process		Application to develop I-PROTECT model
Step 1	Research evidence and clinical experience	<ul style="list-style-type: none"> <li>▶ Literature review.</li> <li>▶ Expertise of the research team.</li> <li>▶ Results from I-PROTECT study 1.</li> </ul>
Step 2	Consult experts	<ul style="list-style-type: none"> <li>▶ Discipline-specific workshops with experts in physiology/biomechanics and psychology, respectively.</li> <li>▶ Interdisciplinary workshop with experts in physiology/biomechanics and psychology.</li> </ul> <p><b>Develop first version of I-PROTECT model</b></p>
Step 3	End-user consultation	<ul style="list-style-type: none"> <li>▶ Results from I-PROTECT study 1.</li> <li>▶ Workshops with coaches, players, administrators, caregivers and key stakeholders.</li> </ul> <p><b>Revision of I-PROTECT model</b></p>
Step 4	Test feasibility, acceptability and usability	<ul style="list-style-type: none"> <li>▶ 3–4 weeks of pilot testing in teams led by coaches who participated in step 3.</li> <li>▶ Qualitative feedback from coaches and players.</li> </ul> <p><b>Revision of I-PROTECT model</b></p>
Step 5	Evaluate against theory	<ul style="list-style-type: none"> <li>▶ Evaluate using HAPA and RE-AIM SSM.</li> </ul> <p><b>Revision of I-PROTECT model</b></p>
Step 6	Feedback from early implementers	<ul style="list-style-type: none"> <li>▶ One-season feasibility trial with all youth teams in two clubs.</li> <li>▶ Quantitative and qualitative feedback from coaches, players, administrators and caregivers.</li> </ul> <p><b>Revision of I-PROTECT model</b></p> <p><b>Final I-PROTECT model</b></p>

Key stakeholder input throughout all steps

HAPA, Health Action Process Approach; I-PROTECT, Implementing injury Prevention training ROoutines in TEams and Clubs in youth Team handball; RE-AIM SSM, Reach, Effectiveness, Adoption, Implementation, and Maintenance Sport Setting Matrix.

## Step 2: consulting with experts

Between six and eight experts<sup>27</sup> in physiology/biomechanics and six and eight experts in psychology will participate in structured discipline-specific and interdisciplinary 1-day workshops to develop injury prevention training specifically for Swedish youth handball players. Members of the research team will use their professional networks, knowledge of the relevant literature and connections with the handball community to identify and recruit experts (researchers and handball representatives, including coaches, players and administrators). Experts will be recruited based on their in-depth knowledge of handball, sports more generally and/or physical/psychological development in youth, in addition to their discipline expertise.

The experts will be provided with information concerning the current research evidence and the implementation context from I-PROTECT study 1,<sup>17</sup> identified in step 1. This information will be made available via an open source online platform for collaboration in science research. Discipline-specific workshops will be conducted with these experts (1) to identify and reach consensus on the principles of injury prevention training for youth handball players and (2) to propose examples of context-specific exercises that represent these principles. An interdisciplinary workshop with these experts will then be held to reflect on the findings from the discipline-specific workshops and draft the first version of the I-PROTECT model, including a holistic injury prevention training. Nominal group technique<sup>27,28</sup> will be employed in these face-to-face workshops to generate consensus on the principles of training and examples of exercises. The nominal group technique will include<sup>29</sup> (1) introduction and explanation (ie, background to the study and specific aim); (2) silent (individual) generation of ideas; (3) sharing ideas without debate; (4) group discussion; and (5) consensus. Research team members will facilitate all workshops with the aim of generating a first draft of the I-PROTECT model, featuring injury prevention training incorporating both physical and psychological perspectives, at the conclusion of the interdisciplinary workshop.

## Step 3: engaging end users

In addition to the results from study 1,<sup>17</sup> the initial end-user acceptability of the first draft of the I-PROTECT model developed in step 2 will be evaluated. Handball representatives, including coaches, players and administrators from the two clubs and the district handball federation, will participate in structured workshops led and facilitated by members of the research team.

First, we will hold a half-day workshop with six to eight coaches and administrators. The coaches are programme deliverers at the handball practice, and the administrators are responsible for club/federation operation. Second, we will conduct a half-day workshop with the same coaches and administrators from the first workshop and a group of approximately 15 players. A third half-day workshop focusing on integrating injury prevention training within existing gym training (relevant to players aged 15–17 years) will be held with six to eight physical therapists (programme deliverers at the gym), coaches and players. All workshops will start with an introductory didactic session to provide participants with information about the I-PROTECT project, current research evidence and knowledge of the implementation context from study 1<sup>17</sup> (step 1), as well as a summary from the workshops with experts (step 2). The participants will then be provided with, and will practice, examples of exercises intended to be integrated in handball practice or gym training. To evaluate acceptability, workshop participants will be asked to give feedback regarding practicability, relevance

and meaningfulness of the exercises, as well as suggest revisions to improve the training. The principles of user-centred design<sup>30</sup> will be applied to ensure the programme package will meet the end users' needs. The workshop participants will be asked their perceptions about programme usability to ensure that the end users will perceive the programme as simple, easy to understand and use, efficient, acceptable, appealing and valuable. Expert technology and graphic designers will be engaged to produce a digital prototype platform to be tested in step 4. Any programme revisions will be discussed with the experts (from step 2) to ensure they are supported. The aim of these three workshops is to generate a draft of the I-PROTECT model including injury prevention training, which is evidence-based, theory-informed and implementation context-specific.

A final workshop will be held to develop a context-specific implementation strategy for the injury prevention training. Workshop participants will include administrators, coaches, players and caregivers. Research team members will facilitate the workshop. Step 5 of the intervention mapping health promotion programme planning framework,<sup>31</sup> focusing on planning programme adoption, implementation and maintenance, will be followed to develop the implementation strategy. Alongside step 5 of the intervention mapping, we will use the results from study 1 and from previous workshops (steps 2–4). Step 5 of the intervention mapping framework includes seven tasks that will be applied as follows: *task 1*: administrators and coaches will be identified as key programme adopters and implementers; *task 2*: to facilitate shared responsibility of the implementation of the injury prevention training, the research team and key representatives of the clubs and district federation will form an implementation planning group; *task 3*: the anticipated implementation outcomes will be awareness (reach), perceived effectiveness, adoption, implementation and maintenance of the injury prevention training<sup>7</sup>; *task 4*: key determinants for adoption and implementation of the programme are expected to be aligned with the HAPA constructs of motivational and volitional strategies<sup>15</sup>; *task 5*: any changes to the programme required, based on the determinants identified in task 4, will be made to facilitate implementation; *task 6*: specific, evidence-based and theory-informed strategies to implement the training programme within the clubs and district federation will be identified; *task 7*: material and resources to operationalise the implementation strategies will be developed.

The aim of Step 3 is to generate a second draft of the I-PROTECT model, including evidence-based, theory-informed, and context-specific injury prevention training along with an associated implementation strategy, at the conclusion of the workshops.

## Step 4: testing feasibility, acceptability and usability

The I-PROTECT model, generated in step 3, will be tested for feasibility, acceptability and usability over a period of 3–4 weeks in teams led by the coaches who participated in the workshops in step 3. As high levels of trainer competency and self-efficacy are acknowledged drivers of implementation success,<sup>6</sup> a 'train-the-trainer' workshop will be held with coaches<sup>32</sup> on how to deliver the programme to their players. End users will also be asked to identify how the programme and its packaging could be improved. A research assistant will visit each team once during the period of 3–4 weeks to receive feedback from coaches and players on programme feasibility, acceptability and usability. Focus groups<sup>33</sup> with coaches and players aged 13–14 years and 15–17 years, respectively, will be conducted to generate

an in-depth understanding of the feasibility, acceptability and usability of the programme, and of any potential barriers for adoption and sustainability. Any revisions will be discussed with the experts (from step 2) to ensure they are supported. Step 4 will generate a third version of the I-PROTECT model.

### Step 5: evaluating against theory

The research team will evaluate the third version of the I-PROTECT model, particularly the way the training content is presented, and the accompanying implementation strategy, generated in step 4 against the behaviour change theory, HAPA, during a structured round table discussion. This will ensure the I-PROTECT model is aligned with the HAPA constructs of motivational and volitional strategies. During the discussion, the RE-AIM SSM framework<sup>7</sup> will be used to ensure the I-PROTECT model has a social-ecological and evidence-based focus (effectiveness). For example, the implementation strategies will be reviewed to ensure they address the awareness (reach), adoption, implementation and maintenance dimensions at the individual player, coach, club and federation levels. Any revisions will be discussed with the key stakeholders (club and district representatives) to ensure support.

### Step 6: obtaining feedback from early implementers

Before the final version of the I-PROTECT model is implemented in study 3 (figure 1), all youth teams in the two clubs with representatives of the stakeholder group overseeing the I-PROTECT project will use the I-PROTECT model for one handball season. The anticipated implementation outcomes will be that coaches, players and administrators will be aware of the I-PROTECT model (reach), deliver the programme (adoption) and use the programme as intended (implementation). We will develop educational strategies and support materials for coaches, players, caregivers and club administrators modified from Padua *et al.*<sup>32</sup> Although the specific nature of the implementation activities to be undertaken will be tailored according to the outcomes of the implementation planning processes described in step 3, it is anticipated that the I-PROTECT model will be disseminated to all stakeholders (players, coaches, caregivers and administrators) through promotional, communication and educational activities (eg, websites, social media and workshops), and resource distribution. Club administrators will have the opportunity to participate in an educational activity (eg, workshop) to learn about the I-PROTECT model in order to build their capacity to provide organisational and resource support to the coaches. It is also anticipated that all coaches of teams for youth players within the two participating clubs will have the opportunity to participate in educational activities (eg, workshop) on why and how to deliver the programme to players, and have support materials meeting their needs. The I-PROTECT model will be implemented two times a week or more over one handball season.

Because the overall aim of the I-PROTECT project is to achieve widespread, sustained and high-fidelity use of evidence-based injury prevention training in youth team handball, we will evaluate the effectiveness of the implementation. The HAPA theory will be used to evaluate behaviour change, and the RE-AIM SSM framework<sup>7</sup> will be used to evaluate implementation outcomes of the I-PROTECT model among players, coaches, caregivers and administrators. Questionnaire data will be collected at baseline, midseason and at the end of the season. We will also conduct focus groups with end users to enable an in-depth understanding of the feasibility, acceptability and usability of the programme, including its packaging. An 'exit strategy'<sup>32</sup> will be employed to

refine the model, address any potential barriers for adoption and sustainability and embed the I-PROTECT model into the organisations that have participated in the study. Step 6 will generate the final draft of the I-PROTECT model, including injury prevention training and an associated implementation strategy to be implemented in study 3 (2021–2022, figure 1). Study 3 will include clubs that have not been involved in the development of the I-PROTECT model. It is expected that the final version of the I-PROTECT model can be used, but that minor adjustments may need to be made in the implementation strategy to meet any specific needs of a club (due to differences in organisational structures between clubs). If we succeed, the I-PROTECT model can be used in youth handball in Sweden, and in other countries.

### CONCLUSION

Engaging end users at the individual and organisational levels in the process of developing an intervention is important for successful implementation of any evidence-based practice, including injury prevention training. The generalisable six-step intervention development process, similar to steps 1–4 of the intervention mapping, is applied as a systematic and pragmatic guide to enhance the development of the I-PROTECT model. The I-PROTECT model will be an end user-driven implementable intervention including evidence-based, theory-informed and context-specific injury prevention training for youth handball and an associated implementation strategy.

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#### What is already known on the subject

- ▶ Female and male youth handball players are vulnerable to musculoskeletal injury, but there are no available context-specific injury prevention training programmes targeting both upper and lower limbs or incorporating the psychological aspects of injury.
- ▶ Evidence-based injury prevention training has limited public health impact because it is not widely or properly implemented or sustained.
- ▶ End users are rarely engaged in the process of developing an intervention, although this is important for successful implementation.

#### What this study adds

- ▶ This paper describes the development of the I-PROTECT model, which is study 2 in the 'Implementing injury Prevention training Routines in TEams and Clubs in youth Team handball (I-PROTECT)' project.
- ▶ The generalisable six-step intervention development process is applied as a systematic and pragmatic guide to enhance the development of the I-PROTECT model.
- ▶ The I-PROTECT model will be an end user-driven implementable intervention including evidence-based, theory-informed and context-specific injury prevention training for youth handball and an associated implementation strategy.

Olympic Committee (IOC) centre of research excellence for the prevention of injuries and promotion of health in athletes.

**Contributors** EA conceived of the project. EA, AD and SB designed the study, and PN contributed with intellectual input in this process. EA drafted the manuscript and AD contributed to the writing of the manuscript. AD, SB and PN reviewed and revised the manuscript critically for important content. All authors approved the final version and take responsibility for the integrity of the work.

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**Competing interests** None declared.

**Patient consent for publication** Not required.

**Ethics approval** In this paper, we describe the process of developing injury prevention training and an accompanying implementation strategy. Thus, no data are provided. However, the Regional Ethical Review Board in Lund, Sweden, approved the Implementing injury Prevention training Routines in TEams and Clubs in youth Team handball project (EPN 2014/713).

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**Data availability statement** There are no data in this work.

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#### ORCID iD

Eva Ageberg <http://orcid.org/0000-0002-8639-3006>

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