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Perspectives on usability and adoption of a new ACL injury prevention programme for female handball players: a mixed methods approach

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ABSTRACT

Effective injury prevention programmes (IPPs) hold promise for mitigating ACL injuries in female handball players, yet adherence remains a challenge. This mixed methods study explores the relationship between programme usability characteristics and the potential effectiveness of a newly developed ACL IPP through survey and interview data from 23 female handball players aged 15–18 and their four coaches. Players' knee abduction moment (KAM) was measured during a cutting task and used to measure potential effectiveness. Findings reveal significant correlations between reductions in KAM and players' perceived effectiveness of the programme in reducing ACL injury risk and their intention to use it (Spearman's rho (r_s) −0.52, 95% CI −0.78 to −0.1, p=0.02 and r_s −0.46, 95% CI −0.75 to −0.03, p=0.04, respectively). Coaches and players identified efficiency and perceived effectiveness as key factors influencing programme adoption. Concerns regarding programme length and doubts about exercise efficacy and transferability emerged as barriers, while perceived effectiveness, efficiency and enjoyability were facilitators for programme use. Players' suggestions for programme improvement included shortening the duration and incorporating playful elements. Design thinking sessions yielded strategies to optimise time efficiency and integrate IPPs into existing training routines. The study reaffirms the importance of balancing programme effectiveness with practicality and clear communication about its purpose and benefits to facilitate programme adoption. Enhancing programme usability and involving all end-users in the design process are crucial steps toward promoting the acceptance and adoption of IPPs among target populations.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Injury prevention programmes (IPPs) can reduce the risk of sustaining an ACL injury by more than 50% in female athletes participating in pivoting sports. However, adherence to these programmes is low and the number of ACL injuries in female athletes is not decreasing. Several barriers and facilitators to implementing IPPs have been suggested, including programme design, player enjoyment and a lack of knowledge and resources.

WHAT THIS STUDY ADDS

⇒ Our results show that the perceived effectiveness, efficiency, flexibility and enjoyability of using the programme affect coaches' and players' adoption and acceptance of the programme.

⇒ As long as players believe in the programme's effectiveness, it seems less important to be perceived as enjoyable for it to reduce knee abduction moments as an objective measure of the programme's effectiveness.

⇒ Communication between programme developers and target users (eg, between researchers and coaches/players and between coaches and players) should heavily emphasise understanding the rationale and potential value of IPPs.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our results indicate that collecting data on the coach's and players' perceptions of the usability of exercise programmes can add important insights during the development and testing phases of the programme. Including end-users and assessing programme usability should be emphasised early on in developing new IPPs.

INTRODUCTION

Exercise interventions, widely acknowledged for their efficacy in preventing and treating various diseases and injuries, face a significant challenge in adherence, thereby limiting their potential benefits.[1 2] This issue is particularly evident in the context of ACL injuries among female athletes engaged in pivoting sports like soccer and handball.[3 4] Despite the proven effectiveness of injury prevention programmes (IPP) in reducing ACL injury risk, adherence rates remain notably low (approximately 4–20%).[3 5]

The adherence issue is multifaceted and many different facilitators and barriers have been identified in previous research.[3 6–10] Knowledge, resources (eg, time) and player enjoyability have been considered barriers to use. In contrast, programme content/design, the relevance of exercises and the ease of

learning have been identified as facilitators.[3 6–10] Additionally, behavioural theories such as the self-determination theory and the theory of planned behaviour propose factors affecting individuals' engagement in a behaviour (change) (eg, intrinsic motivation, attitudes, subjective norms and perceived behavioural control) and how these predict intention to perform injury prevention and rehabilitation.[11–13]

Usability testing and end-user engagement have become an important part of product development, particularly within technology and computer-based products, due to their ability to detect barriers and enhance user experience.[14 15] Despite increasing emphasis during product development, usability testing is not typically used in exercise intervention development. The International Organization of Standardization (ISO) defines usability as the 'extent to which a system, product or service can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use' (ISO/TS 20282-2:2013, 2023). Other outcomes of use in the context of usability include user experience, accessibility and avoidance of harm.[16] Implicitly, end-user involvement is critical in usability assessments. Conducting usability testing throughout an exercise intervention's development and testing phase can potentially help address the adherence issues commonly observed in injury prevention implementation research.

Recently, Bill *et al* found that female handball players with high knee abduction moments (KAM), a likely risk factor for ACL injuries,[17–19] show increased vertical centre of mass excursions and knee valgus angles across cutting tasks.[20] High KAM during these activities places excessive strain on the ACL, increasing the likelihood of injury.[21] To mitigate this risk, a randomised controlled trial (RCT) was conducted to test a new ACL IPP for female handball players, specifically targeting cutting technique and strengthening the hip abductors, hip external rotators, calf and core muscles to reduce KAM. Research indicates that targeted exercises can reduce KAM by enhancing neuromuscular control and strengthening the surrounding muscles.[22 23] Additionally, evaluating the usability of these programmes early in their development is crucial. This evaluation should focus on perceived effectiveness, efficiency and user satisfaction to identify potential barriers to programme use. If the programme is proven effective in reducing injury risk and associated factors such as KAM, it remains uncertain whether athletes will continue to use it in the long term. Therefore, it is interesting to explore whether athletes who experience a reduction in KAM are more likely to have positive perceptions of the programme, such as finding it more enjoyable and whether this influenced their intention to continue using it. Such early evaluations ensure that the programmes are not only effective in reducing KAM but also adopted outside research settings, maximising their real-world impact.

This mixed methods study aims to gain deeper insights into coaches' and players' perceived barriers and facilitators for using the newly developed ACL IPP. Additionally, we explored the relationship between players' reduction in KAM and their perceptions of and intention to use the programme.

METHODS AND MATERIALS

This mixed methods study included survey and interview data collected from the intervention group participating in a RCT conducted by researchers at the Oslo Sports Trauma and Research Center during the Fall of 2022 investigating whether a programme particularly targeting cutting technique and muscle strength exercises for hip, calf and core could reduce KAM in female handball players. The ethical aspects of the study adhered to the principles outlined in the Declaration of Helsinki and prior approval was obtained, including the exemption of parental consent when the player belonged to the same grade as the rest of the players.

Sample

The players all attended the same high school where the intervention was executed. They both took part in training sessions at their school and played competitively for different sports clubs (including the top two national tiers and junior level). All players conducted the surveys. A subset of the players was also included in a focus group/design thinking activity with one female interviewer (AIM). The coaches responsible for the execution of the IPP individually took part in semi-structured interviews with one female interviewer (AIM).

Intervention

The 9-week intervention involved performing a warm-up with cutting and landing exercises and strength exercises for the hip, core and calves two to three times per week. See online supplemental materials for programme specifics. The intervention was developed by researchers at the Oslo Sports Trauma and Research Center in collaboration with the coaches involved in the study. Prior to the intervention start, all coaches were instructed on how to supervise the exercise programme by the head coach from the intervention group most heavily involved in the design of the programme. The team's coaches supervised the programme, mainly performed during their handball session, in the gym or on the court. The whole programme (eg, warm-up and strength exercises) was designed to take about 20 min to complete.

Outcome measures

The primary quantitative outcome measure in the original RCT was the players' reduction in KAM. KAM was evaluated using a three-dimensional motion capture system (24 cameras, Qualisys, Gothenburg, Sweden, 200 Hz) and two floor-embedded force plates (AMTI, Watertown, Massachusetts, USA, 1000 Hz, 1200×600 mm) as players executed a sidestep cutting manoeuvre to

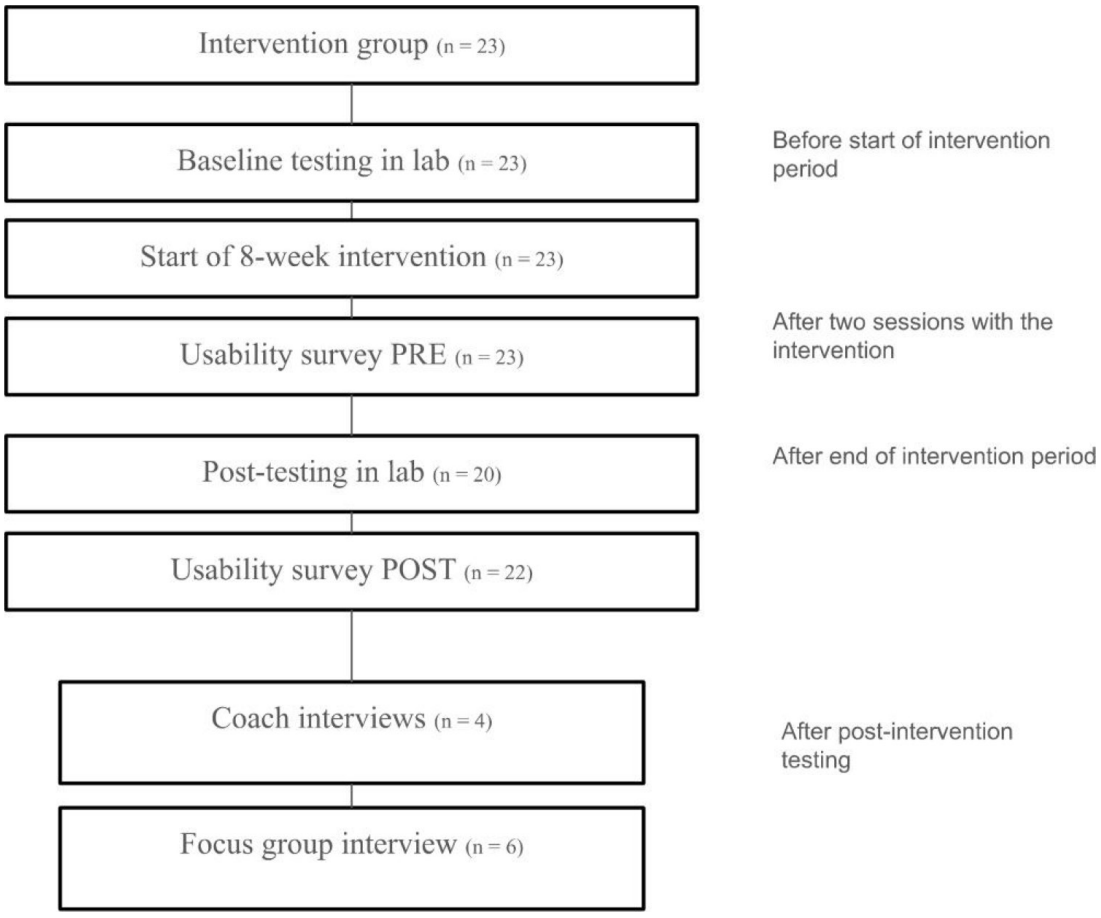

Figure 1 Flow chart of laboratory testing, survey distribution and interviews. The numbers in parentheses refer to a number of players included in that specific part of the study.

bypass a stationary defender. For more information on how changes in KAM were analysed, see online supplemental materials. See figure 1 for a flow chart of assessing outcome measures.

Surveys were distributed to the players in the intervention group after two sessions and after the intervention period was over. The PRE survey was distributed using pen and paper and the POST survey was distributed through Qualtrics (Qualtrics, Provo, Utah, USA, November 2022). The presurvey was administered after two interventions to ensure the players had performed the programme at least once. The two usability surveys included 13 items, all responded to through a 5-point Likert scale. Six items were collected from the modified Intervention Usability Scale (IUS).[24] We removed three negatively worded items from the IUS scale because they were redundant. Additionally, research suggests that scales containing both positively and negatively worded items can reduce reliability, as mixed-tone items may introduce confusion and affect the consistency of responses.[25] Seven items that mapped more directly onto the player's enjoyment, perceived effectiveness and efficiency of the programme were also given, consistent with findings from previous literature on programme adherence and behavioural theories.[8 11 12] One item from the IUS was used to measure intention to use the programme. Hypothesised constructs of the usability scale included learnability, perceived overall effectiveness, ease of use, enjoyability and efficiency. See figure 2 for the full list of usability scale items and their affiliation to the hypothesised constructs.

Semi-structured interviews were conducted individually with four of the coaches in the intervention group responsible for the execution of the programme, each lasting between 25 and 30 min. They were invited to the interviews via email and all consented to participate. Additionally, six players participated in a 60 min, semi-structured focus group interview. The head coach selected and invited them based on age and experience levels. All interviews were conducted by AIM (physiotherapist and PhD student) who had previous experience conducting semi-structured interviews within a research setting. Personal bias was excluded as the interviewer and interviewees did not know each other before conducting the interview. All interviews were conducted in person at the Norwegian School of Sport Sciences; only the participants and the interviewer were present. The coaches and the group of players were asked questions about what they liked/disliked about the programme, what they would change about the programme and general feedback about facilitators and barriers to implementing and using IPPs. The laboratory testing and survey data results were not presented to the coaches or players before the

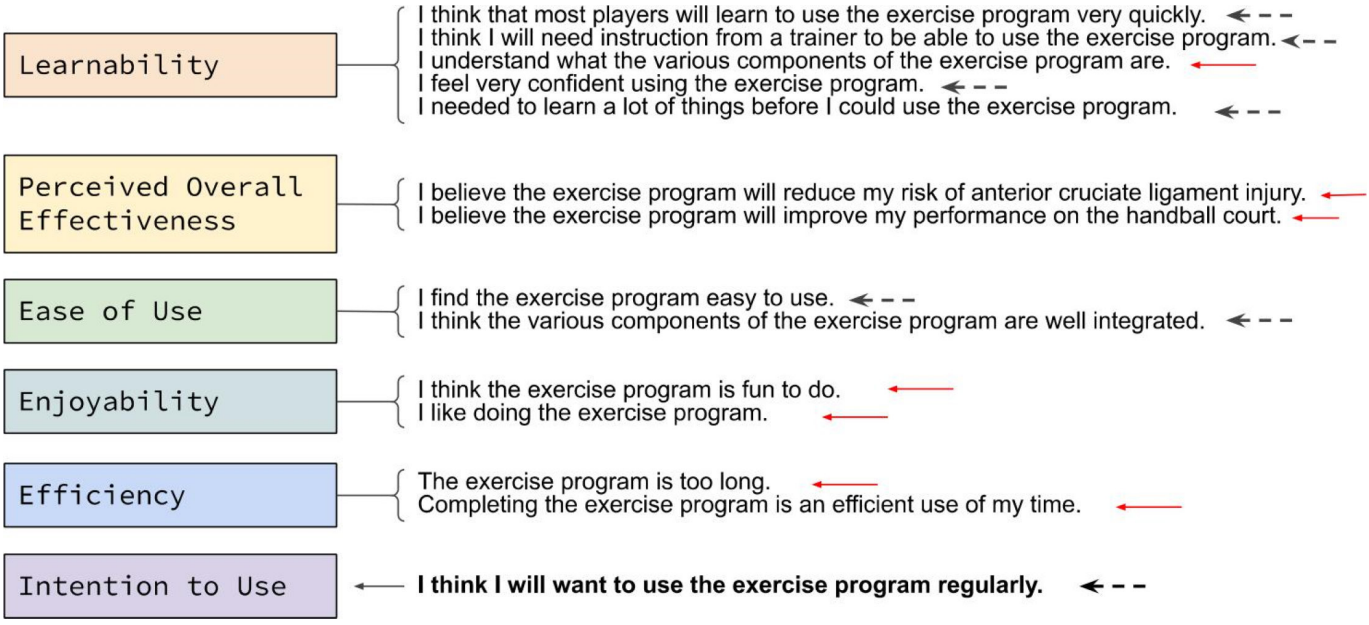

Figure 2 Usability scale items (on the right) and affiliation to subcomponents (on the left). Note: Red arrows indicate items added by the research team. Black, dotted arrows indicate items from the Intervention Usability Scale. The item in bold is used as an outcome measure for players' intention to use the programme.

interviews. Sound recordings from interviews were transcribed and thematically synthesised subsequently.

As part of the focus group interview, the six players were also involved in a design thinking activity[26] to generate ideas on designing an exercise-based IPP players would like to use in the long term. The design thinking method contains five different stages: (1) Empathise (what is the users' needs), (2) Define (state the users' needs and problems), (3) Ideate (challenge assumptions and create ideas), (4) Prototype (create your solution) and (5) Test (try out your solution).[26] For this interview, the problem was already defined and stated to the players: (1) How can we, as researchers, coaches or others, help encourage players to perform injury prevention training (IPT) frequently? (2) How can this programme become more enjoyable? and (3) Do you have any suggestions for how you can integrate IPT as part of your weekly training schedule? They were given one problem at a time and asked to challenge assumptions, create ideas (stage 3) and subsequently rate ideas and create a solution for the highest-rated ideas (stage 4). During this procedure, players were divided into two groups, spent 3–5 min per question and were asked to write one idea per post-it. Additionally, they were encouraged to discuss and build off each other's ideas. All interviews were audio recorded.

Patient and public involvement

The players were not involved in this research's design, conduct, reporting or dissemination plans. However, the coaches participating in the study were involved in the planning and designing of the intervention before baseline testing. Second, one of the coaches was invited to a meeting with TK to work out the intervention details. Before the intervention, the players took part in a lecture on the study and exercise selection rationale.

Statistical analysis

Power analysis and sample size justification were made for the main objective of the RCT (eg, changes in KAM). Distributions were assessed through visual inspection of histograms and Q-Q plots and Spearman's rho (r_s) was used to assess correlations between the hypothetical constructs and changes in KAM. A p value of≤0.05 was considered statistically significant. Statistical analyses were conducted using RStudio (Posit Software, 2023, Boston, Massachusetts, USA). Players with early intervention exit (eg, injuries) or lacking laboratory testing results were excluded from the analyses. Similarly, aberrant responses were excluded from the analyses (eg, straightlining).[27] Qualitative description methodology[28] was used to thematically analyse the interview data and was conducted by AIM. Qualitative description methodology is used in qualitative research to explore and describe a specific phenomenon or topic in a detailed and comprehensive manner.[28] For the coaches, themes emerge if two or more coaches report on them. For the focus group interview with players, themes emerged based on individual contributions and discussion in the group.

RESULTS

The intervention group consisted of 23 female handball players aged 15–18. 20 players were included in the analyses, including changes in KAM. One player was excluded from the study early due to an injury and two players were excluded from post-laboratory testing analyses due to a broken wrist and post-Covid, respectively. Two players

Table 1 Demographics

Players	Age (years) mean (SD)	Weight (kg) mean (SD)	Height (m) mean (SD)	Level of play*	Number of technique sessions mean (SD)	Number of strength sessions mean (SD)
n=21	16.71 (1.10)	69.33 (8.20)	1.75 (0.06)	Level 1: 3 Level 2: 10 Junior: 2 Girls 2006: 6	17.25 (3.27)	18.25 (3.70)
Coaches	Age (years) mean (range)	Sex		Years of experience mean (range)		
n=4	40.5 (26–53)	Female: 2 Male: 2		12.5 (2–25)		

*Levels 1 and 2 refer to the top two tiers nationally.

were excluded from survey data analyses, one due to early intervention exit due to injury and one due to aberrant responses (eg, straight-lining). For demographic data of the players and coaches, see table 1.

Usability characteristics affecting the use of the programme

Narrative findings and quotes from interviews with players and coaches are presented in online supplemental materials. Table 2 shows the themes that were identified after thematic analyses. None of the coaches wanted to continue using the programme as designed after the intervention period was over. Players indicated they would continue using it only if it was proven to effectively reduce ACL injury risk.

Correlations between usability characteristics and improvement in KAM

Reduction in KAM significantly correlated with perceived effectiveness in reducing ACL injury risk (r_s −0.52, 95% CI −0.78 to −0.10, p=0.02) and the players' intention to use the programme (r_s −0.46, 95% CI −0.75 to −0.03, p=0.04), where a higher score (eg, higher level of agreement) on these items was correlated with a reduction in KAM (figure 3). These correlations are considered moderate to strong.[29] There were no significant correlations between KAM and other programme usability characteristics (learnability, perceived performance effectiveness, ease of use, enjoyability or efficiency).

Design thinking

From the collaborative ideation and prototyping session, key themes in the generated ideas included optimising time efficiency, breaking down the programme into manageable parts, emphasising the programme's purpose and rationale, using rewards and punishments, introducing exercise variations, incorporating IPT into warm-ups, addressing stakeholder attitudes and adapting

Table 2 Themes identified during interviews with coaches and players

	Themes	
Questions	Coaches	Players
What did you specifically like about the exercise programme?	Purpose and potential value Strength exercises	Perceived effectiveness integration into warm-up Programme content variation Relatedness Exercise purpose
What did you specifically dislike about the exercise programme?	Programme length Doubts about cutting task effectiveness and transferability Exercise feasibility	Programme length Doubts about cutting task effectiveness and transferability Exercise feasibility Perceived effectiveness
What other factors affect your willingness to use this programme?	Lack of proof Integration with existing training routines Communicating purpose and potential value Enjoyability Change of routines	Evidence and testing Attitude Perceptions and communication of IPT

IPT, injury prevention training.

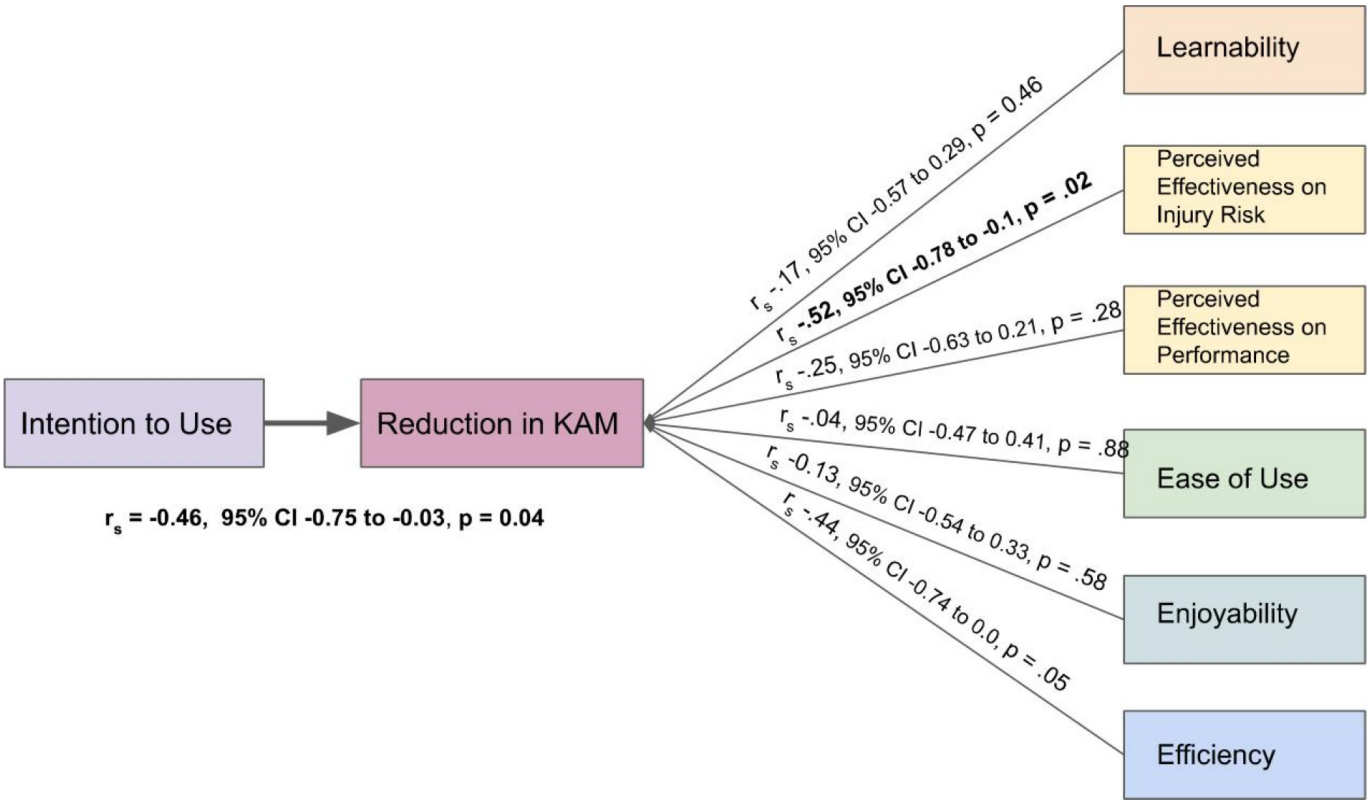

Figure 3 Spearman's rho (r_s) correlations between usability characteristics and improvements in KAM (right side) and between intention to use the programme and KAM (left side). Significant correlations are in bold. KAM, knee abduction moment.

equipment. In total, 31 ideas were generated between the two groups. The highest-rated ideas focused on reducing the time commitment, spreading IPT across multiple sessions and introducing playful exercise elements. Prototyping suggestions included modifying sets and repetitions, integrating IPT into existing playful activities (eg, cannonball, tag games), adding competitive elements within the exercises and creating obstacle courses where IPT exercises are also included. See table 3 for a summary of the results.

DISCUSSION

A team of female handball players tested out a new IPP for 9 weeks. This team will not adopt this intervention for long-term use for two important reasons: efficiency and perceived effectiveness. Notably, none of the coaches favoured continuing the programme postintervention period due to insufficient evidence of its effectiveness, the substantial time commitment and inflexible design. Second, the reduction in KAM was significantly correlated with players' perceived effectiveness in reducing ACL injury risk and their intention to use the programme.

Perceived effectiveness, efficiency and enjoyability were barriers and facilitators for programme use. This is in line with previous studies.[9 30] In a literature review, Minnig *et al* report that time was the biggest barrier to implementing evidence-based IPPs noted by coaches. In the current study, coaches reported spending up to 40 min completing the programme. This is twice as much time as expected by the programme designers and likely had a negative effect on their motivation to use the programme. Lack of importance placed on the programme and lack of player motivation were other barriers identified in their review which can be considered part of intrinsic motivation and enjoyability. Similarly, the results of this study, to a great extent, mimic findings from Moesch *et al*.[9] They reported that about 10–15 min of IPT per session seemed feasible, exercises that the players understood the purpose of, experienced improvements in and considered handball-specific increased their motivation. Additionally, including competitive elements and exercise variation was appreciated, whereas requiring specific resources was a perceived barrier.

The interviews identified programme flexibility, or lack thereof, as an important factor for use among coaches and players. The coaches indicated that if the programme was proven effective in reducing ACL injuries, they would be more inclined to adopt parts of it. Still, they would organise it differently and integrate specific elements of the IPP where they fell naturally about the rest of their training session. For example, they would include strength exercises during their weekly strength sessions in the gym. Previous literature has also proposed that the intervention needs to be delivered in a 'propose' rather than 'impose' manner, allowing the coaches to adapt the intervention based on the needs and resources of the team.[30–32]

Table 3 Results from the design thinking approach

Ideate—results **(Challenge assumptions and create ideas)**	
Group 1: 14 ideas generated, Group 2: 17 ideas generated.	
Themes emerged*: **Time** (n=7): **Split up programme** (n=6): **Purpose/rationale** (n=6): **Reward/punishment** (n=4): **Variation** (n=3): **Warm-up** (n=3): **Stakeholder attitude** (n=3): **Equipment** (n=2): **Assorted singles statements** (n=8):	A shorter duration of IPT and/or more time are added to each handball session. Implement a few exercises each session, not one long block. Focus on and clearly explain the purpose and importance of the programme and its potential consequences on injury risk and performance. Get a reward for completion, reward the one with the greatest results or use exercises as punishment in competitions. Vary and swap out exercises. IPT as part of the warm-up. Communicate positively about the IPT/programme. Exercises with elastic bands or weights instead of partners. Add IPT to end low-intensity sessions, plan training week individually and take responsibility to get IPT done, use role models, inform the club, add playful activities, look at statistics of previous test results, fewer sets/reps, add strength exercises to current strength programme.
Rate the best and second best idea 'Our goal is to design an IP programme that you find okay to use long term. We know that you didn't enjoy this programme and was happy when the 8 weeks were over. So which idea can we build on to address this issue—making IPT feel quite alright to do and something that feels natural for you to implement in your weekly training schedule?'	
Best idea: 'Not spending so much time on it'—four best votes, one second best vote. 'Do a little bit each session'—one best vote, one second best vote. 'Add some playful components into the exercise'—one best vote. ('focus on consequences' got two second best votes and 'work towards a reward' and 'more variation' both got one second best vote).	
Prototype—results (Find a solution)	
'Design the programme that you find reasonable with regard to time use'	
1. Cut down on set and reps (especially the side push exercise, 6×6 reps). 2. Spread it out over three sessions instead of two. 3. Remove the calf raise exercise.	
'If you think about spreading it out more, how would that look?'	
1. Can do the same exercises but split up and spread it out over all weekly sessions. 2. 10 min per session feels like a cut-off. 3. Since we have to do a warm-up anyway, 10 min is fine.	
'If you think about the idea of making IPT part of a more playful activity, can you design a playful activity?'	
1. The exercises can be added to most of the playful activities we are already doing (eg, cannonball, tag games). 2. Include in competitive games where you have to do IPT when you lose. 3. Make the IPT exercise itself a competition (eg, standing in the plank position the longest). 4. One group plays a game, the other does IPT and then we swap. 5. If it does not have to be these exercises, we can learn from gymnastics where they jump around with weights and stuff. 6. Make an obstacle course including the IP exercises but also more fun stuff in between. 7. Circuit training format.	

*n=x refers to the number of ideas affiliated with that theme.
IPT, injury prevention training.

Some coaches and players appreciated the programme's purpose of preventing ACL injuries. They found value in certain exercises, particularly those related to strength and external hip rotation, while others had reservations. Overall, the coaches' feedback highlighted the need to balance programme effectiveness with practicality and ensure clear communication about its purpose and benefits, stressing the importance of communication, information and referencing research to motivate players and facilitate programme adoption. While the players appreciated perceived improvements in certain exercises, they also desired more evidence of their effectiveness in reducing injuries and/or improving performance. Although the lack of importance placed on the programme was identified as a barrier in the review by Minnig *et al*,[30] their recommendations for facilitating the

implementation of IPPs do not explicitly include communication and information about rationale and evidence of effectiveness targeted to the players to increase their motivation. Nonetheless, the exceptionally high motivation to improve performance in this sample (eg, the majority play for the top two tiers nationally) may have negatively influenced the ease with which the research team and coaches could convince them to incorporate such exercises before strong evidence for their effectiveness and value exists.

In general, IPT was seen as a necessary but unenjoyable task among the players, highlighting the importance of communication and understanding its purpose. When asked for programme design ideas, players leaned towards shortening the programme, splitting it into shorter blocks and making it more playful, indicating that time efficiency and enjoyment affect adherence. Most of their ideas to improve enjoyability seem reasonable and possible to incorporate (eg, obstacle courses, tag games, circuit training). Previous research suggested similar formats where end-users were involved in programme development.[7] Additionally, incorporating some form of competition and feedback on improvements (eg, force measures) motivates these players. However, the players indicated that as long as they knew it would effectively reduce ACL injury risk, they would be inclined to do it even though it might not be fun.

On the same note, the reduction in KAM was significantly correlated with players' perceived effectiveness in reducing ACL injury risk. While previous research has largely focused on enhancing the enjoyability of intervention programmes to improve adherence, our findings suggest that perceived effectiveness may play an equally (or more) important role in influencing players' intention to use the programme and injury risk. These results indicate that increasing perceived effectiveness, potentially through educational components that clarify the programme's benefits, could directly enhance programme effectiveness. Additionally, the correlation between perceived effectiveness and intention to use, as opposed to other usability criteria, may stem from the fact that players are more motivated to adopt interventions they believe will tangibly reduce injury risk. Enjoyability alone may not be sufficient unless players feel confident in the programme's practical outcomes. Perceived effectiveness may also lead to greater exercise fidelity and hence greater reduction in KAM. Future studies should further explore the mechanisms by which these usability criteria influence programme adherence.

Coaches' buy-in has, in previous studies, been reported as the crucial first step of injury prevention implementation as well as having the players do the programme.[30 33–35] For example, when coaches use the IPPs (eg, compliance>50%) in research settings, compliance rates among players are close to 90%.[36 37] On the other hand, poor player buy-in has been reported as a barrier to implementation indicating that coach buy-in alone is not enough for long-term implementation.[30 38] Behavioural theories such as the self-determination theory, the theory of planned behaviour and previous research on youth handball players suggest that IPPs must be made more enjoyable to increase the likelihood of use.[10 12 13] Although player enjoyment did not significantly correlate with injury risk reduction (eg, reducing KAM), there is reason to believe that player enjoyability will affect long-term use of the programme.

This study underscores the need for a holistic approach to exercise intervention development and design. This aligns with previous research (eg, Prep-to-Play and I-PROTECT), where end-users at different organisational levels were extensively involved in developing new IPPs.[39 40] For instance, the Prep-to-Play PRO IPP yielded high implementation, likely affected by the programme's flexibility and engagement of various stakeholders throughout the development and implementation phase.[31] However, such approaches are notably intricate, time-intensive and resource-demanding. Alternative methods, like surveys or usability scales employed in this study, may offer a streamlined means of identifying barriers and gauging the likelihood of adoption. Nonetheless, creating and validating such tools must precede their deployment, ensuring their efficacy as efficient substitutes for more exhaustive methods such as workshops.

Limitations

A notable limitation was the relatively small sample size which impacted the generalisability of the findings. Power analysis and sample size justification were not made for the exploratory and qualitative nature of the usability assessment and results should be interpreted cautiously. Although the number of items per construct can influence reliability, exploring the psychometrics of these constructs was beyond the scope of this study and our sample size did not allow for robust reliability metrics. However, our data provides some evidence of differential and predictive validity as certain constructs were related to injury risk reduction while others were not.

The players participating in this study are ambitious and play at a relatively high level. The barriers and facilitators may differ for different players (eg, younger, less ambitious). Using pen and paper during the first assessment and then distributing the survey online for the second assessment might have affected how players responded. There might also be a bias of players performing the programme after being lectured about exercise selection rationale and being specifically asked about the effect, enjoyability, etc. One of four coaches was heavily involved in designing the technical exercises in the intervention (eg, cutting exercises), including suggesting how to practically implement and execute the warm-up exercises. This could potentially bias the results. However, the results indicate that this coach was among the most critical stakeholders.

Interviewees did not provide feedback on findings and responses may have been interpreted inaccurately. Interviews and subsequent analyses were performed by

one researcher which may also have led to bias. Interview guides were not pilot-tested and no repeat interviews were carried out. Data saturation was not discussed and transcripts were not returned to interview subjects for further comments/corrections. Despite these limitations, the study results offer valuable insights into exercise interventions' usability and potential effectiveness.

CONCLUSION

Although players indicated that they were inclined to perform the newly developed ACL IPP if it was proven effective, this study found that coaches and players overall did not want to continue using it outside a research setting, particularly due to their lack of belief in the programme's effectiveness, enjoyability, flexibility and time. Furthermore, these factors seem important to target when designing sustainable IPPs. Commencing with the design of better programmes, including usability testing and end-user involvement throughout the design and development process, may represent a promising starting point. Even in the presence of highly effective prevention programmes, their value is diminished if we cannot facilitate acceptance and adoption by the target population.

Clinical implications

This study supports the need for a holistic approach to IPP development and implementation, focusing on efficacy, usability, communication and athlete engagement. The results of this study align with previous research on barriers and facilitators to IPP use. The importance of player enjoyment seemed less clear in this population whereas knowledge and beliefs about programme effectiveness appeared crucial to target. In this study, we discovered that employing the design thinking approach to co-create or modify IPPs may be beneficial, suggesting its potential as an innovative and collaborative strategy for enhancing programme effectiveness.

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Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the regional Ethics Committee of the Norwegian School of Sport Sciences (233–160622). Participants gave informed consent to participate in the study before taking part.

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