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Attitudes, beliefs, and behaviour to the Adductor Strengthening Programme in Norwegian male professional football teams: Successfully adopted, but frequently modified

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ABSTRACT

Objectives: Groin injuries represent a substantial problem in male football, with the Adductor Strengthening Programme (ASP) being the only exercise programme demonstrated to significantly reduce the risk of groin problems. We aimed first, to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among injury prevention delivery agents (i.e., staff with main responsibility for implementing and conducting injury prevention exercises). Secondly, we aimed to identify a real-world application of the ASP protocol used in a professional team setting.

Methods: A descriptive cross-sectional survey of 32 injury prevention delivery agents in Norwegian male professional football teams.

Results: Twenty-nine (91%) participants responded. All (100%) respondents were aware of the ASP and its potential to mitigate the burden of groin problems. The two most stated reasons for using the ASP were its injury preventive effect and that it doesn't require equipment. The ASP was adopted by all (100%) delivery agents, but only 10% used it in accordance with the original protocol. The main modifications were that the players in 72% of the teams were instructed to perform a non-progressive number of repetitions during pre-season, and in 86% of the teams instructed to perform more sets, but fewer repetitions per set, during in-season. In total, 97% of the delivery agents planned to continue using the ASP.

Conclusion: The delivery agents have positive attitudes and beliefs to the ASP, but they frequently modify it. Also, we identified a real-world application of the ASP protocol.

Key words: Football, groin injury, injury prevention, Adductor Strengthening Programme, Copenhagen Adduction, RE-AIM, implementation

Strengths and limitations of this study

- The questionnaire was pilot tested by delivery agents with relevant experience.
- Thorough data collection process leading to a high response rate.
- The internal validity of the questionnaire was not systematically explored.
- Some of the questionnaire's questions are prone to recall bias as the survey was conducted towards the end of the competitive season.

What is already known?

- The Adductor Strengthening Programme prevents groin problems in football, and is suggested implemented in football training
- Many injury prevention programmes and exercises are not successfully implemented in a real-world setting, limiting their effectiveness
- Knowledge of attitudes, beliefs, and behaviour regarding injury prevention exercises is key for successful implementation

What are the new findings?

- Team staff responsible for injury prevention exercises in Norwegian male professional football teams are aware of and familiar with the Adductor Strengthening Programme and it´s preventative effect
- The programme is widely adopted by all teams.
- We have identified a real-world application of the programme used in a professional team setting

INTRODUCTION

Groin problems represent a substantial problem in football. They accounting for 4-19% and 2-11% of all time-loss injuries in male and female football, respectively.[1] Moreover, the average weekly proportion of male players with any groin problem causing pain and/or reduced performance is 21% in a full competitive season[2] and, 29% in periods with match congestion.[3]

In a controlled clinical trial, the Adductor Strengthening Programme (ASP) demonstrated a significant 41% reduction in risk of groin problems in male players performing the ASP during one full season.[2] Consequently, dissemination and widespread implementation of the programme in football is recomended.[2 4] The ASP is based on the Copenhagen Adduction exercise,[4] structured with three progression levels and a protocol with a pre-season and in-season exercise prescription. In the clinical trial, players completed on average about 70% of the exercise prescription, demonstrating a considerably higher compliance than previous groin injury prevention programmes.[5 6] The high compliance is an important strength of the ASP, as only successfully implemented injury prevention programmes (i.e. widely adopted, complied with and maintained over time) will reach effectiveness outside controlled clinical trials.[7]

Knowledge of attitudes, beliefs, and behaviour regarding injury prevention exercises is important for successful implementation.[7 10] For this purpose, it is suggested to integrate the Reach Efficacy Adoption Implementation Maintenance (RE-AIM) framework.[8 9] The framework is a procedure where five key implementation dimensions are evaluated, ideally across all levels of the sport setting hierarchy from players and team staff in one end, to national and international sporting organisations at the other end.[9]

Attitudes and beliefs to the ASP is previously investigated in players participating in the ASP clinical trial, revealing that only 31% of the players anticipated continuing using it in line with the original protocol.[10] Also, a recent study on the Copenhagen Adduction exercise among coaches in international male professional teams reported that 72% were aware of the exercise, while 94% of those had adopted it.[11] These findings aligns with previous research emphasising that evidence-based injury prevention exercises can be challenging to apply in the real-world settings.[12] To enhance knowledge, we believed it was important to conduct a survey among team staff, specifically among those being main responsible for implementing and conducting injury prevention exercises (hereafter referred to as “delivery agents”).

Therefore, the primary aim of this study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. The secondary aim was to identify a real-world application of the ASP protocol used in a professional team setting.

METHODS

Study design and participants

This was a cross-sectional study conducted in September and October 2020. Participants were the primary delivery agent in each team in the top two divisions of Norwegian male professional football (n=32): Eliteserien (n=16) and OBOS-ligaen (n=16). The study is described according to the STROBE statement checklist for cross-sectional studies.[13]

Survey

A new questionnaire based on the RE-AIM[8] framework was developed. The final version consisted of 38 questions, primarily closed-ended. The questionnaire was developed and delivered in Norwegian, however, a translated English version is provided as an appendix to this paper (Supplementary file 1).

Data collection

All delivery agents received an email with detailed information about the study and a link with access to an online survey software (SurveyXact, Rambøll Management Consulting AS, Oslo). We distributed the questionnaire during an international break in September 2020. Weekly reminders were sent to non-responders by email for four weeks, and after five weeks, non-responders were contacted by telephone.

Analysis

We performed statistical analysis using SPSS statistical software (SPSS V24, IBM Corporation, Armonk, NY). Data consisted of categorical nominal variables, presented as

proportions. Open-ended text responses were analysed using a qualitative content analysis.[14] One non-completed response was excluded from the analysis.

Patient and public involvement

Three experienced delivery agents (two physiotherapists and one football coach) not involved as participants did pilot test the questionnaire and gave feedback on its understanding and readability. Patients and/or the public were not involved in any other part of the conduct, or reporting, or dissemination plans of this research.

RESULTS

Participant characteristics

Twenty-nine (91%) of the 32 delivery agents participated in the survey (14 from Eliteserien and 15 from OBOS-ligaen). The three non-respondents did not report any specific reasons for not participating. Twenty-three (79%) of the respondents were physiotherapists, five (17%) were strength and conditioning coaches and one (3%) was a naprapath. Respondents' experience as delivery agents in football is shown in Table 1.

Table 1: *Years of experience as delivery agents of injury prevention exercises in football*

Years of experience as delivery agent	n (%)
0-4 years	5 (17)
5-9 years	13 (45)
10-14 years	7 (24)
15-19 years	3 (10)
≥ 20 years	1 (3)

Risk and importance of mitigation of groin problems

Football players risk of sustaining a groin problem was assumed to be high or moderate by 19 (66%) and 9 (31%) delivery agents, respectively, while one respondent considered the risk to be low. All (100%) respondents thought prevention exercises to mitigate groin problems was important, replied by 27 (93%) as highly important and by 2 (7%) as moderately important.

Adductor Strengthening Programme awareness and beliefs about its effect

All (100%) respondents were prior to the study aware of either one or both of ASP and the Copenhagen Adduction exercise. All (100%) delivery agents thought the ASP has potential to successfully mitigate the burden of groin problems, with 11 (38%) perceiving the groin problem mitigation as large and 18 (62%) perceiving it as moderate. Beliefs about the ASP´s effect on player availability can be viewed in Figure 1.

[INSERT FIGURE 1 WITH LEGEND HERE]

Implementation of the Adductor Strengthening Programme

All (100%) delivery agents had adopted the ASP in their team the current season, of which three (10%) replied that their usage was in accordance with the original ASP protocol. Most delivery agents modified the program both during pre-season and in-season. The players were instructed to perform a wide range of different training frequencies, sets per side in each session and repetitions per set (Table 2 and 3). Twenty-eight (97%) delivery agents planned to continue using the ASP in the subsequent season, of which 20 (71%) planned to continue using a modified protocol.

Table 2: *Overview of reported training volume of the Adductor Strengthening Programme. during* ***pre-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than 3 times a week	2 (7)
3 times a week	4 (14)
Twice a week	16 (55)
Once a week	5 (17)
We carried out the program, but less than once a week	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	8 (28)
2 sets per side	17 (59)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions each week	1 (3)
12-15 repetitions each week	3 (10)
7-10 repetitions each week	16 (55)
3-5 repetitions each week	1 (3)
3-15 repetitions, weekly progressive as in protocol	3 (10)

3-15 repetitions, weekly progressive as own modification	5 (17)

ASP - Adductor Strengthening Programme
*Specified as under normal circumstances, e.g., not influenced by Covid-19

Table 3: *Overview of reported training volume of the Adductor Strengthening Programme during* ***in-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than once a week	9 (31)
Once a week	16 (55)
Once every two weeks	2 (7)
We carried out the program, but less than once every two weeks	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	7 (24)
2 sets per side	18 (62)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions	1 (3)
12-15 repetitions	6 (21)
8-11 repetitions	14 (48)
4-7 repetitions	8 (28)

ASP - Adductor Strengthening Programme
*Specified as under normal circumstances, e.g., not influenced by Covid-19

Facilitators and barriers

The most often stated reasons to use the ASP were first, the documented preventive effect of the ASP (100%, both in current and subsequent season) and second, that no additional equipment is needed (52% in current and 43% in subsequent season) (Figure 2). On an open-ended non-mandatory question, four respondents (27%) defined an indirect performance enhancing effect as an additional positive effect of ASP. Five (31%) respondents described the ASP progression levels as being too demanding, while four (25%) thought it was likely to cause muscle soreness. Two of these four respondents indicated soreness was a reason for modifying the original ASP protocol.

[INSERT FIGURE 2 WITH LEGEND HERE]

DISCUSSION

The primary aim of the present study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour regarding the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. A secondary aim was to identify a real-world application of the ASP used in a professional team setting. The main findings were that all delivery agents were aware of the ASP, all thought the programme can mitigate the burden of groin problems, all stated to use the ASP in their team the current season and, almost everyone planned to continue using it in the subsequent season. However, only 10% used the ASP in accordance with the original ASP protocol.

Attitudes and beliefs to groin problems and the Adductor Strengthening Programme

Knowing the extent of an injury problem and the associated injury risk is the first crucial step towards successful real-world implementation of injury prevention exercises.[9 15-17] In this study, 97% of the delivery agents considered football players to be at great or moderate risk of sustaining groin problems, which aligns well with epidemiological studies on groin injury rates.[1 3 18] Moreover, successful real-world implementation also depends on the targeted population being aware of the given injury prevention intervention.[19 20] Therefore, it is encouraging that all surveyed delivery agents were aware of the ASP. The awareness level in the current study is better than demonstrated for the Copenhagen Adduction exercise among coaches in a recent study[11] and, better than the awareness of the injury prevention exercise programme FIFA 11+ among team staff[21] in male professional football. The high awareness level of the ASP among the delivery agents in the current study can be attributed to the fact that the original scientific research on the ASP was conducted in Norway, too.

Another premise for successful real-world implementation is that key stakeholders think that the given programme can mitigate the relevant injury problem.[9 22] In this study, all the delivery agents considered the ASP to be capable of mitigating the burden of groin problems. This result is consistent with a recent study among coaches in international male professional teams, rating the Copenhagen Adduction exercise as effective to prevent groin injuries.[11]

Importantly, it is also consistent with the only clinical trial evaluating the ASP´s effect, demonstrating a 41% lower risk of groin problems in the intervention group.[2]

Implementation of the Adductor Strengthening Programme

All respondents reported using the ASP throughout the entire season. This is a slightly better adoption rate than shown in a recent study of the Copenhagen Adduction exercise in international male professional teams.[11] To be successful, the final step of any injury prevention exercise implemented in the real-world setting is that the exercise or the program is maintained over multiple seasons. In our study, a total of 97% of the delivery agents planned to continue using the ASP in the subsequent season. This planned continued usage is considerably more extensive than what previously has been reported among players experienced in the use of the ASP.[10] A particular challenge, however, is that team staff members, including medical staff, are frequently replaced when managers are replaced, increasing the risk of preventative measures not being persistently maintained over time.[20] It is yet to be confirmed whether ASP has been established as part of the teams´ or clubs´ sports plans or policies on injury prevention measures.

Real-world application of the Adductor Strengthening Programme

When implementing the programme, the current study shows that delivery agents in professional football usually modify the ASP to fit their team's training context. Similar findings have been demonstrated for the Nordic Hamstring exercise programme[23 24] and the FIFA 11+.[25 26] So far, no other studies on specific modifications of single-exercise injury prevention programmes exist.

The original ASP protocol prescribes a pre-season strengthening phase containing a detailed eight-week progression, and an in-season maintenance phase with a continuous number of repetitions (Table 4). The intention of the ASP original protocol is first, to provide hip adductor muscle strength gains in players and second, to maintain the increased muscle strength, as reduced hip adductor muscle strength is the only consistently reported risk factor for groin injury in sports.[27]

Compared to the original programme, the delivery agents usually prescribed two sets per side instead of one set per side throughout the whole season, however, with fewer repetitions per set, especially during in-season. Furthermore, they generally conducted fewer sessions per week during pre-season, and the vast majority did not adopt the detailed eight-week progression recommendation during pre-season. Table 4 shows the most often-used ASP modifications, which we consider to be an identified real-world application of the ASP protocol used in a professional team setting.

Table 4: *Adductor Strengthening Programme real-world application in Norwegian male professional football teams and, the original protocol*[2]

Adductor Strengthening Programme – real-world application			
Week	Sessions per week	Sets per side	Repetitions per side
Pre-season – week 1-8	2	2	7-10
In-season – all weeks	1	2	8-11
Adductor Strengthening Programme – original protocol			
Week	Sessions per week	Sets per side	Repetitions per side
Pre-season 1	2	1	3-5
Pre-season 2	3	1	3-5
Pre-season 3-4	3	1	7-10
Pre-season 5-6	3	1	12-15
Pre-season 7-8	2	1	12-15
In-season – all weeks	1	1	12-15

We did not investigate why the delivery agents modified the ASP. However, a potential reason for non-progression during pre-season strengthening phase might be that the delivery agents consider most professional players to already have gained, and maintained, adequate hip adductor muscle strength. This would limit the delivery agent's perceived need for players to commence a progressive strengthening phase. Another reason for the modifications of the ASP could also be lack of support and acceptance from players and/or coaches. Such support is considered a key facilitator in the implementation process[9 21] and, motivation to comply with the original ASP protocol has already been shown to be low among players.[10] A reason for modifying previous injury prevention strengthening exercises has been attributed to a

possible fear of muscle soreness.[12 28] However, only two respondents reported to have modified the ASP partly due to such fear, and there is evidence that even the most strenuous level of the ASP barely caused any reported muscle soreness if the number of repetitions was progressed gradually.[29 30] Consequently, fear of muscle soreness seems to not be an important barrier to optimal ASP implementation in the real-world setting.

Effectiveness of the modifications of the real-world application

An important aspect is that the delivery agents modify the ASP without knowing the impact. As mentioned, the ASP aims to mitigate groin problems by targeting hip adductor muscle strength. There is compelling evidence that muscle strength effects are dose dependent,[31] which also has been suggested for the Copenhagen Adduction exercise.[32] The reported used pre-season ASP exercise volume is approximately 640 repetitions during eight weeks, which, interestingly, is a higher volume than what the evidence-based original ASP protocol prescribes (470 repetitions).[2] Moreover, it accommodates a suggested minimum of 500-800 repetitions during eight weeks, when aiming to facilitate meaningful hip adductor muscle strength gains.[32] Since the reported used weekly in-season ASP exercise volume is almost equal to pre-season, it is reasonable to assume that players somewhat maintain their hip adductor muscle strength during in-season.

Beyond volume considerations, progression seems required to elicit the greatest strength training gains.[33] As the ASP consists of a bodyweight exercise, weekly increase in the number of repetitions is the main progression variable. A critical assessment is therefore whether the reported lack of pre-season progression can reduce the ASP´s effectiveness in groin problem mitigation. Additionally, muscle strength gains also depends on recruitment of high-threshold motor units, through accumulation of neuromuscular fatigue induced when performing sets to at least somewhat near neuromuscular failure.[34] Therefore, another critical assessment would be whether more sets but fewer repetitions per set, as respondents have reported, affect the ASP´s effectiveness.

So far, changes in physiological characteristics when performing the ASP, such as effects on muscle cross-sectional area and architecture, musculotendinous stiffness, and motor unit recruitment and synchronization,[33] have not been scientifically investigated. Similarly, the exact dose-response relationship between ASP exercise volume and hip adductor muscle

strength gains, and between ASP exercise volume and groin injury mitigation rates also remains to be investigated. And lastly, the importance of a progression strengthening phase(s) when aiming to mitigate groin problems, is unknown. Discussions around the most often-used modification's impact on the ASP´s effectiveness are therefore currently theoretical, only.

Consequently, we will argue that there is no convincing evidence claiming that the ASP modifications applied by the delivery agents affect the mitigation of groin problems in male professional players, compared to the original protocol. Additionally, considerations on ASP exercise volume and other modifications are subordinated to the fact that no injury prevention programme will reach its full potential unless it is implemented, adopted, and maintained, by teams in the real-world setting.[20]

Methodological considerations

The high response rate (91%) is a strength of this study. However, it is uncertain whether our results can be generalised to other delivery agents and professional football settings outside Norway. Especially, considering that the literature on ASP and the Copenhagen Adduction exercise primarily has been conducted in Norway and Denmark. A further strength of the current study is the pilot testing of the questionnaire ensuring valuable input to the final questionnaire. A limitation is that the internal validity of the questionnaire was not systematically explored, which is a prerequisite to draw firm valid conclusions.[35] The pilot study ensured, however, some degree of internal validity, by providing adequate understanding and readability of the questionnaire dimensions. Furthermore, questions related to the "implementation" dimensions, especially regarding the pre-season application of the ASP, are prone to some degree of recall bias as the survey was conducted towards the end of the competitive season.[36] Therefore, this study describes how the teams in overall perform the ASP, only, while it is likely that the programme was individualised depending on players previous injury record and experience with specific strength exercises. Moreover, this study did not include a question about delivery agents' perceived involvement in and support from players and coaches, which is considered a key facilitator to successful implementation in the real-world football setting.[9]

Importantly, 79% of the respondents had a defined team staff role as a physiotherapist. This contrasts with previous studies, where surveyed delivery agents were either strength and

conditioning coaches, head coaches or medical doctors.[21 23 28 37 38] It cannot be ruled out that some of the discrepancies in attitudes, beliefs and behaviour between the present and previous studies are due to differences in the participant's formal team staff role and educational background.

PERSPECTIVES

The delivery agents are aware of the ASP, they have adopted it, and they anticipate maintaining the usage. The implementation of the programme, however, is slightly different in each team. Further studies are warranted to acquire knowledge about why the ASP is being modified, and the impact of the modifications on the ASP´s effectiveness. As this in previous studies primarily has been conducted in male adult teams, future studies should include women's and youth football, too. Also, widespread dissemination of the ASP outside the Scandinavian countries is needed is to achieve reach world-wide. Finally, as recommended,[9] similar investigations of attitudes, beliefs, and behaviour to the ASP among other stakeholder, e.g. coaches, club officials and relevant sporting organisations, are needed in order to further explore the complexity of introducing preventative measures in the real-world professional setting.

CONCLUSION

The present study found that delivery agents of injury prevention exercises in Norwegian male professional football teams have positive attitudes and beliefs to the ASP, using it frequently and planning to maintain the usage of it in the subsequent season. Most delivery agents, however, instructed players to complete the ASP with modifications. Therefore, we have identified a real-world application of the ASP protocol used in a professional team setting.

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Author contributions

All authors planned the study. The data collection and the data analysis were done by JS. All authors have been involved in the drafting and the revision of the manuscript, and all have approved the final version.

Competing interests

None declared

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Patient and public involvement

Three experienced delivery agents (two physiotherapists and one football coach) not involved as participants did pilot test the questionnaire and gave feedback on its understanding and readability. Patients and/or the public were not involved in any other part of the conduct, or reporting, or dissemination plans of this research.

Ethics approval

This study involves human participants and was approved by the ethics board at the Norwegian School of Sport Sciences (134-130820) and from the Norwegian Centre for Research Data (NSD 2020/837286) prior to conducting this study. All respondents gave informed consent to participate.

Data sharing statement

All de-identified date is available upon reasonable request. Suitability of data request and access to data will be determined by all authors collectively.

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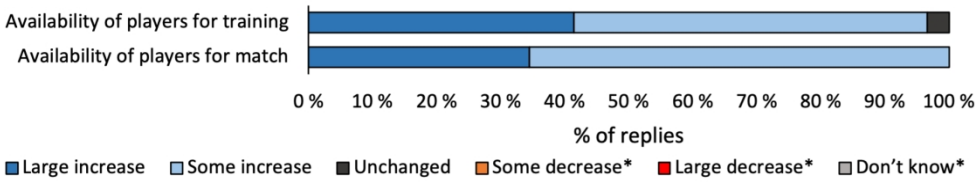

Figure 1: Beliefs regarding whether Adductor Strengthening Programme can influence availability of players in training and match-play. *No respondent replied some decrease, large decrease or don't know.

382x75mm (130 x 130 DPI)

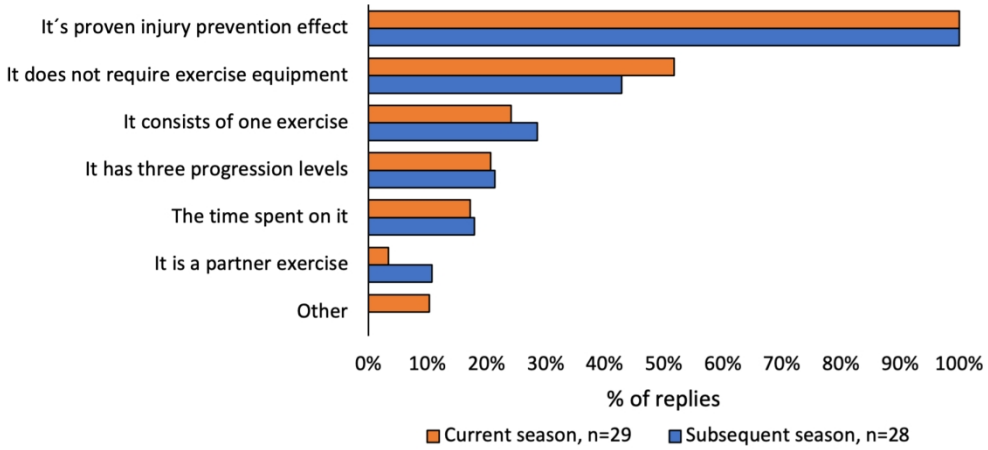

Figure 2: Reasons for choosing to use the Adductor Strengthening Programme this season and reasons for planning using the programme the following season.

372x174mm (130 x 130 DPI)

Questionnaire

Have you read and approved the informed consent?

- ☐ Yes

1. What is your age?
   - ☐ 18-30 years
   - ☐ 31-45 years
   - ☐ 46-60 years
   - ☐ More than 60 years

2. At what level does the team where you are employed play?
   - ☐ Eliteserien (Norwegian Premier League)
   - ☐ OBOS-ligaen (Norwegian First Division)

3. What is your role in the team staff where you are employed?
   - ☐ Head coach
   - ☐ Assistant coach
   - ☐ Fitness coach
   - ☐ Physiotherapist
   - ☐ Medical doctor
   - ☐ Other healthcare profession (specify) _____
   - ☐ Other position (specify) _____

4. What education and / or courses do you have?
   It is possible to check several options
   - ☐ UEFA PRO License
   - ☐ UEFA A License
   - ☐ UEFA B License
   - ☐ One-year study in sport science
   - ☐ Bachelor's degree in sport science
   - ☐ Master's degree in sport science
   - ☐ Bachelor's degree in a health profession
   - ☐ Master's degree in a health profession
   - ☐ Other education and/or courses (specify) _____

5. How many years of experience do you have as delivery agent of preventative training for football players?
   - ☐ 0-4 years
   - ☐ 5-9 years
   - ☐ 10-14 years
   - ☐ 15-20 years
   - ☐ More than 20 years

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/cathing or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

6. How much risk do you think football players have getting groin problems?
   - ☐ Great risk
   - ☐ Moderate risk
   - ☐ Small risk
   - ☐ No risk
   - ☐ Don't know

7. How important do you think it is to perform preventative training to mitigate groin problems?
   - ☐ Greatly important
   - ☐ Moderately important
   - ☐ A little important
   - ☐ Not important
   - ☐ Don't know

8. Were you aware of the "Adductor Strengthening Programme" and/or the "Copenhagen Adduction" exercise prior to reading the information in the introduction to this questionnaire?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

9. Where did you get information about the “Adductor Strengthening Programme” and/or the "Copenhagen Adduction Exercise"?
   It is possible to check several options
   - ☐ “Skadefri” website
   - ☐ “Skadefri” application
   - ☐ Article in the British Journal of Sports Medicine
   - ☐ Conference/course
   - ☐ Infographics
   - ☐ Social media (Twitter, Facebook, Instagram etc.)
   - ☐ Other (specify) _____
   - ☐ Don’t know

10. Check if you are aware that you can find information about the “Adductor Strengthening Programme” and/or the «Copenhagen Adduction Exercise» in these relevant places:
    It is possible to check several options
    - ☐ “Skadefri” website
    - ☐ “Skadefri” application
    - ☐ Article in the British Journal of Sports Medicine
    - ☐ Infographics
    - ☐ Social media (Twitter, Facebook, Instagram etc.)
    - ☐ Other (specify) _____

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/catching or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

11. Do you think that the “Adductor Strengthening Programme” can influence the burden of groin problems?
    - ☐ Yes, the program can greatly mitigate the burden
    - ☐ Yes, the program can moderately mitigate the burden
    - ☐ No, the program cannot have an effect on the burden
    - ☐ Yes, the program can moderately aggravate the burden
    - ☐ Yes, the program can greatly aggravate the burden
    - ☐ Don’t know

12. Do you think that the "Adductor Strengthening Programme" can influence football performance?
    - ☐ Yes, the program can greatly increase performance
    - ☐ Yes, the program can moderately increase performance
    - ☐ No, the program cannot have an effect on performance
    - ☐ Yes, the program can moderately decrease performance
    - ☐ Yes, the program can greatly decrease performance
    - ☐ Don't know

How do you think the following of the players' physical skills may be affected by doing the "Adductor Strengthening Programme"?

13. Linear acceleration?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don't know

14. Top speed?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don't know

15. Change of direction?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don't know

16. Vertical jump ability?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

17. Duelling power?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

How do you think other factors can may be affected by doing the "Adductor Strengthening Programme":

18. Availability of players for match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

19. Availability of players for training?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

20. Chance of winning a match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

21. What other positive characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

22. What other negative characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

23. Do you use the "Adductor Strengthening Programme" in your team?
- ☐ Yes, as described in the protocol
- ☐ Yes, as modified version
- ☐ No
- ☐ Don't know

24. How do you use the "Adductor Strengthening Programme" in your training schedule?
- ☐ As part of organised football training
- ☐ As part of organised strength training
- ☐ As an independent preparation in the locker room or strength room before training
- ☐ As guided preparation in the locker room or strength room before training
- ☐ As independent training in a separate strength training session
- ☐ Other way (specify) _____

When using the "Adductor Strengthening Programme" in season (under normal circumstances, not influenced by covid-19):

25. How often did the players perform the program?
- ☐ More than once a week
- ☐ Once a week
- ☐ Once every two weeks
- ☐ We carried out the program, but less than once every two weeks

26. How many sets did the players perform?
- ☐ More than 2 sets per side
- ☐ 2 sets per side

- ☐ 1 set per side

27. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per side
    - ☐ 12-15 repetitions per side
    - ☐ 8-11 repetitions per side
    - ☐ 4-7 repetitions per side
    - ☐ Less than 4 repetitions per side

When using the "Adductor Strengthening Programme" in preseason (under normal circumstances, not influenced by covid-19):

28. How often did the players perform the program?
    - ☐ More than 3 times a week
    - ☐ 3 times a week
    - ☐ Twice a week
    - ☐ Once a week
    - ☐ We carried out the program, but less than once a week

29. How many sets did the players perform?
    - ☐ More than 2 sets per side
    - ☐ 2 sets per side
    - ☐ 1 set per side

30. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per set each week
    - ☐ 12-15 repetitions per set each week
    - ☐ 7-10 repetitions per set each week
    - ☐ 3-5 repetitions per set each week
    - ☐ 3-15 repetitions per set, weekly progressive (as in protocol)
    - ☐ 3-15 repetitions per set, weekly progressive (as own modification)

31. What has been important for you in choosing to use the "Adductor Strengthening Programme"?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The programme consists of one exercise
    - ☐ The programme consists of three progression levels
    - ☐ The programme is a partner exercise
    - ☐ The programme does not require exercise equipment
    - ☐ Other (specify) _____

32. Do you use other preventative training in addition to the "Adductor Strengthening Programme", with the intention to mitigate the burden of groin problems?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

33. What training do you use in addition to, or instead of, the "Adductor Strengthening Programme" to mitigate the burden of groin problems? Describe in your own words as detailed as possible which exercise (s), how they are performed, dosage (series, repetitions, intensity), and anything else you consider relevant.

34. Why did you choose to do what is described in the previous answer, and who participated in the decision? Describe in your own words.

35. Do you anticipate using the "Adductor Strengthening Programme" in your team the following season?
    - ☐ Yes, as described in the protocol
    - ☐ Yes, as an own modification
    - ☐ No
    - ☐ Don't know

36. What is the reason why you anticipate using the "Adductor Strengthening Programme" in your team in the following season?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The program consists of one exercise
    - ☐ The program consists of three progression levels
    - ☐ The program can be performed as a partner exercise
    - ☐ The program does not require exercise equipment
    - ☐ Other (specify) _____

37. What is the reason why you do not anticipate using the “Adductor Strengthening Programme” in your team in the following season?
    It is possible to check several options
    - ☐ The program's lack of injury prevention effect
    - ☐ The time spent on the program
    - ☐ The program consists of only one exercise
    - ☐ The program consists of only three levels of difficulty
    - ☐ The program can be performed as a partner exercise
    - ☐ The program does not require exercise equipment
    - ☐ Other (specify) _____

38. Do you have any suggestions for changes to the “Adductor Strengthening Programme” that may make it more relevant to use the program? Describe in your own words.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Ok

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Adductor Strengthening Programme is successfully adopted but frequently modified in Norwegian male professional football teams: a cross sectional study

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The Adductor Strengthening Programme is successfully adopted but frequently modified in Norwegian male professional football teams: a cross sectional study

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ABSTRACT

Objectives: Groin injuries represent a substantial problem in male football, with the Adductor Strengthening Programme (ASP) being the only exercise programme demonstrated to significantly reduce the risk of groin problems. We aimed first, to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among injury prevention delivery agents (i.e., staff with main responsibility for implementing and conducting injury prevention exercises). Secondly, we aimed to identify a real-world application of the ASP protocol used in a professional team setting.

Methods: A descriptive cross-sectional survey of 32 injury prevention delivery agents in Norwegian male professional football teams. The questionnaire was designed to cover all five dimensions of the Reach Adoption Effectiveness Implementation Maintenance (RE-AIM) framework and, were pilot tested prior to the survey.

Results: Twenty-nine (91%) participants responded. All (100%) respondents were aware of the ASP and its potential to mitigate the burden of groin problems. The two most stated reasons for using the ASP were its injury preventive effect and that it does not require equipment. The ASP was adopted by all (100%) delivery agents, but only 10% used it in accordance with the original protocol. The main modifications were that the players in 72% of the teams were instructed to perform a non-progressive number of repetitions during pre-season, and in 86% of the teams instructed to perform more sets, but fewer repetitions per set, during in-season. In total, 97% of the delivery agents planned to continue using the ASP.

Conclusion: The delivery agents have positive attitudes and beliefs to the ASP, but they frequently modify it. We identified and reported a real-world application of the ASP protocol.

Key words: Football, groin injury, injury prevention, Adductor Strengthening Programme, Copenhagen Adduction, RE-AIM, implementation

Strengths and limitations of this study

- The questionnaire was pilot tested by delivery agents with relevant experience.
- Thorough data collection process leading to a high response rate.
- The internal validity of the questionnaire was not systematically explored.
- Some of the questionnaire's questions are prone to recall bias as the survey was conducted towards the end of the competitive season.

What is already known?

- The Adductor Strengthening Programme (ASP) prevents groin problems in football, and is suggested implemented in football training
- Many injury prevention programmes and exercises are not successfully implemented in a real-world setting, limiting their effectiveness
- Knowledge of attitudes, beliefs, and behaviour regarding injury prevention exercises is key for successful implementation

What are the new findings?

- Team staff responsible for injury prevention exercises in Norwegian male professional football teams are aware of and familiar with the ASP and it´s preventative effect
- The programme is widely adopted by all teams
- We have identified a real-world application of the programme used in a professional team setting

INTRODUCTION

Groin problems represent a substantial problem in football. They account for 4-19% and 2-11% of all time-loss injuries in male and female football, respectively.[1] Moreover, the average weekly proportion of male players with any groin problem causing pain and/or reduced performance is 21% in a full competitive season[2] and, 29% in periods with match congestion.[3]

In a clinical trial, the Adductor Strengthening Programme (ASP) showed a significant 41% reduction in risk of groin problems in male semi-professional players performing the programme during one full season.[2] Consequently, dissemination and widespread implementation of the ASP in football training seems beneficial.[2 4] The ASP is based on a single-exercise, the Copenhagen Adduction (CA) exercise,[4] structured with three progression levels and a protocol with a pre-season and in-season exercise prescription. In the clinical trial, players completed on average about 70% of the recommended exercise prescription, demonstrating a considerably higher compliance than previous groin injury prevention programmes.[5 6] The high compliance is an important strength of the ASP, as only injury prevention programmes that are successfully implemented (i.e. widely adopted, complied with and maintained over time) will reach effectiveness outside controlled clinical trials.[7]

Gaining knowledge on attitudes, beliefs, and behaviour to injury prevention exercises are important when evaluating their implementation in the real-world setting.[7] For this purpose, integrating the Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) framework[8 9] is recommended, ideally evaluated across all levels of the sport setting hierarchy.[9] In brief, the framework evaluates the proportion of a targeted population that is aware of a given intervention (Reach), the interventions positive outcomes (Effectiveness), the proportions that has adopted the intervention (Adoption) and implemented it as intended (Implementation), and the extent to which it is sustained (Maintenance).[8 9] Note that the specific RE-AIM implementation dimension refers to the extent to which an exercise or a programme is used as intended in the real-world setting.[9] The general term implementation also used in this article, however, refers to all initiatives applied to put an exercise or a programme into practice.[10]

Attitudes and beliefs towards the ASP is previously investigated among players participating in the clinical ASP trial.[11] The study revealed that only 31% of the players anticipated to continue using the ASP in accordance with the original protocol.[11] Also, a recent study on the CA among coaches in international male professional teams reported that 72% were aware of the exercise, while 94% of those had adopted it.[12] These findings are consistent with previous research emphasising that evidence-based injury prevention exercises can be challenging to apply in the real-world settings.[13] To enhance knowledge, we believed it was important to conduct a survey among team staff, specifically among those having the main responsibility for implementing and conducting injury prevention exercises (hereafter referred to as "delivery agents").

Therefore, the primary aim of this study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. The secondary aim was to identify a real-world application of the ASP protocol used in a professional team setting, which to our knowledge, previously has not been conducted for any single-exercise injury prevention programme.

METHODS

Study design and participants

This was a cross-sectional study conducted in September and October 2020. Participants were the primary delivery agent in each team in the top two divisions of Norwegian male professional football (n=32): Eliteserien (n=16) and OBOS-ligaen (n=16). The study was approved by the ethics board at the Norwegian School of Sport Sciences (134-130820) and by the Norwegian Centre for Research Data (NSD 2020/837286), and all respondents gave informed consent to participate. The study is described according to the STROBE statement checklist for cross-sectional studies.[14]

Survey

A new questionnaire designed to cover all dimensions of the RE-AIM[8] framework was developed. The final version consisted of 38 questions, primarily closed-ended. The

questionnaire was developed and delivered in Norwegian, however, a translated English version is provided as an appendix to this paper (Supplementary file 1).

Data collection

All delivery agents received an email with detailed information about the study and a link with access to an online survey software (SurveyXact, Rambøll Management Consulting AS, Oslo). We distributed the questionnaire during an international break in September 2020. Weekly reminders were sent to non-responders by email for four weeks, and after five weeks, non-responders were contacted by telephone.

Analysis

We performed statistical analysis using SPSS statistical software (SPSS V24, IBM Corporation, Armonk, NY). Data consisted of categorical nominal variables, presented as proportions, including for the specific RE-AIM dimensions. Open-ended text responses were analysed using a qualitative content analysis.[15] One non-completed response was excluded from the analysis.

Patient and public involvement

Three experienced delivery agents (two physiotherapists and one football coach) not involved as participants did pilot test the questionnaire and gave feedback on its understanding and readability. Patients and/or the public were not involved in any other part of the conduct, or reporting, or dissemination plans of this research.

RESULTS

Participant characteristics

Twenty-nine (91%) of the 32 delivery agents participated in the survey (14 from Eliteserien and 15 from OBOS-ligaen). The non-responders gave no specific reasons for not participating. Twenty-three (79%) of the respondents were physiotherapists, five (17%) were

strength and conditioning coaches and one (3%) was a naprapath. Respondents' experience as delivery agents in football is shown in Table 1.

Table 1: *Years of experience as delivery agents of injury prevention exercises in football*

Years of experience as delivery agent	**n (%)**
0-4 years	5 (17)
5-9 years	13 (45)
10-14 years	7 (24)
15-19 years	3 (10)
≥ 20 years	1 (3)

Attitudes to groin injury risk and importance of injury mitigation

Football players risk of getting a groin problem was assumed to be high or moderate by 19 (66%) and 9 (31%) delivery agents, respectively, while one respondent considered the risk to be low. All (100%) respondents thought prevention exercises to mitigate groin problems was important, replied by 27 (93%) as highly important and by 2 (7%) as moderately important.

Reach and effectiveness of the ASP

All (100%) respondents were aware of either one or both of ASP and the CA. All (100%) delivery agents thought the ASP has potential to successfully mitigate the burden of groin problems, with 11 (38%) perceiving the groin problem mitigation as large and 18 (62%) perceiving it as moderate. Beliefs about the ASP´s effect on player availability can be viewed in Figure 1.

[INSERT FIGURE 1 WITH LEGEND HERE]

Adoption and implementation of the ASP

All (100%) delivery agents had adopted the ASP in their team the current season, of which three (10%) replied that their usage was in accordance with the original ASP protocol. How the teams reported the usage of the ASP in terms of exercise frequency, sets and repetitions, is shown in Table 2 and 3 for pre-season and in-season, respectively.

Table 2: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***pre-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than 3 times a week	2 (7)
3 times a week	4 (14)
Twice a week	16 (55)
Once a week	5 (17)
We carried out the program, but less than once a week	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	8 (28)
2 sets per side	17 (59)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions each week	1 (3)
12-15 repetitions each week	3 (10)
7-10 repetitions each week	16 (55)
3-5 repetitions each week	1 (3)
3-15 repetitions, weekly progressive as in protocol	3 (10)
3-15 repetitions, weekly progressive as own modification	5 (17)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

Table 3: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***in-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than once a week	9 (31)
Once a week	16 (55)
Once every two weeks	2 (7)
We carried out the program, but less than once every two weeks	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	7 (24)
2 sets per side	18 (62)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions	1 (3)
12-15 repetitions	6 (21)
8-11 repetitions	14 (48)
4-7 repetitions	8 (28)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

The most often-used ASP modifications are summed up in Table 4, which is the identified real-world application of the ASP protocol used in a professional team setting.

Table 4: *Adductor Strengthening Programme- real-world application in Norwegian male professional football teams*

Adductor Strengthening Programme – real-world application			
Week	Sessions per week	Sets per side	Repetitions per side
Pre-season – week 1-8	2	2	7-10
In-season – all weeks	1	2	8-11

Maintenance of the ASP

Twenty-eight (97%) delivery agents planned to continue using the ASP in the subsequent season, of which 20 (71%) planned using a modified protocol.

Facilitators and barriers to implementation of the ASP

The most often stated reasons to use the ASP were first, the documented preventive effect of the ASP (100%, both in current and subsequent season) and second, that no additional equipment is needed (52% in current and 43% in subsequent season) (Figure 2). On an open-ended non-mandatory question, four respondents (27%) defined an indirect performance enhancing effect as an additional positive effect of ASP. Five (31%) respondents described the ASP progression levels as being too demanding, while four (25%) thought it was likely to cause muscle soreness. Two of these four respondents indicated soreness was the reason for modifying the original ASP protocol.

[INSERT FIGURE 2 WITH LEGEND HERE]

DISCUSSION

The primary aim of the present study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour regarding the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. A secondary aim was to

identify a real-world application of the ASP used in a professional team setting. The main findings were that all delivery agents were aware of the ASP, all thought the programme can mitigate the burden of groin problems, all stated to use the ASP in their team the current season and, almost everyone planned to continue using it in the subsequent season. However, only 10% used the ASP in accordance with the original ASP protocol.

Reach and effectiveness

Having a targeted population to recognize injury risk, to be aware of relevant injury prevention exercises or programs, and to acknowledge the exercise's or program's ability to mitigate the injury risk, are vital for successful real-world implementation of effective injury prevention exercise programs.[9 16-18 19 20] The surveyed delivery agents´ belief that players are at moderate to great risk of groin problems aligns well with epidemiological data.[1 3 21] The reported awareness level of ASP on the other hand is higher than previously reported for the CA[12] and the injury prevention exercise programme, FIFA 11+.[22] Discrepancies in awareness levels between members of the team around the players may be due to, unlike the current study surveying mostly physiotherapists, comparable studies having primarily surveyed head coaches which clearly also have other responsibilities besides being updated on injury prevention exercises and measures.

All delivery agents considering the ASP as capable of mitigating the burden of groin problems aligns with its evidence-based effect, and coincides with previously reported perceptions of the CA.[12] Moreover, the high ASP awareness level and the positive attitude towards its efficacy implies that the ASP dissemination strategies have been successful within this specific population of clinicians.

Adoption

All respondents reported using the ASP throughout the season. This is a similar finding to the adoption rate seen for the CA[12] in male professional football, when only accounting for users being aware of the exercise. Compared to what has been reported for the Nordic Hamstring (NH) exercise[23] in male professional football however, the ASP adoption rate is substantially higher. Interestingly, all respondents stated that the evidence-based efficacy of the ASP was an important reason for choosing to adopt the programme. Why the ASP seems easier adopted

than the NH is undiscovered, as they share the same main characteristics, e.g., able to be performed pitch-side without equipment and both having evidence-based injury preventative effect.

Implementation

When implementing the programme, the current study shows that delivery agents in professional football usually modify the ASP to fit their team's training philosophy and schedule. Similar findings have been demonstrated for the NH[23 24] and the FIFA 11+.[25 26] So far, no other studies on specific modifications of single-exercise injury prevention programmes exist.

The original ASP protocol[2] prescribes a pre-season strengthening phase containing a detailed eight-week progression, and an in-season maintenance phase with a continuous number of repetitions. The intention is first, to provide hip adductor muscle strength gains, and second, to maintain the increased muscle strength, as reduced hip adductor muscle strength is the only consistently reported risk factor for groin injury in sports.[27]

Compared to the original programme, in total, the delivery agents usually prescribed slightly more repetitions per session, but divided into two sets, especially during in-season. Furthermore, they generally conducted fewer sessions per week during pre-season, and the vast majority did not adopt the eight-week progression recommended for pre-season.

We did not investigate why the delivery agents modified the ASP. However, a potential reason for non-progression during pre-season strengthening phase might be that the delivery agents consider most professional players to already have gained, and maintained, adequate hip adductor muscle strength. This would limit the delivery agent's perceived need for players to commence a progressive strengthening phase. Another reason for the modifications of the ASP could also be lack of support and acceptance from players and/or coaches. Such support is considered a key facilitator in the implementation process[9 22] and, motivation to comply with the original ASP protocol has already been shown to be low among players.[11] A reason for modifying previous injury prevention strengthening exercises has been attributed to a possible fear of muscle soreness.[13 28] However, only two respondents reported to have modified the ASP partly due to such fear, and there is evidence that even the most strenuous

level of the ASP barely caused any reported muscle soreness if the number of repetitions was progressed gradually.[29 30] Consequently, fear of muscle soreness seems to not be an important barrier to optimal ASP implementation in the real-world setting.

Effectiveness of the real-world application of the ASP

An important aspect is that the delivery agents modify the ASP without knowing the impact. As mentioned, the ASP aims to mitigate groin problems by targeting hip adductor muscle strength. There is compelling evidence that muscle strength effects are dose dependent,[31] which also has been suggested for the CA.[32] The reported used pre-season ASP exercise volume is approximately 640 repetitions during eight weeks, which, interestingly, is a higher volume than what the evidence-based original ASP protocol prescribes (470 repetitions).[2] Moreover, it accommodates a suggested minimum of 500-800 repetitions during eight weeks, when aiming to facilitate meaningful hip adductor muscle strength gains.[32] Since the reported used weekly in-season ASP exercise volume is almost equal to pre-season, it is reasonable to assume that players somewhat maintain their hip adductor muscle strength during in-season.

Beyond volume considerations, progression seems required to elicit the greatest strength training gains.[33] As the ASP consists of a bodyweight exercise, weekly increase in the number of repetitions is the main progression variable. A critical assessment is therefore whether the reported lack of pre-season progression can reduce the ASP´s effectiveness in groin problem mitigation. Additionally, muscle strength gains also depends on recruitment of high-threshold motor units, through accumulation of neuromuscular fatigue induced when performing sets to at least somewhat near neuromuscular failure.[34] Therefore, another critical assessment would be whether more sets but fewer repetitions per set, as respondents have reported, affect the ASP´s effectiveness.

So far, changes in physiological characteristics when performing the ASP, such as effects on muscle cross-sectional area and architecture, musculotendinous stiffness, and motor unit recruitment and synchronization,[33] have not been scientifically investigated. Similarly, the exact dose-response relationship between ASP exercise volume and hip adductor muscle strength gains, and between ASP exercise volume and groin injury mitigation rates also remains to be investigated. And lastly, the importance of a progression strengthening phase(s)

when aiming to mitigate groin problems, is unknown. Discussions around the most often-used modification's impact on the ASP´s effectiveness are therefore currently theoretical, only.

Consequently, we will argue that there is no convincing evidence claiming that the ASP modifications applied by the delivery agents affect the mitigation of groin problems in male professional players, compared to the original protocol. Additionally, considerations on ASP exercise volume and other modifications are subordinated to the fact that no injury prevention programme will reach its full potential unless it is implemented, adopted, and maintained, by teams in the real-world setting.[20]

Maintenance

To be successful, the final step of any injury prevention exercise implemented in the real-world setting is that the exercise or the program is maintained over multiple seasons. In our study, nearly all respondents planned to continue using the ASP in the subsequent season, representing a considerably higher maintenance level than previously reported.[11] A particular challenge, however, is that team staff members, including medical staff, are frequently replaced when managers are replaced, increasing the risk of preventative measures not being persistently maintained over time.[20] It is yet to be confirmed whether ASP has been established as part of the teams´ or clubs´ sports plans or policies on injury prevention measures.

Methodological considerations

The high response rate (91%) is a strength of this study. However, it is uncertain whether our results can be generalised to other delivery agents and professional football settings outside Norway. Especially, considering that the literature on ASP and the CA primarily has been conducted in Norway and Denmark. A further strength of the current study is the pilot testing of the questionnaire ensuring valuable input to the final questionnaire. A limitation is that the internal validity of the questionnaire was not systematically explored, which is a prerequisite to draw firm valid conclusions.[35] The pilot study ensured, however, some degree of internal validity, by providing adequate understanding and readability of the questionnaire dimensions. Furthermore, questions related to the "implementation" dimensions, especially regarding the pre-season application of the ASP, are prone to some degree of recall bias as the

survey was conducted towards the end of the competitive season.[36] Therefore, this study describes how the teams in overall perform the ASP, only, while it is likely that the programme was individualised depending on players previous injury record and experience with specific strength exercises. Moreover, this study did not include a question about delivery agents' perceived involvement in and support from players and coaches, which is considered a key facilitator to successful implementation in the real-world football setting.[9]

Importantly, 79% of the respondents had a defined team staff role as a physiotherapist. This contrasts with previous studies, where surveyed delivery agents were either strength and conditioning coaches, head coaches or medical doctors.[22 23 28 37 38] It cannot be ruled out that some of the discrepancies in attitudes, beliefs and behaviour between the present and previous studies are due to differences in the participant's formal team staff role and educational background.

PERSPECTIVES

The delivery agents are aware of the ASP, they have adopted it, and they anticipate maintaining the usage. The implementation of the programme, however, is slightly different in each team. Further studies are warranted to acquire knowledge about why the ASP is being modified, and the impact of the modifications on the ASP´s effectiveness. As this in previous studies primarily has been conducted in male adult teams, future studies should include women's and youth football, too. Also, widespread dissemination of the ASP outside the Scandinavian countries is needed is to achieve reach world-wide. Finally, as recommended,[9] similar investigations of attitudes, beliefs, and behaviour to the ASP among other stakeholder, e.g. coaches, club officials and relevant sporting organisations, are needed in order to further explore the complexity of introducing preventative measures in the real-world professional setting.

CONCLUSION

The present study found that delivery agents of injury prevention exercises in Norwegian male professional football teams have positive attitudes and beliefs to the ASP, using it

frequently and planning to maintain the usage of it in the subsequent season. Most delivery agents, however, instructed players to complete the ASP with modifications. Therefore, we have identified a real-world application of the ASP protocol used in a professional team setting.

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Competing interests

None declared

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Author contributions

All authors planned the study. The data collection and the data analysis were done by JS. All authors have been involved in the drafting and revision of the manuscript, and all have approved the final version.

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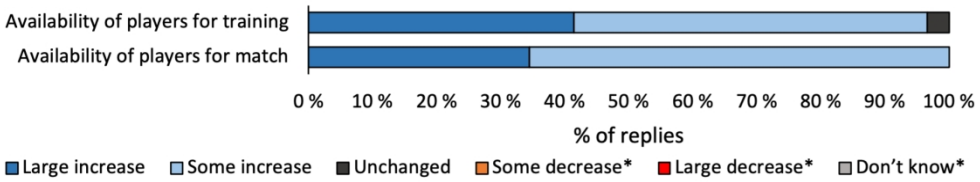

Figure 1: Beliefs regarding whether Adductor Strengthening Programme can influence availability of players in training and match-play. *No respondent replied some decrease, large decrease or don't know.

382x75mm (130 x 130 DPI)

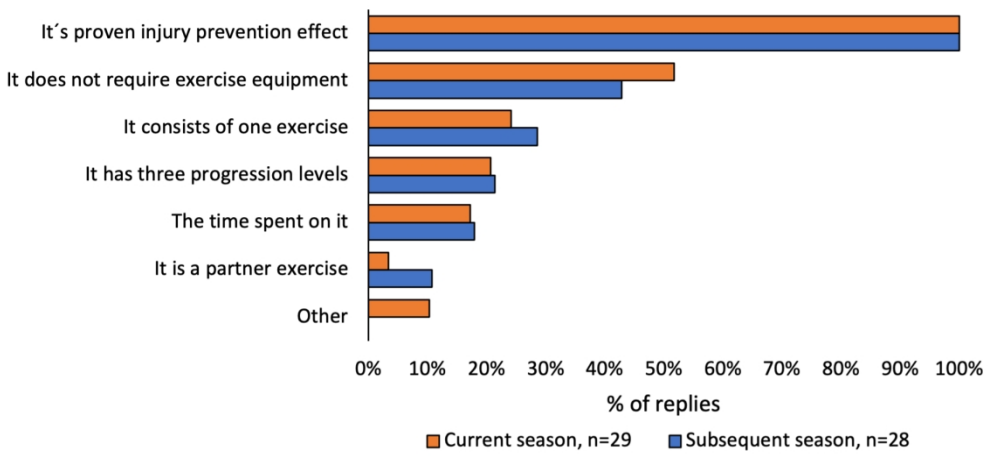

Figure 2: Reasons for choosing to use the Adductor Strengthening Programme this season and reasons for planning using the programme the following season.

372x174mm (130 x 130 DPI)

Questionnaire

Have you read and approved the informed consent?

- ☐ Yes

1. What is your age?
   - ☐ 18-30 years
   - ☐ 31-45 years
   - ☐ 46-60 years
   - ☐ More than 60 years

2. At what level does the team where you are employed play?
   - ☐ Eliteserien (Norwegian Premier League)
   - ☐ OBOS-ligaen (Norwegian First Division)

3. What is your role in the team staff where you are employed?
   - ☐ Head coach
   - ☐ Assistant coach
   - ☐ Fitness coach
   - ☐ Physiotherapist
   - ☐ Medical doctor
   - ☐ Other healthcare profession (specify) _____
   - ☐ Other position (specify) _____

4. What education and / or courses do you have?
   It is possible to check several options
   - ☐ UEFA PRO License
   - ☐ UEFA A License
   - ☐ UEFA B License
   - ☐ One-year study in sport science
   - ☐ Bachelor's degree in sport science
   - ☐ Master's degree in sport science
   - ☐ Bachelor's degree in a health profession
   - ☐ Master's degree in a health profession
   - ☐ Other education and/or courses (specify) _____

5. How many years of experience do you have as delivery agent of preventative training for football players?
   - ☐ 0-4 years
   - ☐ 5-9 years
   - ☐ 10-14 years
   - ☐ 15-20 years
   - ☐ More than 20 years

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/cathing or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

6. How much risk do you think football players have getting groin problems?
   - ☐ Great risk
   - ☐ Moderate risk
   - ☐ Small risk
   - ☐ No risk
   - ☐ Don't know

7. How important do you think it is to perform preventative training to mitigate groin problems?
   - ☐ Greatly important
   - ☐ Moderately important
   - ☐ A little important
   - ☐ Not important
   - ☐ Don't know

8. Were you aware of the "Adductor Strengthening Programme" and/or the "Copenhagen Adduction" exercise prior to reading the information in the introduction to this questionnaire?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

9. Where did you get information about the “Adductor Strengthening Programme” and/or the "Copenhagen Adduction Exercise"?
   It is possible to check several options
   - ☐ “Skadefri” website
   - ☐ “Skadefri” application
   - ☐ Article in the British Journal of Sports Medicine
   - ☐ Conference/course
   - ☐ Infographics
   - ☐ Social media (Twitter, Facebook, Instagram etc.)
   - ☐ Other (specify) _____
   - ☐ Don’t know

10. Check if you are aware that you can find information about the “Adductor Strengthening Programme” and/or the «Copenhagen Adduction Exercise» in these relevant places:
    It is possible to check several options
    - ☐ “Skadefri” website
    - ☐ “Skadefri” application
    - ☐ Article in the British Journal of Sports Medicine
    - ☐ Infographics
    - ☐ Social media (Twitter, Facebook, Instagram etc.)
    - ☐ Other (specify) _____

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/catching or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

11. Do you think that the “Adductor Strengthening Programme” can influence the burden of groin problems?
    - ☐ Yes, the program can greatly mitigate the burden
    - ☐ Yes, the program can moderately mitigate the burden
    - ☐ No, the program cannot have an effect on the burden
    - ☐ Yes, the program can moderately aggravate the burden
    - ☐ Yes, the program can greatly aggravate the burden
    - ☐ Don’t know

12. Do you think that the “Adductor Strengthening Programme” can influence football performance?
    - ☐ Yes, the program can greatly increase performance
    - ☐ Yes, the program can moderately increase performance
    - ☐ No, the program cannot have an effect on performance
    - ☐ Yes, the program can moderately decrease performance
    - ☐ Yes, the program can greatly decrease performance
    - ☐ Don’t know

How do you think the following of the players' physical skills may be affected by doing the “Adductor Strengthening Programme”?

13. Linear acceleration?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

14. Top speed?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

15. Change of direction?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

16. Vertical jump ability?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

17. Duelling power?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

How do you think other factors can may be affected by doing the "Adductor Strengthening Programme":

18. Availability of players for match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

19. Availability of players for training?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

20. Chance of winning a match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

21. What other positive characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

22. What other negative characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

23. Do you use the "Adductor Strengthening Programme" in your team?
- ☐ Yes, as described in the protocol
- ☐ Yes, as modified version
- ☐ No
- ☐ Don't know

24. How do you use the "Adductor Strengthening Programme" in your training schedule?
- ☐ As part of organised football training
- ☐ As part of organised strength training
- ☐ As an independent preparation in the locker room or strength room before training
- ☐ As guided preparation in the locker room or strength room before training
- ☐ As independent training in a separate strength training session
- ☐ Other way (specify) _____

When using the "Adductor Strengthening Programme" in season (under normal circumstances, not influenced by covid-19):

25. How often did the players perform the program?
- ☐ More than once a week
- ☐ Once a week
- ☐ Once every two weeks
- ☐ We carried out the program, but less than once every two weeks

26. How many sets did the players perform?
- ☐ More than 2 sets per side
- ☐ 2 sets per side

- ☐ 1 set per side

27. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per side
    - ☐ 12-15 repetitions per side
    - ☐ 8-11 repetitions per side
    - ☐ 4-7 repetitions per side
    - ☐ Less than 4 repetitions per side

When using the "Adductor Strengthening Programme" in preseason (under normal circumstances, not influenced by covid-19):

28. How often did the players perform the program?
    - ☐ More than 3 times a week
    - ☐ 3 times a week
    - ☐ Twice a week
    - ☐ Once a week
    - ☐ We carried out the program, but less than once a week

29. How many sets did the players perform?
    - ☐ More than 2 sets per side
    - ☐ 2 sets per side
    - ☐ 1 set per side

30. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per set each week
    - ☐ 12-15 repetitions per set each week
    - ☐ 7-10 repetitions per set each week
    - ☐ 3-5 repetitions per set each week
    - ☐ 3-15 repetitions per set, weekly progressive (as in protocol)
    - ☐ 3-15 repetitions per set, weekly progressive (as own modification)

31. What has been important for you in choosing to use the "Adductor Strengthening Programme"?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The programme consists of one exercise
    - ☐ The programme consists of three progression levels
    - ☐ The programme is a partner exercise
    - ☐ The programme does not require exercise equipment
    - ☐ Other (specify) _____

32. Do you use other preventative training in addition to the "Adductor Strengthening Programme", with the intention to mitigate the burden of groin problems?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

33. What training do you use in addition to, or instead of, the "Adductor Strengthening Programme" to mitigate the burden of groin problems? Describe in your own words as detailed as possible which exercise (s), how they are performed, dosage (series, repetitions, intensity), and anything else you consider relevant.

34. Why did you choose to do what is described in the previous answer, and who participated in the decision? Describe in your own words.

35. Do you anticipate using the "Adductor Strengthening Programme" in your team the following season?
    - ☐ Yes, as described in the protocol
    - ☐ Yes, as an own modification
    - ☐ No
    - ☐ Don't know

36. What is the reason why you anticipate using the "Adductor Strengthening Programme" in your team in the following season?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The program consists of one exercise
    - ☐ The program consists of three progression levels
    - ☐ The program can be performed as a partner exercise
    - ☐ The program does not require exercise equipment
    - ☐ Other (specify) _____

37. What is the reason why you do not anticipate using the “Adductor Strengthening Programme” in your team in the following season?
It is possible to check several options

- ☐ The program's lack of injury prevention effect
- ☐ The time spent on the program
- ☐ The program consists of only one exercise
- ☐ The program consists of only three levels of difficulty
- ☐ The program can be performed as a partner exercise
- ☐ The program does not require exercise equipment
- ☐ Other (specify) _____

38. Do you have any suggestions for changes to the “Adductor Strengthening Programme” that may make it more relevant to use the program? Describe in your own words.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Ok

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Adductor Strengthening Programme is successfully adopted but frequently modified in Norwegian male professional football teams: a cross sectional study

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ABSTRACT

Objectives: Groin injuries represent a substantial problem in male football, with the Adductor Strengthening Programme (ASP) being the only exercise programme demonstrated to significantly reduce the risk of groin problems. We aimed first, to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among injury prevention delivery agents (i.e., staff with main responsibility for implementing and conducting injury prevention exercises). Secondly, we aimed to identify a real-world application of the ASP protocol used in a professional team setting.

Methods: A descriptive cross-sectional survey of 32 injury prevention delivery agents in Norwegian male professional football teams. The questionnaire was designed to cover all five dimensions of the Reach Adoption Effectiveness Implementation Maintenance (RE-AIM) framework and were pilot tested prior to the survey.

Results: Twenty-nine (91%) participants responded. All (100%) respondents were aware of the ASP and its potential to mitigate the burden of groin problems. The two most stated reasons for using the ASP were its injury preventive effect and that it does not require equipment. The ASP was adopted by all (100%) delivery agents, but only 10% used it in accordance with the original protocol. The main modifications were that the players in 72% of the teams were instructed to perform a non-progressive number of repetitions during pre-season, and in 86% of the teams instructed to perform more sets, but fewer repetitions per set, during in-season. In total, 97% of the delivery agents planned to continue using the ASP.

Conclusion: The delivery agents have positive attitudes and beliefs to the ASP, but they frequently modify it. We identified and reported a real-world application of the ASP protocol.

Key words: Football, groin injury, injury prevention, Adductor Strengthening Programme, Copenhagen Adduction, RE-AIM, implementation

Strengths and limitations of this study

- The questionnaire was pilot tested by delivery agents with relevant experience.
- Thorough data collection process leading to a high response rate.
- The internal validity of the questionnaire was not systematically explored.
- Some of the questionnaire's questions are prone to recall bias as the survey was conducted towards the end of the competitive season.

What is already known?

- The Adductor Strengthening Programme (ASP) prevents groin problems in football, and is suggested implemented in football training
- Many injury prevention programmes and exercises are not successfully implemented in a real-world setting, limiting their effectiveness
- Knowledge of attitudes, beliefs, and behaviour regarding injury prevention exercises is key for successful implementation

What are the new findings?

- Team staff responsible for injury prevention exercises in Norwegian male professional football teams are aware of and familiar with the ASP and it´s preventative effect
- The programme is widely adopted by all teams
- We have identified a real-world application of the programme used in a professional team setting

INTRODUCTION

Groin problems represent a substantial problem in football. They account for 4-19% and 2-11% of all time-loss injuries in male and female football, respectively[1]. Moreover, the average weekly proportion of male players with any groin problem causing pain and/or reduced performance is 21% in a full competitive season[2] and, 29% in periods with match congestion[3].

In a clinical trial, the Adductor Strengthening Programme (ASP) showed a significant 41% reduction in risk of groin problems in male semi-professional players performing the programme during one full season[2]. Consequently, dissemination and widespread implementation of the ASP in football training seems beneficial[2, 4]. The ASP is based on a single-exercise, the Copenhagen Adduction (CA) exercise[4], structured with three progression levels and a protocol with a pre-season and in-season exercise prescription. In the clinical trial, players completed on average about 70% of the recommended exercise prescription, demonstrating a considerably higher compliance than previous groin injury prevention programmes[5, 6]. The high compliance is an important strength of the ASP, as only injury prevention programmes that are successfully implemented (i.e. widely adopted, complied with and maintained over time) will reach effectiveness outside controlled clinical trials[7].

Gaining knowledge on attitudes, beliefs, and behaviour to injury prevention exercises are important when evaluating their implementation in the real-world setting[7]. For this purpose, integrating the Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) framework[8, 9] is recommended, ideally evaluated across all levels of the sport setting hierarchy[9]. In brief, the framework evaluates the proportion of a targeted population that is aware of a given intervention (Reach), the interventions positive outcomes (Effectiveness), the proportions that has adopted the intervention (Adoption) and implemented it as intended (Implementation), and the extent to which it is sustained (Maintenance)[8, 9]. Note that the specific RE-AIM implementation dimension refers to the extent to which an exercise or a programme is used as intended in the real-world setting[9]. The general term implementation

also used in this article, however, refers to all initiatives applied to put an exercise or a programme into practice[10].

Attitudes and beliefs towards the ASP is previously investigated among players participating in the clinical ASP trial[11]. The study revealed that only 31% of the players anticipated to continue using the ASP in accordance with the original protocol[11]. Also, a recent study on the CA among coaches in international male professional teams reported that 72% were aware of the exercise, while 94% of those had adopted it[12]. These findings are consistent with previous research emphasising that evidence-based injury prevention exercises can be challenging to apply in the real-world settings[13]. To enhance knowledge, we believed it was important to conduct a survey among team staff, specifically among those having the main responsibility for implementing and conducting injury prevention exercises (hereafter referred to as "delivery agents").

Therefore, the primary aim of this study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. The secondary aim was to identify a real-world application of the ASP protocol used in a professional team setting, which to our knowledge, previously has not been conducted for any single-exercise injury prevention programme.

METHODS

Study design and participants

This was a cross-sectional study conducted in September and October 2020. Participants were the primary delivery agent in each team in the top two divisions of Norwegian male professional football (n=32): Eliteserien (n=16) and OBOS-ligaen (n=16). The study was approved by the ethics board at the Norwegian School of Sport Sciences (134-130820) and by the Norwegian Centre for Research Data (NSD 2020/837286), and all respondents gave informed consent to participate. The study is described according to the STROBE statement checklist for cross-sectional studies[14].

Survey

A new questionnaire designed to cover all dimensions of the RE-AIM[8] framework was developed, based on previous questionnaires used in studies investigating implementation of preventative training in elite and sub-elite sport´s settings[11, 15]. The final version consisted of 38 questions, primarily closed-ended. The questionnaire was developed and delivered in Norwegian, however, a translated English version is provided as an appendix to this paper (Supplementary file 1).

Data collection

We collected contact information to the delivery agents either through our network of contacts or by contacting the team´s directly. All delivery agents received an email with detailed information about the study and a link with access to an online survey software (SurveyXact, Rambøll Management Consulting AS, Oslo). We distributed the questionnaire during an international break in September 2020. Weekly reminders were sent to non-responders by email for four weeks, and after five weeks, non-responders were contacted by telephone.

Analysis

We performed statistical analysis using SPSS statistical software (SPSS V24, IBM Corporation, Armonk, NY). Data consisted of categorical nominal variables, presented as proportions, including for the specific RE-AIM dimensions. Open-ended text responses were analysed with a quantitative content analysis[16], using a structured code form counting frequencies of variables mentioned. The code form was also used to categorise whether the participants had a positive, negative, or neutral attitude.

Patient and public involvement

Three experienced delivery agents (two physiotherapists and one football coach) not involved as participants did pilot test the questionnaire and gave feedback on its understanding and readability. Patients and/or the public were not involved in any other part of the conduct, or reporting, or dissemination plans of this research.

RESULTS

Participant characteristics

Twenty-nine (91%) of the 32 delivery agents participated in the survey (14 from Eliteserien and 15 from OBOS-ligaen). The non-responders gave no specific reasons for not participating. Twenty-three (79%) of the respondents were physiotherapists, five (17%) were strength and conditioning coaches and one (3%) was a naprapath. Respondents' experience as delivery agents in football is shown in Table 1.

Table 1: *Years of experience as delivery agents of injury prevention exercises in football*

Years of experience as delivery agent	**n (%)**
0-4 years	5 (17)
5-9 years	13 (45)
10-14 years	7 (24)
15-19 years	3 (10)
≥ 20 years	1 (3)

Attitudes to groin injury risk and importance of injury mitigation

Football players risk of getting a groin problem was assumed to be high or moderate by 19 (66%) and 9 (31%) delivery agents, respectively, while one respondent considered the risk to be low. All (100%) respondents thought prevention exercises to mitigate groin problems was important, replied by 27 (93%) as highly important and by 2 (7%) as moderately important.

Reach and effectiveness of the ASP

All (100%) respondents were aware of either one or both of ASP and the CA. All (100%) delivery agents thought the ASP has potential to successfully mitigate the burden of groin problems, with 11 (38%) perceiving the groin problem mitigation as large and 18 (62%) perceiving it as moderate. Beliefs about the ASP´s effect on player availability can be viewed in Figure 1.

[INSERT FIGURE 1 WITH LEGEND HERE]

Adoption and implementation of the ASP

All (100%) delivery agents had adopted the ASP in their team the current season, of which three (10%) replied that their usage was in accordance with the original ASP protocol. How the teams reported the usage of the ASP in terms of exercise frequency, sets and repetitions, is shown in Table 2 and 3 for pre-season and in-season, respectively.

Table 2: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***pre-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than 3 times a week	2 (7)
3 times a week	4 (14)
Twice a week	16 (55)
Once a week	5 (17)
We carried out the program, but less than once a week	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	8 (28)
2 sets per side	17 (59)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions each week	1 (3)
12-15 repetitions each week	3 (10)
7-10 repetitions each week	16 (55)
3-5 repetitions each week	1 (3)
3-15 repetitions, weekly progressive as in protocol	3 (10)
3-15 repetitions, weekly progressive as own modification	5 (17)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

Table 3: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***in-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than once a week	9 (31)
Once a week	16 (55)
Once every two weeks	2 (7)
We carried out the program, but less than once every two weeks	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**

More than 2 sets per side	7 (24)
2 sets per side	18 (62)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions	1 (3)
12-15 repetitions	6 (21)
8-11 repetitions	14 (48)
4-7 repetitions	8 (28)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

The most often-used ASP modifications are summed up in Table 4, which is the identified real-world application of the ASP protocol used in a professional team setting.

Table 4: *Adductor Strengthening Programme real-world application in Norwegian male professional football teams*

Adductor Strengthening Programme – real-world application			
Week	Sessions per week	Sets per side	Repetitions per side
Pre-season – week 1-8	2	2	7-10
In-season – all weeks	1	2	8-11

Maintenance of the ASP

Twenty-eight (97%) delivery agents planned to continue using the ASP in the subsequent season, of which 20 (71%) planned to use a modified protocol.

Facilitators and barriers to implementation of the ASP

The most often stated reasons to use the ASP were first, the documented preventive effect of the ASP (100%, both in current and subsequent season) and second, that no additional equipment is needed (52% in current and 43% in subsequent season) (Figure 2). On an open-ended non-mandatory question, four respondents (27%) defined an indirect performance enhancing effect as an additional positive effect of ASP. Five (31%) respondents described the ASP progression levels as being too demanding, while four (25%) thought it was likely to cause muscle soreness. Two of these four respondents indicated soreness was the reason for modifying the original ASP protocol.

[INSERT FIGURE 2 WITH LEGEND HERE]

DISCUSSION

The primary aim of the present study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour regarding the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. A secondary aim was to identify a real-world application of the ASP used in a professional team setting. The main findings were that all delivery agents were aware of the ASP, all thought the programme can mitigate the burden of groin problems, all stated to use the ASP in their team the current season and, almost everyone planned to continue using it in the subsequent season. However, only 10% used the ASP in accordance with the original ASP protocol.

Reach and effectiveness

Having a targeted population to recognize injury risk, to be aware of relevant injury prevention exercises or programs, and to acknowledge the exercise's or program's ability to mitigate the injury risk, are vital for successful real-world implementation of effective injury prevention exercise programs[9, 17-20]. The surveyed delivery agents´ belief that players are at moderate to great risk of groin problems aligns well with epidemiological data[1, 3, 21]. The reported awareness level of ASP on the other hand is higher than previously reported for the CA[12] and the injury prevention exercise programme, FIFA 11+[22]. Discrepancies in awareness levels between members of the team around the players may be due to, unlike the current study surveying mostly physiotherapists, comparable studies having primarily surveyed head coaches which clearly also have other responsibilities besides being updated on injury prevention exercises and measures.

All delivery agents considering the ASP as capable of mitigating the burden of groin problems aligns with its evidence-based effect, and coincides with previously reported perceptions of the CA[12]. Moreover, the high ASP awareness level and the positive attitude towards its efficacy implies that the ASP dissemination strategies have been successful within this specific population of clinicians.

Adoption

All respondents reported using the ASP throughout the season. This is a similar finding to the adoption rate seen for the CA[12] in male professional football, when only accounting for users being aware of the exercise. Compared to what has been reported for the Nordic Hamstring (NH) exercise[23] in male professional football however, the ASP adoption rate is substantially higher. Interestingly, all respondents stated that the evidence-based efficacy of the ASP was an important reason for choosing to adopt the programme. The discrepancy in ASP and NH adoption rates are interesting, as they share the same exercise characteristics, and both were originally studied in clinical trials including Norwegian male football teams[2, 23]. One variation, however, that may explain some of the discrepancy in adoption rates is the six-year's difference between our data collection and the data collection of the NH adoption[24]. This is likely due to evidence-based efforts to prevent injuries having improved among practitioners in elite teams in recent years[25].

Implementation

When implementing the programme, the current study shows that delivery agents in professional football usually modify the ASP to fit their team's training philosophy and schedule. Similar findings have been demonstrated for the NH[24, 26] and the FIFA 11+[27, 28]. So far, no other studies on specific modifications of single-exercise injury prevention programmes exist.

The original ASP protocol[2] prescribes a pre-season strengthening phase containing a detailed eight-week progression, and an in-season maintenance phase with a continuous number of repetitions. The intention is first, to provide hip adductor muscle strength gains, and second, to maintain the increased muscle strength, as reduced hip adductor muscle strength is the only consistently reported risk factor for groin injury in sports[29].

Compared to the original programme, in total, the delivery agents usually prescribed slightly more repetitions per session, but divided into two sets, especially during in-season. Furthermore, they generally conducted fewer sessions per week during pre-season, and the vast majority did not adopt the eight-week progression recommended for pre-season.

We did not investigate why the delivery agents modified the ASP. However, a potential reason for non-progression during pre-season strengthening phase might be that the delivery

agents consider most professional players to already have gained, and maintained, adequate hip adductor muscle strength. This would limit the delivery agent's perceived need for players to commence a progressive strengthening phase. Another reason for the modifications of the ASP could also be lack of support and acceptance from players and/or coaches. Such support is considered a key facilitator in the implementation process[9, 22] and, motivation to comply with the original ASP protocol has already been shown to be low among players[11]. A reason for modifying previous injury prevention strengthening exercises has been attributed to a possible fear of muscle soreness[13, 30]. However, only two respondents reported to have modified the ASP partly due to such fear, and there is evidence that even the most strenuous level of the ASP barely caused any reported muscle soreness if the number of repetitions was progressed gradually[31, 32]. Consequently, fear of muscle soreness seems to not be an important barrier to optimal ASP implementation in the real-world setting.

Effectiveness of the real-world application of the ASP

An important aspect is that the delivery agents modify the ASP without knowing the impact. As mentioned, the ASP aims to mitigate groin problems by targeting hip adductor muscle strength. There is compelling evidence that muscle strength effects are dose dependent[33], which also has been suggested for the CA[34]. The reported used pre-season ASP exercise volume is approximately 640 repetitions during eight weeks, which, interestingly, is a higher volume than what the evidence-based original ASP protocol prescribes (470 repetitions)[2]. Moreover, it accommodates a suggested minimum of 500-800 repetitions during eight weeks, when aiming to facilitate meaningful hip adductor muscle strength gains[34]. Since the reported used weekly in-season ASP exercise volume is almost equal to pre-season, it is reasonable to assume that players somewhat maintain their hip adductor muscle strength during in-season.

Beyond volume considerations, progression seems required to elicit the greatest strength training gains[35]. As the ASP consists of a bodyweight exercise, weekly increase in the number of repetitions is the main progression variable. A critical assessment is therefore whether the reported lack of pre-season progression can reduce the ASP´s effectiveness in groin problem mitigation. Additionally, muscle strength gains also depends on recruitment of high-threshold motor units, through accumulation of neuromuscular fatigue induced when performing sets to at least somewhat near neuromuscular failure[36]. Therefore, another

critical assessment would be whether more sets but fewer repetitions per set, as respondents have reported, affect the ASP´s effectiveness.

So far, changes in physiological characteristics when performing the ASP, such as effects on muscle cross-sectional area and architecture, musculotendinous stiffness, and motor unit recruitment and synchronization[35], have not been scientifically investigated. Similarly, the exact dose-response relationship between ASP exercise volume and hip adductor muscle strength gains, and between ASP exercise volume and groin injury mitigation rates also remains to be investigated. And lastly, the importance of a progression strengthening phase(s) when aiming to mitigate groin problems, is unknown. Discussions around the most often-used modification's impact on the ASP´s effectiveness are therefore currently theoretical, only.

Consequently, we will argue that there is no convincing evidence claiming that the ASP modifications applied by the delivery agents affect the mitigation of groin problems in male professional players, compared to the original protocol. Additionally, considerations on ASP exercise volume and other modifications are subordinated to the fact that no injury prevention programme will reach its full potential unless it is implemented, adopted, and maintained, by teams in the real-world setting[19].

Maintenance

To be successful, the final step of any injury prevention exercise implemented in the real-world setting is that the exercise or the program is maintained over multiple seasons. In our study, nearly all respondents planned to continue using the ASP in the subsequent season, representing a considerably higher maintenance level than previously reported[11]. A particular challenge, however, is that team staff members, including medical staff, are frequently replaced when managers are replaced, increasing the risk of preventative measures not being persistently maintained over time[19]. It is yet to be confirmed whether ASP has been established as part of the teams´ or clubs´ sports plans or policies on injury prevention measures.

Methodological considerations

The high response rate (91%) is a strength of this study. However, it is uncertain whether our results can be generalised to other delivery agents and professional football settings outside Norway. Especially, considering that the original ASP intervention study was conducted among Norwegian male football teams. This may have led to a "word of mouth" effect in the Norwegian football community, which to some extent can explain the higher ASP awareness level and adoption rates in this study.

A further strength of the current study is the pilot testing of the questionnaire ensuring valuable input to the final questionnaire. A limitation is that the internal validity of the questionnaire was not systematically explored, which is a prerequisite to draw firm valid conclusions[37]. The pilot study ensured, however, some degree of internal validity, by providing adequate understanding and readability of the questionnaire dimensions. Furthermore, questions related to the "implementation" dimensions, especially regarding the pre-season application of the ASP, are prone to some degree of recall bias as the survey was conducted towards the end of the competitive season[38]. Therefore, this study describes how the teams in overall perform the ASP, only, while it is likely that the programme was individualised depending on players previous injury record and experience with specific strength exercises. Moreover, this study did not include a question about delivery agents' perceived involvement in and support from players and coaches, which is considered a key facilitator to successful implementation in the real-world football setting[9].

Importantly, 79% of the respondents had a defined team staff role as a physiotherapist. This contrasts with previous studies, where surveyed delivery agents were either strength and conditioning coaches, head coaches or medical doctors[22, 26, 30, 39, 40]. In contrast to the other members of the medical and coaching staff, physiotherapists are educated and trained in health science with special emphasis on injury prevention and rehabilitation. Therefore, it is not unlikely that some of the variations in attitudes, beliefs and behaviour between the present and previous studies are due to differences in the participant's formal team staff role and educational background.

Regarding data collection methods, we chose to develop and conduct a survey for the following reasons. Firstly, a survey is an appropriate tool to collect responses from

individuals living in a widespread geographical area. Secondly, it is suitable when investigating several variables at the same time, such as all the RE-AIM dimensions, and thirdly, a survey provides a cost-effective and relatively seamless data collection method. Therefore, a survey using a questionnaire was considered appropriate to accommodate the research questions in our study.

PERSPECTIVES

The delivery agents are aware of the ASP, they have adopted it, and they anticipate maintaining the usage. The implementation of the programme, however, is slightly different in each team. Further studies are warranted to acquire knowledge about why the ASP is being modified, and the impact of the modifications on the ASP´s effectiveness. As this in previous studies primarily has been conducted in male adult teams, future studies should include women's and youth football, too. Also, widespread dissemination of the ASP outside the Scandinavian countries is needed is to achieve reach world-wide. Finally, as recommended[9], similar investigations of attitudes, beliefs, and behaviour to the ASP among other stakeholder, e.g. coaches, club officials and relevant sporting organisations, are needed in order to further explore the complexity of introducing preventative measures in the real-world professional setting.

CONCLUSION

The present study found that delivery agents of injury prevention exercises in Norwegian male professional football teams have positive attitudes and beliefs to the ASP, using it frequently and planning to maintain the usage of it in the subsequent season. Most delivery agents, however, instructed players to complete the ASP with modifications. Therefore, we have identified a real-world application of the ASP protocol used in a professional team setting.

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Competing interests

None declared

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Author contributions

All authors planned the study. The data collection and the data analysis were done by JS. All authors have been involved in the drafting and revision of the manuscript, and all have approved the final version.

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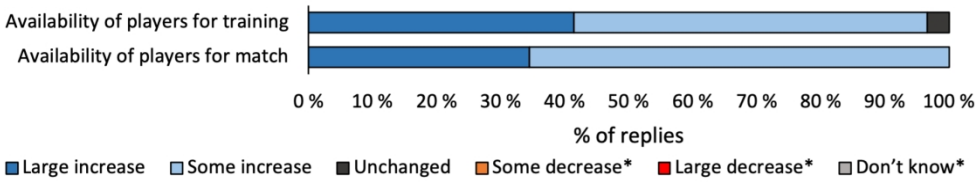

Figure 1: Beliefs regarding whether Adductor Strengthening Programme can influence availability of players in training and match-play. *No respondent replied some decrease, large decrease or don't know.

382x75mm (130 x 130 DPI)

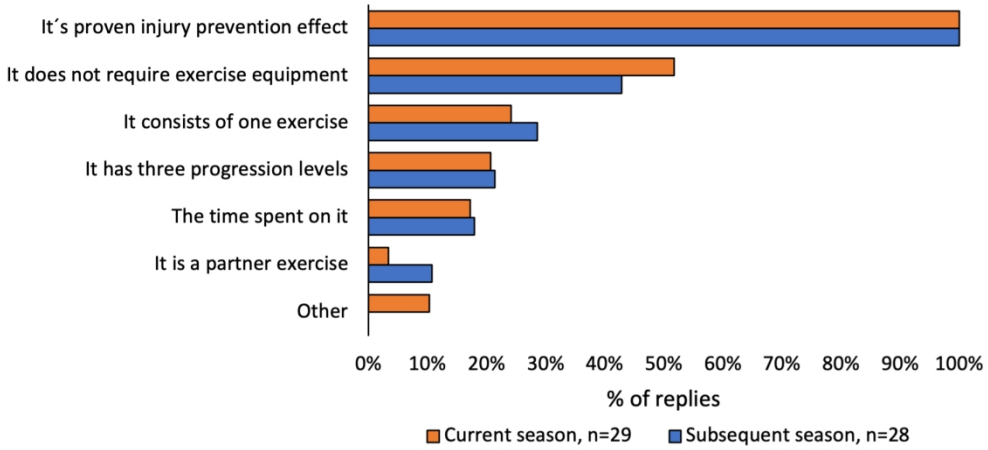

Figure 2: Reasons for choosing to use the Adductor Strengthening Programme this season and reasons for planning using the programme the following season.

372x174mm (130 x 130 DPI)

Questionnaire

Have you read and approved the informed consent?

- ☐ Yes

1. What is your age?
   - ☐ 18-30 years
   - ☐ 31-45 years
   - ☐ 46-60 years
   - ☐ More than 60 years

2. At what level does the team where you are employed play?
   - ☐ Eliteserien (Norwegian Premier League)
   - ☐ OBOS-ligaen (Norwegian First Division)

3. What is your role in the team staff where you are employed?
   - ☐ Head coach
   - ☐ Assistant coach
   - ☐ Fitness coach
   - ☐ Physiotherapist
   - ☐ Medical doctor
   - ☐ Other healthcare profession (specify) _____
   - ☐ Other position (specify) _____

4. What education and / or courses do you have?
   It is possible to check several options
   - ☐ UEFA PRO License
   - ☐ UEFA A License
   - ☐ UEFA B License
   - ☐ One-year study in sport science
   - ☐ Bachelor's degree in sport science
   - ☐ Master's degree in sport science
   - ☐ Bachelor's degree in a health profession
   - ☐ Master's degree in a health profession
   - ☐ Other education and/or courses (specify) _____

5. How many years of experience do you have as delivery agent of preventative training for football players?
   - ☐ 0-4 years
   - ☐ 5-9 years
   - ☐ 10-14 years
   - ☐ 15-20 years
   - ☐ More than 20 years

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/cathing or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

6. How much risk do you think football players have getting groin problems?
   - ☐ Great risk
   - ☐ Moderate risk
   - ☐ Small risk
   - ☐ No risk
   - ☐ Don't know

7. How important do you think it is to perform preventative training to mitigate groin problems?
   - ☐ Greatly important
   - ☐ Moderately important
   - ☐ A little important
   - ☐ Not important
   - ☐ Don't know

8. Were you aware of the "Adductor Strengthening Programme" and/or the "Copenhagen Adduction" exercise prior to reading the information in the introduction to this questionnaire?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

9. Where did you get information about the “Adductor Strengthening Programme” and/or the "Copenhagen Adduction Exercise"?
   It is possible to check several options
   - ☐ “Skadefri” website
   - ☐ “Skadefri” application
   - ☐ Article in the British Journal of Sports Medicine
   - ☐ Conference/course
   - ☐ Infographics
   - ☐ Social media (Twitter, Facebook, Instagram etc.)
   - ☐ Other (specify) _____
   - ☐ Don’t know

10. Check if you are aware that you can find information about the “Adductor Strengthening Programme” and/or the «Copenhagen Adduction Exercise» in these relevant places:
    It is possible to check several options
    - ☐ “Skadefri” website
    - ☐ “Skadefri” application
    - ☐ Article in the British Journal of Sports Medicine
    - ☐ Infographics
    - ☐ Social media (Twitter, Facebook, Instagram etc.)
    - ☐ Other (specify) _____

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/catching or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

11. Do you think that the “Adductor Strengthening Programme” can influence the burden of groin problems?
    - ☐ Yes, the program can greatly mitigate the burden
    - ☐ Yes, the program can moderately mitigate the burden
    - ☐ No, the program cannot have an effect on the burden
    - ☐ Yes, the program can moderately aggravate the burden
    - ☐ Yes, the program can greatly aggravate the burden
    - ☐ Don’t know

12. Do you think that the “Adductor Strengthening Programme” can influence football performance?
    - ☐ Yes, the program can greatly increase performance
    - ☐ Yes, the program can moderately increase performance
    - ☐ No, the program cannot have an effect on performance
    - ☐ Yes, the program can moderately decrease performance
    - ☐ Yes, the program can greatly decrease performance
    - ☐ Don’t know

How do you think the following of the players' physical skills may be affected by doing the “Adductor Strengthening Programme”?

13. Linear acceleration?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

14. Top speed?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

15. Change of direction?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

16. Vertical jump ability?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

17. Duelling power?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

How do you think other factors can may be affected by doing the "Adductor Strengthening Programme":

18. Availability of players for match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

19. Availability of players for training?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

20. Chance of winning a match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

21. What other positive characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

22. What other negative characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

23. Do you use the "Adductor Strengthening Programme" in your team?
- ☐ Yes, as described in the protocol
- ☐ Yes, as modified version
- ☐ No
- ☐ Don't know

24. How do you use the "Adductor Strengthening Programme" in your training schedule?
- ☐ As part of organised football training
- ☐ As part of organised strength training
- ☐ As an independent preparation in the locker room or strength room before training
- ☐ As guided preparation in the locker room or strength room before training
- ☐ As independent training in a separate strength training session
- ☐ Other way (specify) _____

When using the "Adductor Strengthening Programme" in season (under normal circumstances, not influenced by covid-19):

25. How often did the players perform the program?
- ☐ More than once a week
- ☐ Once a week
- ☐ Once every two weeks
- ☐ We carried out the program, but less than once every two weeks

26. How many sets did the players perform?
- ☐ More than 2 sets per side
- ☐ 2 sets per side

- ☐ 1 set per side

27. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per side
    - ☐ 12-15 repetitions per side
    - ☐ 8-11 repetitions per side
    - ☐ 4-7 repetitions per side
    - ☐ Less than 4 repetitions per side

When using the "Adductor Strengthening Programme" in preseason (under normal circumstances, not influenced by covid-19):

28. How often did the players perform the program?
    - ☐ More than 3 times a week
    - ☐ 3 times a week
    - ☐ Twice a week
    - ☐ Once a week
    - ☐ We carried out the program, but less than once a week

29. How many sets did the players perform?
    - ☐ More than 2 sets per side
    - ☐ 2 sets per side
    - ☐ 1 set per side

30. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per set each week
    - ☐ 12-15 repetitions per set each week
    - ☐ 7-10 repetitions per set each week
    - ☐ 3-5 repetitions per set each week
    - ☐ 3-15 repetitions per set, weekly progressive (as in protocol)
    - ☐ 3-15 repetitions per set, weekly progressive (as own modification)

31. What has been important for you in choosing to use the "Adductor Strengthening Programme"?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The programme consists of one exercise
    - ☐ The programme consists of three progression levels
    - ☐ The programme is a partner exercise
    - ☐ The programme does not require exercise equipment
    - ☐ Other (specify) _____

32. Do you use other preventative training in addition to the "Adductor Strengthening Programme", with the intention to mitigate the burden of groin problems?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

33. What training do you use in addition to, or instead of, the "Adductor Strengthening Programme" to mitigate the burden of groin problems? Describe in your own words as detailed as possible which exercise (s), how they are performed, dosage (series, repetitions, intensity), and anything else you consider relevant.

34. Why did you choose to do what is described in the previous answer, and who participated in the decision? Describe in your own words.

35. Do you anticipate using the "Adductor Strengthening Programme" in your team the following season?
    - ☐ Yes, as described in the protocol
    - ☐ Yes, as an own modification
    - ☐ No
    - ☐ Don't know

36. What is the reason why you anticipate using the "Adductor Strengthening Programme" in your team in the following season?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The program consists of one exercise
    - ☐ The program consists of three progression levels
    - ☐ The program can be performed as a partner exercise
    - ☐ The program does not require exercise equipment
    - ☐ Other (specify) _____

37. What is the reason why you do not anticipate using the “Adductor Strengthening Programme” in your team in the following season?
It is possible to check several options

- ☐ The program's lack of injury prevention effect
- ☐ The time spent on the program
- ☐ The program consists of only one exercise
- ☐ The program consists of only three levels of difficulty
- ☐ The program can be performed as a partner exercise
- ☐ The program does not require exercise equipment
- ☐ Other (specify) _____

38. Do you have any suggestions for changes to the “Adductor Strengthening Programme” that may make it more relevant to use the program? Describe in your own words.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Ok

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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The Adductor Strengthening Programme is successfully adopted but frequently modified in Norwegian male professional football teams: a cross sectional study

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The Adductor Strengthening Programme is successfully adopted but frequently modified in Norwegian male professional football teams: a cross sectional study

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ABSTRACT

Objectives: Groin injuries represent a substantial problem in male football, with the Adductor Strengthening Programme (ASP) being the only exercise programme demonstrated to significantly reduce the risk of groin problems. We aimed first, to use the Reach Adoption Effectiveness Implementation Maintenance (RE-AIM) framework to investigate attitudes, beliefs, and behaviour to the ASP among primary delivery agents of injury prevention exercises in Norwegian male professional football teams. Secondly, we aimed to identify a real-world application of the ASP protocol used in a professional team setting.

Design: A descriptive cross-sectional survey, using a questionnaire designed to cover all five dimensions of the RE-AIM framework.

Setting: The top two divisions of Norwegian male professional football.

Participants: 32 primary injury prevention delivery agents

Primary and secondary outcome measures: Primarily, the proportion of respondents being aware of the ASP and its effect; having adopted it; having implemented it as intended; and considering maintaining using it. Secondary, the most often used ASP modifications.

Results: Twenty-nine (91%) participants responded. All (100%) respondents were aware of the ASP and its injury preventive effect. The two most stated reasons for using the ASP were its injury preventive effect and that it does not require equipment. The ASP was adopted by all (100%) delivery agents, but only 10% used it in accordance with the original protocol. The main modifications were that the players in 72% of the teams were instructed to perform a non-progressive number of repetitions during pre-season, and in 86% of the teams instructed to perform more sets, but fewer repetitions per set, during in-season. In total, 97% of the delivery agents planned to continue using the ASP.

Conclusion: The delivery agents have positive attitudes and beliefs to the ASP, but they frequently modify it. We identified and reported a real-world application of the ASP protocol.

Key words: Football, groin injury, injury prevention, Adductor Strengthening Programme, Copenhagen Adduction, RE-AIM, implementation

Strengths and limitations of this study

- The questionnaire was pilot tested by delivery agents with relevant experience.
- Thorough data collection process leading to a high response rate.
- The internal validity of the questionnaire was not systematically explored.
- Some of the questionnaire's questions are prone to recall bias as the survey was conducted towards the end of the competitive season.

INTRODUCTION

Groin problems represent a substantial problem in football. They account for 4-19% and 2-11% of all time-loss injuries in male and female football, respectively[1]. Moreover, the average weekly proportion of male players with any groin problem causing pain and/or reduced performance is 21% in a full competitive season[2] and, 29% in periods with match congestion[3].

In a clinical trial, the Adductor Strengthening Programme (ASP) showed a significant 41% reduction in risk of groin problems in male semi-professional players performing the programme during one full season[2]. Consequently, dissemination and widespread implementation of the ASP in football training seems beneficial[2, 4]. The ASP is based on a single-exercise, the Copenhagen Adduction (CA) exercise[4], structured with three progression levels and a protocol with a pre-season and in-season exercise prescription. In the clinical trial, players completed on average about 70% of the recommended exercise prescription, demonstrating a considerably higher compliance than previous groin injury prevention programmes[5, 6]. The high compliance is an important strength of the ASP, as only injury prevention programmes that are successfully implemented (i.e. widely adopted, complied with and maintained over time) will reach effectiveness outside controlled clinical trials[7].

Gaining knowledge on attitudes, beliefs, and behaviour to injury prevention exercises are important when evaluating their implementation in the real-world setting[7]. For this purpose, integrating the Reach Effectiveness Adoption Implementation Maintenance (RE-AIM) framework[8, 9] is recommended, ideally evaluated across all levels of the sport setting hierarchy[9]. In brief, the framework evaluates the proportion of a targeted population that is aware of a given intervention (Reach), the interventions positive outcomes (Effectiveness), the proportions that has adopted the intervention (Adoption) and implemented it as intended (Implementation), and the extent to which it is sustained (Maintenance)[8, 9]. Note that the specific RE-AIM implementation dimension refers to the extent to which an exercise or a programme is used as intended in the real-world setting[9]. The general term implementation also used in this article, however, refers to all initiatives applied to put an exercise or a programme into practice[10].

Attitudes and beliefs towards the ASP is previously investigated among players participating in the clinical ASP trial[11]. The study revealed that only 31% of the players anticipated to continue using the ASP in accordance with the original protocol[11]. Also, a recent study on the CA among coaches in international male professional teams reported that 72% were aware of the exercise, while 94% of those had adopted it[12]. These findings are consistent with previous research emphasising that evidence-based injury prevention exercises can be challenging to apply in the real-world settings[13]. To enhance knowledge, we believed it was important to conduct a survey among team staff, specifically among those having the main responsibility for implementing and conducting injury prevention exercises (hereafter referred to as "delivery agents").

Therefore, the primary aim of this study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour to the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. The secondary aim was to identify a real-world application of the ASP protocol used in a professional team setting, which to our knowledge, previously has not been conducted for any single-exercise injury prevention programme.

METHODS

Study design and participants

This was a cross-sectional study conducted in September and October 2020. Participants were the primary delivery agent in each team in the top two divisions of Norwegian male professional football (n=32): Eliteserien (n=16) and OBOS-ligaen (n=16). The study is described according to the STROBE statement checklist for cross-sectional studies[14].

Survey

A new questionnaire designed to cover all dimensions of the RE-AIM[8] framework was developed, based on previous questionnaires used in studies investigating implementation of preventative training in elite and sub-elite sport´s settings[11, 15]. The final version consisted of 38 questions, primarily closed-ended. The questionnaire was developed and delivered in

Norwegian, however, a translated English version is provided as an appendix to this paper (Supplementary file 1).

Data collection

We collected contact information to the delivery agents either through our network of contacts or by contacting the team´s directly. All delivery agents received an email with detailed information about the study and a link with access to an online survey software (SurveyXact, Rambøll Management Consulting AS, Oslo). We distributed the questionnaire during an international break in September 2020. Weekly reminders were sent to non-responders by email for four weeks, and after five weeks, non-responders were contacted by telephone.

Analysis

We performed statistical analysis using SPSS statistical software (SPSS V24, IBM Corporation, Armonk, NY). Data consisted of categorical nominal variables, presented as proportions, including for the specific RE-AIM dimensions. Open-ended text responses were analysed with a quantitative content analysis[16], using a structured code form counting frequencies of variables mentioned. The code form was also used to categorise whether the participants had a positive, negative, or neutral attitude.

Patient and public involvement

Three experienced delivery agents (two physiotherapists and one football coach) not involved as participants did pilot test the questionnaire and gave feedback on its understanding and readability. Patients and/or the public were not involved in any other part of the conduct, or reporting, or dissemination plans of this research.

RESULTS

Participant characteristic

Twenty-nine (91%) of the 32 delivery agents participated in the survey (14 from Eliteserien and 15 from OBOS-ligaen). The non-responders gave no specific reasons for not participating. Twenty-three (79%) of the respondents were physiotherapists, five (17%) were strength and conditioning coaches and one (3%) was a naprapath. Respondents' experience as delivery agents in football is shown in Table 1.

Table 1: *Years of experience as delivery agents of injury prevention exercises in football*

Years of experience as delivery agent	**n (%)**
0-4 years	5 (17)
5-9 years	13 (45)
10-14 years	7 (24)
15-19 years	3 (10)
≥ 20 years	1 (3)

Attitudes to groin injury risk and importance of injury mitigation

Football players risk of getting a groin problem was assumed to be high or moderate by 19 (66%) and 9 (31%) delivery agents, respectively, while one respondent considered the risk to be low. All (100%) respondents thought prevention exercises to mitigate groin problems was important, replied by 27 (93%) as highly important and by 2 (7%) as moderately important.

Reach and effectiveness of the ASP

All (100%) respondents were aware of either one or both of ASP and the CA. All (100%) delivery agents thought the ASP has potential to successfully mitigate the burden of groin problems, with 11 (38%) perceiving the groin problem mitigation as large and 18 (62%) perceiving it as moderate. Beliefs about the ASP´s effect on player availability can be viewed in Figure 1.

[INSERT FIGURE 1 WITH LEGEND HERE]

Adoption and implementation of the ASP

All (100%) delivery agents had adopted the ASP in their team the current season, of which three (10%) replied that their usage was in accordance with the original ASP protocol. How the teams reported the usage of the ASP in terms of exercise frequency, sets and repetitions, is shown in Table 2 and 3 for pre-season and in-season, respectively.

Table 2: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***pre-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than 3 times a week	2 (7)
3 times a week	4 (14)
Twice a week	16 (55)
Once a week	5 (17)
We carried out the program, but less than once a week	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**
More than 2 sets per side	8 (28)
2 sets per side	17 (59)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions each week	1 (3)
12-15 repetitions each week	3 (10)
7-10 repetitions each week	16 (55)
3-5 repetitions each week	1 (3)
3-15 repetitions, weekly progressive as in protocol	3 (10)
3-15 repetitions, weekly progressive as own modification	5 (17)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

Table 3: *Overview of reported training volume of the Adductor Strengthening Programme (ASP) during* ***in-season****

"How often were the players instructed to perform the ASP?"	**n (%)**
More than once a week	9 (31)
Once a week	16 (55)
Once every two weeks	2 (7)
We carried out the program, but less than once every two weeks	2 (7)
"How many sets were the players instructed to perform per side?"	**n (%)**

More than 2 sets per side	7 (24)
2 sets per side	18 (62)
1 set per side	4 (14)
"How many repetitions were the players instructed to perform per set?"	**n (%)**
More than 15 repetitions	1 (3)
12-15 repetitions	6 (21)
8-11 repetitions	14 (48)
4-7 repetitions	8 (28)

*Specified as under normal circumstances, e.g., not influenced by Covid-19

The most often-used ASP modifications are summed up in Table 4, which is the identified real-world application of the ASP protocol used in a professional team setting.

Table 4: *Adductor Strengthening Programme real-world application in Norwegian male professional football teams*

Adductor Strengthening Programme – real-world application			
Week	Sessions per week	Sets per side	Repetitions per side
Pre-season – week 1-8	2	2	7-10
In-season – all weeks	1	2	8-11

Maintenance of the ASP

Twenty-eight (97%) delivery agents planned to continue using the ASP in the subsequent season, of which 20 (71%) planned to use a modified protocol.

Facilitators and barriers to implementation of the ASP

The most often stated reasons to use the ASP were first, the documented preventive effect of the ASP (100%, both in current and subsequent season) and second, that no additional equipment is needed (52% in current and 43% in subsequent season) (Figure 2). On an open-ended non-mandatory question, four respondents (27%) defined an indirect performance enhancing effect as an additional positive effect of ASP. Five (31%) respondents described the ASP progression levels as being too demanding, while four (25%) thought it was likely to cause muscle soreness. Two of these four respondents indicated soreness was the reason for modifying the original ASP protocol.

[INSERT FIGURE 2 WITH LEGEND HERE]

DISCUSSION

The primary aim of the present study was to use the RE-AIM framework to investigate attitudes, beliefs, and behaviour regarding the ASP among delivery agents of injury prevention exercises in Norwegian male professional football teams. A secondary aim was to identify a real-world application of the ASP used in a professional team setting. The main findings were that all delivery agents were aware of the ASP, all thought the programme can mitigate the burden of groin problems, all stated to use the ASP in their team the current season and, almost everyone planned to continue using it in the subsequent season. However, only 10% used the ASP in accordance with the original ASP protocol.

Reach and effectiveness

Having a targeted population to recognize injury risk, to be aware of relevant injury prevention exercises or programs, and to acknowledge the exercise's or program's ability to mitigate the injury risk, are vital for successful real-world implementation of effective injury prevention exercise programs[9, 17-20]. The surveyed delivery agents´ belief that players are at moderate to great risk of groin problems aligns well with epidemiological data[1, 3, 21]. The reported awareness level of ASP on the other hand is higher than previously reported for the CA[12] and the injury prevention exercise programme, FIFA 11+[22]. Discrepancies in awareness levels between members of the team around the players may be due to, unlike the current study surveying mostly physiotherapists, comparable studies having primarily surveyed head coaches which clearly also have other responsibilities besides being updated on injury prevention exercises and measures.

All delivery agents considering the ASP as capable of mitigating the burden of groin problems aligns with its evidence-based effect, and coincides with previously reported perceptions of the CA[12]. Moreover, the high ASP awareness level and the positive attitude towards its efficacy implies that the ASP dissemination strategies have been successful within this specific population of clinicians.

Adoption

All respondents reported using the ASP throughout the season. This is a similar finding to the adoption rate seen for the CA[12] in male professional football, when only accounting for users being aware of the exercise. Compared to what has been reported for the Nordic Hamstring (NH) exercise[23] in male professional football however, the ASP adoption rate is substantially higher. Interestingly, all respondents stated that the evidence-based efficacy of the ASP was an important reason for choosing to adopt the programme. The discrepancy in ASP and NH adoption rates are interesting, as they share the same exercise characteristics, and both were originally studied in clinical trials including Norwegian male football teams[2, 23]. One variation, however, that may explain some of the discrepancy in adoption rates is the six-year's difference between our data collection and the data collection of the NH adoption[24]. This is likely due to evidence-based efforts to prevent injuries having improved among practitioners in elite teams in recent years[25].

Implementation

When implementing the programme, the current study shows that delivery agents in professional football usually modify the ASP to fit their team's training philosophy and schedule. Similar findings have been demonstrated for the NH[24, 26] and the FIFA 11+[27, 28]. So far, no other studies on specific modifications of single-exercise injury prevention programmes exist.

The original ASP protocol[2] prescribes a pre-season strengthening phase containing a detailed eight-week progression, and an in-season maintenance phase with a continuous number of repetitions. The intention is first, to provide hip adductor muscle strength gains, and second, to maintain the increased muscle strength, as reduced hip adductor muscle strength is the only consistently reported risk factor for groin injury in sports[29].

Compared to the original programme, in total, the delivery agents usually prescribed slightly more repetitions per session, but divided into two sets, especially during in-season. Furthermore, they generally conducted fewer sessions per week during pre-season, and the vast majority did not adopt the eight-week progression recommended for pre-season.

We did not investigate why the delivery agents modified the ASP. However, a potential reason for non-progression during pre-season strengthening phase might be that the delivery

agents consider most professional players to already have gained, and maintained, adequate hip adductor muscle strength. This would limit the delivery agent's perceived need for players to commence a progressive strengthening phase. Another reason for the modifications of the ASP could also be lack of support and acceptance from players and/or coaches. Such support is considered a key facilitator in the implementation process[9, 22] and, motivation to comply with the original ASP protocol has already been shown to be low among players[11]. A reason for modifying previous injury prevention strengthening exercises has been attributed to a possible fear of muscle soreness[13, 30]. However, only two respondents reported to have modified the ASP partly due to such fear, and there is evidence that even the most strenuous level of the ASP barely caused any reported muscle soreness if the number of repetitions was progressed gradually[31, 32]. Consequently, fear of muscle soreness seems to not be an important barrier to optimal ASP implementation in the real-world setting.

Effectiveness of the real-world application of the ASP

An important aspect is that the delivery agents modify the ASP without knowing the impact. As mentioned, the ASP aims to mitigate groin problems by targeting hip adductor muscle strength. There is compelling evidence that muscle strength effects are dose dependent[33], which also has been suggested for the CA[34]. The reported used pre-season ASP exercise volume is approximately 640 repetitions during eight weeks, which, interestingly, is a higher volume than what the evidence-based original ASP protocol prescribes (470 repetitions)[2]. Moreover, it accommodates a suggested minimum of 500-800 repetitions during eight weeks, when aiming to facilitate meaningful hip adductor muscle strength gains[34]. Since the reported used weekly in-season ASP exercise volume is almost equal to pre-season, it is reasonable to assume that players somewhat maintain their hip adductor muscle strength during in-season.

Beyond volume considerations, progression seems required to elicit the greatest strength training gains[35]. As the ASP consists of a bodyweight exercise, weekly increase in the number of repetitions is the main progression variable. A critical assessment is therefore whether the reported lack of pre-season progression can reduce the ASP´s effectiveness in groin problem mitigation. Additionally, muscle strength gains also depends on recruitment of high-threshold motor units, through accumulation of neuromuscular fatigue induced when performing sets to at least somewhat near neuromuscular failure[36]. Therefore, another

critical assessment would be whether more sets but fewer repetitions per set, as respondents have reported, affect the ASP´s effectiveness.

So far, changes in physiological characteristics when performing the ASP, such as effects on muscle cross-sectional area and architecture, musculotendinous stiffness, and motor unit recruitment and synchronization[35], have not been scientifically investigated. Similarly, the exact dose-response relationship between ASP exercise volume and hip adductor muscle strength gains, and between ASP exercise volume and groin injury mitigation rates also remains to be investigated. And lastly, the importance of a progression strengthening phase(s) when aiming to mitigate groin problems, is unknown. Discussions around the most often-used modification's impact on the ASP´s effectiveness are therefore currently theoretical, only.

Consequently, we will argue that there is no convincing evidence claiming that the ASP modifications applied by the delivery agents affect the mitigation of groin problems in male professional players, compared to the original protocol. Additionally, considerations on ASP exercise volume and other modifications are subordinated to the fact that no injury prevention programme will reach its full potential unless it is implemented, adopted, and maintained, by teams in the real-world setting[19].

Maintenance

To be successful, the final step of any injury prevention exercise implemented in the real-world setting is that the exercise or the program is maintained over multiple seasons. In our study, nearly all respondents planned to continue using the ASP in the subsequent season, representing a considerably higher maintenance level than previously reported[11]. A particular challenge, however, is that team staff members, including medical staff, are frequently replaced when managers are replaced, increasing the risk of preventative measures not being persistently maintained over time[19]. It is yet to be confirmed whether ASP has been established as part of the teams´ or clubs´ sports plans or policies on injury prevention measures.

Methodological considerations

The high response rate (91%) is a strength of this study. However, it is uncertain whether our results can be generalised to other delivery agents and professional football settings outside Norway. Especially, considering that the original ASP intervention study was conducted among Norwegian male football teams. This may have led to a "word of mouth" effect in the Norwegian football community, which to some extent can explain the higher ASP awareness level and adoption rates in this study.

A further strength of the current study is the pilot testing of the questionnaire ensuring valuable input to the final questionnaire. A limitation is that the internal validity of the questionnaire was not systematically explored, which is a prerequisite to draw firm valid conclusions[37]. The pilot study ensured, however, some degree of internal validity, by providing adequate understanding and readability of the questionnaire dimensions. Furthermore, questions related to the "implementation" dimensions, especially regarding the pre-season application of the ASP, are prone to some degree of recall bias as the survey was conducted towards the end of the competitive season[38]. Therefore, this study describes how the teams in overall perform the ASP, only, while it is likely that the programme was individualised depending on players previous injury record and experience with specific strength exercises. Moreover, this study did not include a question about delivery agents' perceived involvement in and support from players and coaches, which is considered a key facilitator to successful implementation in the real-world football setting[9].

Importantly, 79% of the respondents had a defined team staff role as a physiotherapist. This contrasts with previous studies, where surveyed delivery agents were either strength and conditioning coaches, head coaches or medical doctors[22, 26, 30, 39, 40]. In contrast to the other members of the medical and coaching staff, physiotherapists are educated and trained in health science with special emphasis on injury prevention and rehabilitation. Therefore, it is not unlikely that some of the variations in attitudes, beliefs and behaviour between the present and previous studies are due to differences in the participant's formal team staff role and educational background.

Regarding data collection methods, we chose to develop and conduct a survey for the following reasons. Firstly, a survey is an appropriate tool to collect responses from

individuals living in a widespread geographical area. Secondly, it is suitable when investigating several variables at the same time, such as all the RE-AIM dimensions, and thirdly, a survey provides a cost-effective and relatively seamless data collection method. Therefore, a survey using a questionnaire was considered appropriate to accommodate the research questions in our study.

PERSPECTIVES

The delivery agents are aware of the ASP, they have adopted it, and they anticipate maintaining the usage. The implementation of the programme, however, is slightly different in each team. Further studies are warranted to acquire knowledge about why the ASP is being modified, and the impact of the modifications on the ASP´s effectiveness. As this in previous studies primarily has been conducted in male adult teams, future studies should include women's and youth football, too. Also, widespread dissemination of the ASP outside the Scandinavian countries is needed is to achieve reach world-wide. Finally, as recommended[9], similar investigations of attitudes, beliefs, and behaviour to the ASP among other stakeholder, e.g. coaches, club officials and relevant sporting organisations, are needed in order to further explore the complexity of introducing preventative measures in the real-world professional setting.

CONCLUSION

The present study found that delivery agents of injury prevention exercises in Norwegian male professional football teams have positive attitudes and beliefs to the ASP, using it frequently and planning to maintain the usage of it in the subsequent season. Most delivery agents, however, instructed players to complete the ASP with modifications. Therefore, we have identified a real-world application of the ASP protocol used in a professional team setting.

Authors contributions

JS, TEA, and JH all conceived the idea for, and planned the study. JS conducted the data collection and the statistical analysis. JS, TEA, and JH have all been involved in the drafting and the revisions of the manuscript. JS, TEA, and JH have all approved the final draft.

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Competing of interests

None declared

Ethics approval

The study was approved by the ethics board at the Norwegian School of Sport Sciences (134-130820) and by the Norwegian Centre for Research Data (NSD 2020/837286), and all respondents gave informed consent to participate.

Data sharing statement

All de-identified date is available upon reasonable request. Suitability of data request and access to data will be determined by all authors collectively.

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Figure legends

Figure 1: Beliefs regarding whether Adductor Strengthening Programme can influence availability of players in training and match-play. *No respondent replied some decrease, large decrease or don't know.

Figure 2: Reasons for choosing to use the Adductor Strengthening Programme this season and reasons for planning using the programme the following season.

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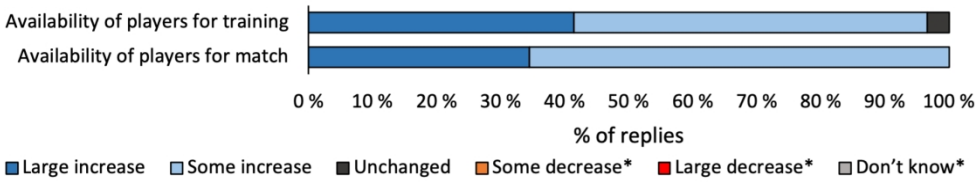

Figure 1: Beliefs regarding whether Adductor Strengthening Programme can influence availability of players in training and match-play. *No respondent replied some decrease, large decrease or don't know.

382x75mm (130 x 130 DPI)

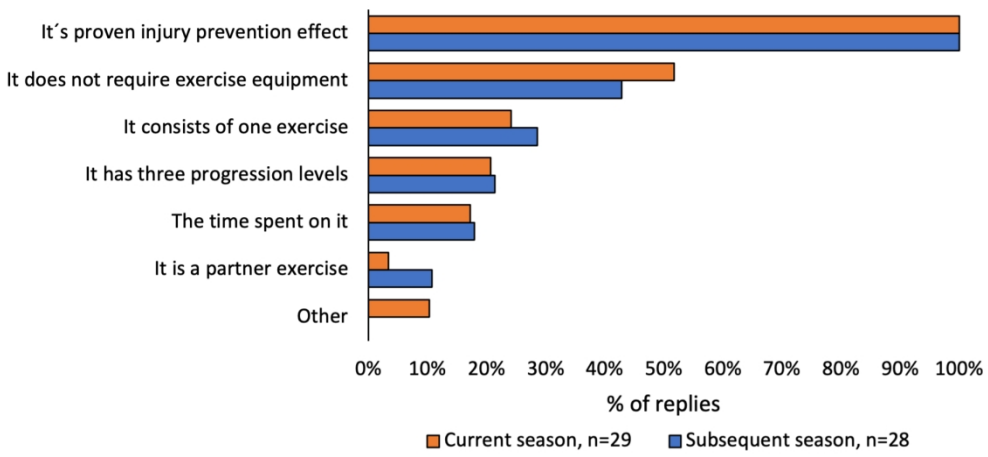

Figure 2: Reasons for choosing to use the Adductor Strengthening Programme this season and reasons for planning using the programme the following season.

372x174mm (130 x 130 DPI)

Questionnaire

Have you read and approved the informed consent?

- ☐ Yes

1. What is your age?
   - ☐ 18-30 years
   - ☐ 31-45 years
   - ☐ 46-60 years
   - ☐ More than 60 years

2. At what level does the team where you are employed play?
   - ☐ Eliteserien (Norwegian Premier League)
   - ☐ OBOS-ligaen (Norwegian First Division)

3. What is your role in the team staff where you are employed?
   - ☐ Head coach
   - ☐ Assistant coach
   - ☐ Fitness coach
   - ☐ Physiotherapist
   - ☐ Medical doctor
   - ☐ Other healthcare profession (specify) _____
   - ☐ Other position (specify) _____

4. What education and / or courses do you have?
   It is possible to check several options
   - ☐ UEFA PRO License
   - ☐ UEFA A License
   - ☐ UEFA B License
   - ☐ One-year study in sport science
   - ☐ Bachelor's degree in sport science
   - ☐ Master's degree in sport science
   - ☐ Bachelor's degree in a health profession
   - ☐ Master's degree in a health profession
   - ☐ Other education and/or courses (specify) _____

5. How many years of experience do you have as delivery agent of preventative training for football players?
   - ☐ 0-4 years
   - ☐ 5-9 years
   - ☐ 10-14 years
   - ☐ 15-20 years
   - ☐ More than 20 years

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/cathing or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

6. How much risk do you think football players have getting groin problems?
   - ☐ Great risk
   - ☐ Moderate risk
   - ☐ Small risk
   - ☐ No risk
   - ☐ Don't know

7. How important do you think it is to perform preventative training to mitigate groin problems?
   - ☐ Greatly important
   - ☐ Moderately important
   - ☐ A little important
   - ☐ Not important
   - ☐ Don't know

8. Were you aware of the "Adductor Strengthening Programme" and/or the "Copenhagen Adduction" exercise prior to reading the information in the introduction to this questionnaire?
   - ☐ Yes
   - ☐ No
   - ☐ Don't know

9. Where did you get information about the “Adductor Strengthening Programme” and/or the "Copenhagen Adduction Exercise"?
   It is possible to check several options
   - ☐ “Skadefri” website
   - ☐ “Skadefri” application
   - ☐ Article in the British Journal of Sports Medicine
   - ☐ Conference/course
   - ☐ Infographics
   - ☐ Social media (Twitter, Facebook, Instagram etc.)
   - ☐ Other (specify) _____
   - ☐ Don’t know

10. Check if you are aware that you can find information about the “Adductor Strengthening Programme” and/or the «Copenhagen Adduction Exercise» in these relevant places:
    It is possible to check several options
    - ☐ “Skadefri” website
    - ☐ “Skadefri” application
    - ☐ Article in the British Journal of Sports Medicine
    - ☐ Infographics
    - ☐ Social media (Twitter, Facebook, Instagram etc.)
    - ☐ Other (specify) _____

Further, you will get two questions that deal with groin problems.
By groin problems is meant any pain, ache, stiffness, clicking/catching or other complaints related to the groin, or reduced training participation, training volume or performance due to groin problems.

11. Do you think that the “Adductor Strengthening Programme” can influence the burden of groin problems?
    - ☐ Yes, the program can greatly mitigate the burden
    - ☐ Yes, the program can moderately mitigate the burden
    - ☐ No, the program cannot have an effect on the burden
    - ☐ Yes, the program can moderately aggravate the burden
    - ☐ Yes, the program can greatly aggravate the burden
    - ☐ Don’t know

12. Do you think that the “Adductor Strengthening Programme” can influence football performance?
    - ☐ Yes, the program can greatly increase performance
    - ☐ Yes, the program can moderately increase performance
    - ☐ No, the program cannot have an effect on performance
    - ☐ Yes, the program can moderately decrease performance
    - ☐ Yes, the program can greatly decrease performance
    - ☐ Don’t know

How do you think the following of the players' physical skills may be affected by doing the “Adductor Strengthening Programme”?

13. Linear acceleration?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

14. Top speed?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

15. Change of direction?
    - ☐ Large increase
    - ☐ Some increase
    - ☐ Unchanged
    - ☐ Some decrease
    - ☐ Large decrease
    - ☐ Don’t know

16. Vertical jump ability?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

17. Duelling power?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

How do you think other factors can may be affected by doing the "Adductor Strengthening Programme":

18. Availability of players for match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

19. Availability of players for training?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

20. Chance of winning a match?
- ☐ Large increase
- ☐ Some increase
- ☐ Unchanged
- ☐ Some decrease
- ☐ Large decrease
- ☐ Don't know

21. What other positive characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

22. What other negative characteristics / achievements / consequences do you think the "Adductor Strengthening Programme" can provide? Describe in your own words.

23. Do you use the "Adductor Strengthening Programme" in your team?
- ☐ Yes, as described in the protocol
- ☐ Yes, as modified version
- ☐ No
- ☐ Don't know

24. How do you use the "Adductor Strengthening Programme" in your training schedule?
- ☐ As part of organised football training
- ☐ As part of organised strength training
- ☐ As an independent preparation in the locker room or strength room before training
- ☐ As guided preparation in the locker room or strength room before training
- ☐ As independent training in a separate strength training session
- ☐ Other way (specify) _____

When using the "Adductor Strengthening Programme" in season (under normal circumstances, not influenced by covid-19):

25. How often did the players perform the program?
- ☐ More than once a week
- ☐ Once a week
- ☐ Once every two weeks
- ☐ We carried out the program, but less than once every two weeks

26. How many sets did the players perform?
- ☐ More than 2 sets per side
- ☐ 2 sets per side

- ☐ 1 set per side

27. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per side
    - ☐ 12-15 repetitions per side
    - ☐ 8-11 repetitions per side
    - ☐ 4-7 repetitions per side
    - ☐ Less than 4 repetitions per side

When using the "Adductor Strengthening Programme" in preseason (under normal circumstances, not influenced by covid-19):

28. How often did the players perform the program?
    - ☐ More than 3 times a week
    - ☐ 3 times a week
    - ☐ Twice a week
    - ☐ Once a week
    - ☐ We carried out the program, but less than once a week

29. How many sets did the players perform?
    - ☐ More than 2 sets per side
    - ☐ 2 sets per side
    - ☐ 1 set per side

30. How many repetitions did the players perform in each set?
    - ☐ More than 15 repetitions per set each week
    - ☐ 12-15 repetitions per set each week
    - ☐ 7-10 repetitions per set each week
    - ☐ 3-5 repetitions per set each week
    - ☐ 3-15 repetitions per set, weekly progressive (as in protocol)
    - ☐ 3-15 repetitions per set, weekly progressive (as own modification)

31. What has been important for you in choosing to use the "Adductor Strengthening Programme"?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The programme consists of one exercise
    - ☐ The programme consists of three progression levels
    - ☐ The programme is a partner exercise
    - ☐ The programme does not require exercise equipment
    - ☐ Other (specify) _____

32. Do you use other preventative training in addition to the "Adductor Strengthening Programme", with the intention to mitigate the burden of groin problems?
    - ☐ Yes
    - ☐ No
    - ☐ Don't know

33. What training do you use in addition to, or instead of, the "Adductor Strengthening Programme" to mitigate the burden of groin problems? Describe in your own words as detailed as possible which exercise (s), how they are performed, dosage (series, repetitions, intensity), and anything else you consider relevant.

34. Why did you choose to do what is described in the previous answer, and who participated in the decision? Describe in your own words.

35. Do you anticipate using the "Adductor Strengthening Programme" in your team the following season?
    - ☐ Yes, as described in the protocol
    - ☐ Yes, as an own modification
    - ☐ No
    - ☐ Don't know

36. What is the reason why you anticipate using the "Adductor Strengthening Programme" in your team in the following season?
    It is possible to check several options
    - ☐ The program's injury prevention effect
    - ☐ The time spent on the program
    - ☐ The program consists of one exercise
    - ☐ The program consists of three progression levels
    - ☐ The program can be performed as a partner exercise
    - ☐ The program does not require exercise equipment
    - ☐ Other (specify) _____

37. What is the reason why you do not anticipate using the “Adductor Strengthening Programme” in your team in the following season?
It is possible to check several options

- ☐ The program's lack of injury prevention effect
- ☐ The time spent on the program
- ☐ The program consists of only one exercise
- ☐ The program consists of only three levels of difficulty
- ☐ The program can be performed as a partner exercise
- ☐ The program does not require exercise equipment
- ☐ Other (specify) _____

38. Do you have any suggestions for changes to the “Adductor Strengthening Programme” that may make it more relevant to use the program? Describe in your own words.

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	-
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	-
Bias	9	Describe any efforts to address potential sources of bias	-
Study size	10	Explain how the study size was arrived at	5-6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	-
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5-6
		(b) Give reasons for non-participation at each stage	6
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	6
		(b) Indicate number of participants with missing data for each variable of interest	-
Outcome data	15*	Report numbers of outcome events or summary measures	6-8
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Ok

		(*b*) Report category boundaries when continuous variables were categorized	-
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.