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Implementation of a neuromuscular training programme in female adolescent football: 3-year follow-up study after a randomised controlled trial

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ABSTRACT

Background Neuromuscular training (NMT) has been shown to reduce anterior cruciate ligament injury rates in highly structured clinical trials. However, there is a paucity of studies that evaluate implementation of NMT programmes in sports.

Aim To evaluate the implementation of an NMT programme in female adolescent football 3 years after a randomised controlled trial (RCT).

Methods Cross-sectional follow-up after an RCT using the RE-AIM SSM (Reach, Effectiveness, Adoption, Implementation, and Maintenance Sports Setting Matrix) framework. Questionnaires were sent to the Swedish Football Association (FA), to eight district FAs and coaches ($n=303$) that participated in the RCT in 2009, and coaches who did not participate in the RCT but were coaching female adolescent football teams during the 2012 season ($n=496$).

Results Response rates were 100% among the FAs, 57% among trial coaches, and 38% among currently active coaches. The reach of the intervention was high, 99% of trial coaches (control group) and 91% of current coaches were familiar with the programme. The adoption rate was 74% among current coaches, but programme modifications were common among coaches. No district FA had formal policies regarding implementation, and 87% of current coaches reported no club routines for programme use. Maintenance was fairly high; 82% of trial coaches from the intervention group and 68% from the control group still used the programme.

Conclusions Reach and adoption of the programme was high among coaches. However, this study identified low programme fidelity and lack of formal policies for its implementation and use in clubs and district FAs.

INTRODUCTION

Anterior cruciate ligament (ACL) injuries pose a considerable threat to the career of football players, and the injury rate is two to three times higher in female players compared with their male counterparts.[1] Several programmes have been developed with neuromuscular training (NMT) components that aim to prevent lower limb injuries, including ACL injuries, in female football players.[2-13] Although these programmes have been shown to be efficacious in highly structured randomised controlled trials (RCTs) and prospective controlled studies, this does not guarantee their effectiveness in the real-world context.[14-16] To date, there is a paucity of studies that go beyond describing the efficacy of interventions under the ideal conditions of an RCT. A key issue is whether the intervention can be successfully implemented, which often proves a challenging task.[17] Awareness of an efficacious NMT programme may not be enough to change the coaches' injury preventive behaviour. Coaches are influenced by a range of factors (personal, interpersonal, organisational, communal and national/international factors) and to receive support when implementing an intervention is crucial.[18-20] A better understanding of the implementation context is important to succeed with implementations in the real world.[15] The RE-AIM (Reach, Effectiveness, Adoption, Implementation, and Maintenance) framework, originally developed to evaluate public health interventions[14] and previously used, for example, in primary health care in Sweden,[21] is applicable to evaluate interventions implemented in the real world. The framework has been extended into the RE-AIM Sports Setting Matrix (RE-AIM SSM) to better suite team sports and more complex interventions.[15, 22]

The NMT programme, Knäkontroll (SISU Idrottsböcker, Sweden, 2005), has previously been evaluated from the perspectives of injury prevention and performance enhancement,[13, 23, 24] and has been described in detail in earlier publications.[13, 25] In a

cluster RCT in 2009, the programme was evaluated in eight Swedish football districts involving 230 clubs and 4564 female players aged 12 to 17 years.[13] The programme was found to reduce the overall ACL injury rate significantly by 64% (rate ratio 0.36, 95% confidence interval 0.15-0.85). The aim of this follow-up study was to evaluate the implementation of the NMT programme according to the RE-AIM SSM framework in Swedish female adolescent football 3 years after the RCT.

MATERIALS AND METHODS

Design

This study used a cross-sectional design to evaluate the implementation of an NMT programme 3 years after an RCT in female adolescent football. Football coaches were the main targets of behaviour change in the present study within the local settings, and additionally, we also evaluated the forming of policies for programme usage and implementation within national and district football associations. Data were collected from November 2012 to February 2013 using web-based questionnaires. The implementation of the NMT programme was evaluated using items from the RE-AIM SSM framework,[15] that were considered relevant and applicable in the current context (table 1). The original definitions of the dimensions were modified slightly to better suit the present context:

- Reach: the proportion of participants in the target population who were familiar with the programme
- Effectiveness: the users' perceptions of the programme's impact on important outcomes
- Adoption: the proportion of potential adopters who reported using the programme
- Implementation: the fidelity with the intervention protocol
- Maintenance: the extent to which the programme has become institutionalized over time and presence of policies regarding its dissemination and usage

The implementation was evaluated in four target groups including national and district football associations (FAs) and two groups of coaches for female adolescent players.

Table 1 Dimensions of the neuromuscular training programme evaluated using the RE-AIM SSM framework

RE-AIM SSM dimension	Target group		Trial coaches	Current coaches
	National	District		
Reach			Knowledge of the programme (control group)	Knowledge of the programme
Effectiveness			Perceived effect in reducing acute knee injuries and enhancing performance, and satisfaction with the programme; Complaints about the programme from players; Complaints about the programme from parents	Perceived effect in reducing acute knee injuries and enhancing performance, and satisfaction with the programme
Adoption			Frequency with which coaches carried on using the programme (intervention group) or started using it (control group) after 2009	Use of the programme
Implementation			Fidelity with the programme (number of exercises)	Participation in education and training in the programme; Fidelity with the programme (dosage and number of exercises)
Maintenance	Presence of policies for programme implementation and use with female adolescent players; Annual education and training for coaches and physiotherapists (2010–2012)	Presence of policies for programme implementation and use with female adolescent players; Annual education and training for coaches and physiotherapists (2010–2012)	Use of the programme over time (2010–2012); intention to continue using the programme	Delivery of education via the club; presence of formal guidelines within the club

RE-AIM SSM, Reach, Effectiveness, Adoption, Implementation and Maintenance Sports Setting Matrix.

Study population and recruitment

To evaluate the active spread of the NMT programme, we contacted representatives of the Swedish national FA and the eight district FAs (of the 24 districts in Sweden) that participated in the RCT in 2009, as well as all coaches for the female football teams that had previously participated in the RCT. To evaluate the passive spread of the programme, currently active coaches for all female adolescent teams participating in the eight district FA series in 2012 were also approached for recruitment.

National and district FAs

Development of education programmes and guidelines for the NMT programme was evaluated in the national and district FAs (table 1). Eight representatives for the district FAs were contacted via e-mail and a joint answer from the project group responsible for the national work on the NMT programme was received from the Swedish FA (figure 1).

Trial coaches

Use of the NMT programme over the 3-year period as well as experiences with the programme were evaluated among coaches who had previously participated in the RCT (table 1). All coaches, in the intervention group and the control group, were contacted and included irrespective of whether they were currently coaching a team or not (figure 1). The coaches were educated in the programme as part of the RCT in 2009 (the coaches in the control group were offered the same instructions after the completion of the RCT) and all coaches were sent information about the results from the RCT. An e-mail was sent to the coaches asking them to confirm their address before receiving the questionnaire. If an e-mail confirmation was not received, five attempts separated in time were made to contact the coaches by telephone.

Current coaches

Current use and experiences with the NMT programme were also evaluated among currently active coaches who had not participated in the previous RCT (table 1). All female football teams with players aged 12 to 17 years that participated in the eight district FA series in 2012 were approached for recruitment. One coach per team was contacted, and each club was represented by one to five teams (figure 1). Contact was made irrespective of the coaches' previous knowledge and use of the programme. Coaches who had previously participated in the RCT were excluded from this group. All coaches were first contacted by e-

mail, and if no e-mail address was available, the coach was contacted by telephone (five attempts).

Questionnaires

Three web-based questionnaires were constructed in Swedish to evaluate the implementation of the NMT programme in the various target groups: one for the national and district FAs and one each for the trial coaches and current coaches (table 1). The first part of all questionnaires included general demographics (age, gender, affiliation, etc.), and the second part included specific items about the programme. The items were generated by the researchers and guided by the RE-AIM SSM. The items were pilot tested before the start of this study with one female adolescent football coach, not included in the present study, to assess face validity and usability of the questionnaires. Face validity was also ensured by the authors' differing experiences from both sports science, prevention and implementation research, and further by comments from the statistician responsible for the web-based questionnaire system. Inconsistent items or items with unclear wording were rephrased. Most items were polytomous and had fixed tick boxes, but a few questions were open ended. Open ended questions were used to validate answers in the fixed tick boxes questions and were not further addressed. It was possible to add comments in all questionnaires. In the questionnaires to the trial and current coaches, three items were rated on a numerical rating scale (NRS): (1) perception of the programme's effectiveness in reducing acute knee injuries, (2) perception of the programme's effectiveness in enhancing performance, and (3) satisfaction with the programme; 0 represented the least favourable option and 10 the most favourable. All respondents except the Swedish FA were ensured confidentiality. Consent was received to publish the results of the Swedish FA separately.

Statistical analyses

Most items in the three questionnaires were of nominal or ordinal scale level and are presented descriptively. The NRS was treated as an ordinal level scale and the results are presented as the median and interquartile range (IQR). Continuous values are presented as means and standard deviations (SDs). Results for the trial coaches are presented for the intervention and control groups together regarding perceived effectiveness and implementation, but presented separately regarding reach, adoption and maintenance. Analyses were only descriptive and were performed using the Statistical Package for the Social Sciences (IBM SPSS Statistics version 21).

RESULTS

The response rate was 36% among current coaches, 57% among trial coaches, and 100% among national and district FA representatives (figure 1). Respondent characteristics are presented in table 2.

Table 2 Implementation of the neuromuscular training programme according to the RE-AIM SSM framework

RE-AIM SSM dimension	National (n=1)	District (n=8)	Trial coaches (n=173)	Current coaches (n=179)
Respondent characteristics				
Males, n (%)	–	6 (75)	126/173 (73)	132/179 (74)
Age, years (SD)	–	–	46.3 (6.4)	43.8 (5.9)
Reach				
Knowledge of the programme, n (%)			CG 80/81 (99)	162/179 (91)
Effectiveness				
Injury prevention NRS, median (IQR)*			8 (2)	8 (3)
Performance improvement NRS, median (IQR)*			8 (3)	8 (2)
Satisfaction NRS, median (IQR)*			8 (2)	8 (3)
Coaches receiving complaints from players, n (%)				
More than a few			5/126 (4)	
A few			49/126 (39)	
No complaints			72/126 (57)	
Coaches receiving complaints from parents, n (%)				
More than a few			0/124	
A few			6/124 (5)	
No complaints			118/124 (95)	
Adoption				
Coaches using the programme, n (%)			IG 49/68 (72); CG 40/69 (58)	132/179 (74)
Implementation				
Fidelity with the programme, n (%)				
Use every week				63/179 (35)
Use sporadically				69/179 (39)
Do not use the programme				47/179 (26)
Use the entire programme †			10/43 (23)	34/130 (26)
Use programme with modifications †			33/43 (77)	96/130 (74)
Maintenance				
Presence of policies for programme implementation and use, n (%)				
Formal policy	Yes	0		
Informal policy		2 (25)		
Plans for policy		4 (50)		
No policy		2 (25)		
Routines for programme use, n (%)				
Have routines				16/178 (9)
Have plans				8/178 (5)
No routines or do not know				154/178 (87)
Education via the club, n (%)				
Education offered				45/175 (26)
Plans to offer education				10/175 (6)
No education				77/175 (44)
Do not know				43/175 (25)
Annual education for physiotherapists, n (%)				
2010	Yes	3 (38)		
2011	Yes	2 (25)		
2012	Yes	2 (25)		

Use of the programme in 2010, n (%)‡	
Use every week	IG 29/56 (52); CG 20/69 (29)
Use sporadically	IG 19/56 (34); CG 25/69 (36)
Do not use the programme	IG 8/56 (14); CG 24/69 (35)
Use of the programme in 2011, n (%)‡	
Use every week	IG 13/34 (38); CG 11/34 (32)
Use sporadically	IG 9/34 (26); CG 14/34 (41)
Do not use the programme	IG 12/34 (35); CG 9/34 (26)
Use of the programme in 2012, n (%)‡	
Use every week	IG 6/16 (38); CG 6/22 (27)
Use sporadically	IG 7/16 (44); CG 9/22 (41)
Do not use the programme	IG 3/16 (19); CG 7/22 (32)
Intention to continue using the programme, n (%)	IG 18/30 (60); CG 22/30 (73)

CG, Control group in the RCT; IG, Intervention group in the RCT; IQR, interquartile range; NRS, numerical rating scale (0–10); RE-AIM

SSM, Reach, Effectiveness, Adoption, Implementation and Maintenance Sports Setting Matrix.

* Median NRS (0-10 scale where 0 represented the least favourable option and 10 the most favourable) reported for trial coaches n=124-126, and current coaches n=104-106.

† Reported for the coaches who used of the programme.

‡ Reported for the total number of trial coaches still active each respective year.

Reach

The reach among the responding trial coaches from the previous control group was high, with 99% being familiar with the NMT programme. Among the current coaches, 91% reported that they were familiar with the programme (table 2).

Effectiveness

Satisfaction with the NMT programme and the coaches' confidence in the programme's ability to reduce acute knee injuries and enhance performance were high among both the trial and current coaches. Complaints from players were received at least once by 43% of the trial coaches, whereas complaints from parents were rarer (table 2).

Adoption

After completion of the RCT, 24% of the trial coaches from the intervention group and 14% of coaches from the control group quit coaching their team. Among the 68 intervention group coaches who carried on coaching the subsequent season (2010), 72% continued using the NMT programme. Among the 69 coaches in the control group who were

still active in 2010, 58% began using the programme (table 2). Among the current coaches, 74% reported that they used the programme.

Implementation

The fidelity with the intervention protocol was low, with 23% of the still active trial coaches using the programme without modifications. The corresponding figure among the current coaches was 26%. The programme was used every week by 35% of the current coaches and sporadically by 39% (table 2).

Maintenance

The Swedish FA had formal written policies regarding the implementation of the NMT programme and informal guidelines were present in two district FAs. Most of the current coaches (87%) reported that their club had not established any routines for the use of the programme. About one-quarter of the current coaches reported that their club offered coaches education in the programme (table 2).

Coach and physiotherapist education was held annually during 2010–2012 by the Swedish FA, and in the district FAs to a varying degree (table 2).

Among the trial coaches who carried on coaching female adolescent teams after 2009, the use of the NMT programme remained fairly stable over time. In 2012, 82% of the still active trial coaches from the intervention group reported using the programme to a full or partial extent, and the corresponding figure among coaches from the control group was 68% (table 2). An intention to carry on using the programme, or to start using it again, at the time of follow-up was expressed by 60% of the still active trial coaches from the intervention group and 73% from the control group.

DISCUSSION

This study showed, with the low response rate borne in mind, that the reach of the NMT programme was high among coaches of female adolescent football teams 3 years after an RCT. Regarding usage, 58–72% of the trial coaches and 74% of the current coaches had adopted the programme, and they rated the programme positively. The programme was fairly well maintained over time among the trial coaches, and many of them reported an intention to carry on using the programme. However, a worrying finding was the low fidelity with the programme with about three-quarters of the coaches reporting that they trained less than the recommended frequency or had modified the programme content. A lack of formal policies for implementation and use of the programme in clubs and district FAs was also identified.

Implementation by the national and district FAs

Educations in the NMT programme were held for coaches in five districts and for physiotherapists in three districts during 2010–2012. Furthermore, none of the district FAs had established formal policies for the implementation and use of the programme despite efforts to promote its use by the Swedish FA. The presence of guidelines and the availability of internal education was sparse within the clubs according to the current coaches. Regional and national guidelines for the practical implementation of injury prevention programmes within teams and formal training for coaches have been emphasized as important facilitators for successful injury prevention work in sports teams.[15] This study highlights the need for continuous educational efforts by the district FAs and the Swedish FA. The programme is well adopted by the Swedish FA and education is currently being initiated and sponsored by the Swedish FA nationwide. It is possible that educational sessions for coaches in the districts were also held by other organisations, such as the developer of the programme (SISU

Idrottsböcker, Sweden), or by physiotherapists not under the auspices of the district FAs, but this was not studied specifically in the current study.

Implementation among coaches

Information about the programme had reached most of the current coaches, which is positive and implies that almost all coaches have had the opportunity to implement the programme within their team. However, knowledge about an efficacious programme does not necessarily imply that it is being used.[26] The positive perceptions about the current NMT programme regarding injury prevention and performance enhancement and the overall satisfaction with the programme probably facilitate its implementation and maintenance, because the coaches' attitudes are crucial when introducing an intervention.[15, 27]

The adoption of the programme among coaches in the current study (58–74%) was similar to a previous study (67%) where an NMT programme was introduced among senior male and female basketball players.[28] By contrast, in another study on female adolescent footballers, only 20% of the coaches who responded (response rate 12%) had adopted an NMT programme to prevent ACL injuries.[29] Based on these results, the findings of the current study are positive. Possible reasons might be that the programme's injury preventive effect had been emphasized by the national FA, that the perceived complexity of the programme was low and that it was compatible with the coaches' usual practice. All these factors could affect the implementation of innovations. Additionally, the programme was easily available for all coaches owing to the educations held free of charge by the FAs. In the aforementioned study on female footballers,[29] there was no similar national initiative to introduce an NMT programme. Despite the fairly high adoption of the programme, a shortcoming was the low fidelity with the programme. Many coaches had modified the programme and thereby only used some exercises per session (74-77% of those who used it)

or did not perform the programme regularly throughout the entire season (52-60% of those who used it). No analysis was, however, done on whether the same coaches modified both the number of exercises per session and the frequency of the training. In the original RCT, only players who were compliant with the programme had a reduced rate of ACL injury,[13, 23] hence regular use of the programme must be advocated. Another finding from the RCT was that the use of the programme and player attendance at football training deteriorated over the season.[23] The problem with low attendance among players has been attributed to the club culture, a challenge that needs to be faced by the coaches.[30] Furthermore, the effect of programme alterations on the injury preventive effect has not been studied, and it is therefore not known which of the programme's components are effective and whether components can be excluded without compromising the injury preventive effect. Hence, reasons for the low fidelity with the current NMT programme need to be explored further.

Lack of knowledge among coaches about how to implement a programme and how to give feedback to players about their performance,[29] lack of time and poor motivation among players and/or parents have been reported as reasons for modifying similar NMT programmes in football and netball.[29, 31] When coaches experience such barriers, the compliance with the programme may also be low.[27] It has not been established whether coaches faced similar barriers with the programme evaluated in this study, but 43% of the trial coaches had received complaints from players about the programme.

The use of the NMT programme among the trial coaches was fairly well maintained over time, although it should be borne in mind that the number of still active coaches deteriorated substantially. Few studies have evaluated the maintenance of NMT interventions over time. One study in Swedish female adolescent football reported that 63% of intervention group teams still used the programme one year after the study,[6] and a study in Swiss

amateur football showed that 57% of coaches still used an NMT programme 1 to 3 years after its introduction.[32] These results are in line with the present study where 60% and 73% of coaches from the former control group and intervention group, respectively, still used the programme 3 years after the RCT.

Methodological considerations

The follow-up was based on the RE-AIM SSM framework, which is an established model to evaluate interventions in sports settings.[14] Use of all five dimensions of the RE-AIM SSM together with the inclusion of four different target groups make this a thorough evaluation of the implementation of the NMT programme. The follow-up was done 3 years after the completion of the RCT, which is in accordance with the recommended times for evaluating implementation (>6 months) and maintenance (>2 years) after introducing an innovation.[14]

Some further limitations of this study other than those already discussed should be acknowledged. First, the response rate among the trial coaches was relatively low, possibly due to the time delay since the completion of the RCT and the fact that many teams had split up or coaches had quit coaching. The response rate among the current coaches was even lower, and it is possible that coaches with favourable experiences of the programme responded to a greater extent. Thus, because of the low response rates, there is a risk of overestimating the use of the NMT programme and its perceived effects and the results should be treated with some caution. Second, the questionnaires used were not validated except for the assessment of face validity. The questionnaires were pilot tested, but this could have been more thoroughly done by including more coaches and by conducting cognitive interviews beforehand to establish how the respondents reason and better establish the content validity of the questionnaires. Third, potential confounders, such as coaching

experience and level of coaching education, and the teams' level of play, were not taken into account. A majority of coaches reported some kind of coaching education (unpublished data) but we were unable to determine the quality and magnitude of these educations from the questionnaires, and this was not analysed further. Fourth, the study relied on self-reported data, which may be influenced by a tendency among responders to answer in a way that they perceive as desirable, so-called social desirability. Fifth, facilitators and barriers for prolonged use among the coaches were not studied, which may be necessary to further improve the maintenance of the programme. The coaches' perspective was not fully covered. Developing and evaluating innovations from the end users' perspective has been proposed as vital to make interventions truly usable, effective and sustainable in the real world.[33] Further qualitative studies are therefore needed to deeper understand the coach perspective of the NMT programme, as well as other stakeholders, such as the players and their parents.

Conclusions

In this study on the implementation of a NMT programme in female adolescent football, reach and adoption of the programme was high among coaches. However, the study also identified low programme fidelity and lack of formal policies for its implementation and use. Further qualitative studies are therefore suggested to gain deeper understanding of the different stakeholders' perspective of the NMT programme.

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Contributor statement

HL, MW, SC and MH were responsible for the conception and design of the study. HL was involved in the data collection over the study period and conducted the analyses, which were planned and checked with the co-authors. All authors contributed to the interpretation of the findings and had full access to all data. HL wrote the first draft of the article, which was critically revised by the other authors. The final manuscript has been approved by all authors. MH is the study guarantor.

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Competing interests

MH and MW were on the medical staff of the male under-19 national team of the Swedish FA between 2007 and 2011.

Ethics approval

The study design was approved by the regional ethical review board in Linköping (2012/299-31).

Provenance and peer review

Not commissioned; externally reviewed.

WHAT ARE THE NEW FINDINGS?

- The reach, perceived effectiveness and adoption of a neuromuscular training programme was fairly high, even though the response rate was quite low, among female adolescent football coaches 3 years after the programme was introduced in an RCT.
- The neuromuscular training programme was fairly well maintained over time among coaches who had used the programme since the RCT.
- Many coaches had modified the programme or used it only sporadically, revealing low fidelity to the programme protocol.

HOW MIGHT IT IMPACT ON CLINICAL PRACTICE IN THE NEAR FUTURE?

- The coaches are key persons in the initiation and maintenance of injury prevention training in youth sports. They may, however, be faced with lack of support from the club or regional sports associations, and adoption of policies regarding implementation and use of injury prevention programmes in clubs and sports associations is warranted. Additionally, the players do not always judge the training positively. Modifications to the current neuromuscular training programme must be made with caution because it is unknown how they may affect the injury preventive effects. Coaches may need support to overcome possible barriers that may reduce the maintenance or fidelity of training interventions.

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Figure 1 Enrolment and inclusion of respondents in the national and district football associations and among trial coaches and current coaches.

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