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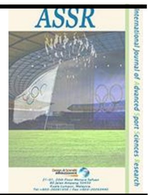

Assessment of Effects Prevention Programmes on Specific Performance in Young Soccer Players

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ABSTRACT

In this article we review effects of prevention programmes on specific performance. Soccer is the most popular sport in the world. Unfortunately players get injured during soccer play. Many researchers have shown a disparity in injury incidence between male and female soccer players. Training programs have been developed to prevent injuries among youth players. These programs are also aimed at improving soccer specific performance. In this article we review the different of prevention programs including comparison between training prevention programs on effects in preventing injury, the results of nineteen performance studies on injury prevention programs. This suggests that the implementation of the programs due to low attendance to soccer training sessions resulting in low player compliance with the programs and lower training frequency than intended. The low compliance may be one reason for the lack of results, and another part of the lack of results may be due to the inability of the test measurements to truly measure training benefits of the previous programs. Therefore a couple of studies have investigated if injury prevention programs may improve performance at the same time, which theoretically will improve compliance with the program.

***Keywords:* soccer players, prevention program, training, injury risk**

Introduction

Participating in sports on a regular basis is considered a vital component of an active and healthy lifestyle to reduce the risk of various diseases and to contribute to better social and physical performance. To some extent, however, sports injuries are inevitable.

The incidence rate of soccer injuries is among the highest of all sports, particularly for young male and female soccer players (Schmikli et al, 2011). Soccer is a high-intensity sport characterized by continuous changes of direction and high-load actions. Participating in soccer imposes high demands on neuromuscular control, agility and eccentric/concentric strength. Most soccer injuries are related to the lower extremities, in which muscle injuries are among the major problems (Ekstrand et al, 2011; Emery et al, 2005). Several studies have shown that the incidence of football injuries can be reduced by adopting various injury prevention strategies including: warm-up, with an emphasis on stretching; proper medical attention for injuries; appropriate recovery methods and time; appropriate cool-down; use of protective equipment; good playing field conditions and adherence to existing rules (Dvorak et al., 2000; Ekstrand et al., 1983; Hawkins and Fuller, 1999).

Injury prevention programs may be more effective if the compliance with the program is high (Van Toggle et al, 2008). Van Toggle et al. (2008) have proposed that injury prevention programs and player behavior in sports should be integrated in the ordinary training at young ages to make those measures routine later in life. The compliance with injury prevention programs is thought to improve if the program is designed as a warm-up program (Renström et al, 2008) and non-compliance is probably less frequent when training under supervision compared to home-exercise programs (Taylor et al, 1996).

Emery et al. (2007) showed in a study on high school basketball players that less than 60% of the players performed the injury prevention balance program at home even once and far less players performed the program as often as intended. DI Stefano et al. (2010) points to the great importance of supportive parents and coaches to achieve better compliance in youths, which may be a problem otherwise. Kiani et al. (2010) reported that most of their involved teams indicated the compliance to be more than 75% (from a scale ranging between less than 50%, more than 50%, more than 75% or 100% compliance), which may be one reason for the good results in injury prevention.

The compliance may have been high since the program was constructed to be part of the regular warm-up and with easily accomplished exercises. Pfeiffer et al. Reported difficulties in introducing an injury prevention program to the coaches and to make them change their training protocols, and consequently no injury incidence reduction were seen. Sometimes it can be hard to motivate the coaches and players to introduce injury prevention programs if you can’t offer some performance improvement at the same time (Vescovi et al, 2010).

Definition of injury

Variations in the definitions and methodologies used in injury epidemiology have contributed to differences in results and conclusions from published investigations. Therefore, some terms and definitions related to sports injury require clarification. The National Athletic Injury Registration System (NAIRS) has defined a sports injury to be an injury which occurs as a result of participation in sports and which limits the athletic participation for at least one day after onset (van Mechelen et al., 1992). A recent consensus statement on injury definitions and data collection procedures in football suggested that an injury is “Any physical complaint sustained by a player that results from a football match or football training, irrespective of the need for medical attention or time loss from football activities”. An injury that results in a player receiving medical attention is referred to as a ‘‘medical attention’’ injury, and an injury that causes the player to be unable to fully take part in match or training sessions the day following the injury is referred to as a “time loss” injury (Fuller et al., 2006).

In most epidemiological studies, regardless of sport, the time loss injury definition as used by NAIRS has commonly been used (Östenberg & Roos, 2000; Söderman et al., 2000 ; Myklebust et al., 2003; Faude et al., 2005; Hägglund et al., 2007; Olsen et al., 2005; Waldén et al., 2005a; Ekstrand et al., 2006; Árnason et al., 2008). However, in tournament football play, Junge et al. (2006) have made use of a definition which defines an injury irregardless of the consequences with respect to absence from the match or training (“tissue” injury definition). A few other studies in female football have limited injury recording to those injuries which were defined as requiring medical treatment or evaluated for insurance claims (Giza et al., 2005).

The time loss and tissue injury definitions have been useful in comparing injury epidemiology within and between sports. However, researchers should be careful of certain limitations when applying these injury definitions. When including time loss injuries only, accuracy in injury recording will depend on the frequency of training and match sessions in the particular study population. Minor injuries in particular can easily be missed in amateur and youth football when there is not play every day, and comparison to higher level play can be biased. Furthermore, easy access to health care, which is the expected standard at the top, first and second division male football, but not necessarily in female and youth football, will also influence the decision as to whether a player will be ready or not to play the day following the injury.

One other limitation of the time loss definition is its sports specificity, as shown by the example of a broken finger. This fracture will usually stop a team handball, basketball or volleyball player from sports participation, but not a football outfield player. The tissue injury definition on the other hand, allows all complaints to be recorded within the particular sport of interest and includes slight injuries which do not necessarily affect players´ health, for example pain, blisters, or skin abrasions. Since these injuries often do not stop the player from playing nor do they require further medical follow-up, high-quality injury recording relies on staff awareness in detecting every tissue injury.

Closely related to the issue of injury definition, is the classification of injury severity, necessary for a comparison between studies. Severity can be described using the following criteria: nature and duration of injury, type of treatment, sporting time lost, working time lost, permanent damage, and costs (van Mechelen et al., 1992). The most frequently used classification systems for injury severity, independent of sport, are based on the number of days of absence from matches or training. NAIRS classifies injuries as minor (1-7 days absence), moderate (8-21 days absence) or major (>21 days absence) (van Mechelen et al. 1992).

According to the latest consensus discussions in FIFA (Federation of International Football Associations) and UEFA (Union of European Football Associations), injury severity is categorized into four categories, slight (1-3 days absence), minor (4-7 days absence), moderate (8-28 days absence) and major (>28 days absence) (Hägglund et al., 2007). This classification system is a further development from that of Ekstrand et al. (1983) which combined slight and minor injuries in one category, “minor”, with 1-7 days absence from play. The latter two injury classifications have primarily been used in investigations with elite players, in male (Waldén et al., 2005a) and female football (Engström et al., 1991; Söderman et al., 2000; Faude et al., 2005) although the exact number of days of absence varies slightly between studies.

However, it is now strongly recommended, regardless of playing level, to follow the football consensus statement (Fuller et al., 2006) and split the first week (1-7 days absence) into “slight” and “minor”. The incidence of injury is usually expressed as the number of injuries per 1000 playing hours of exposure, with one exception. In many studies from North America, one athlete participating in one training session or match is defined as a unit of risk (Agel et al., 2005; Kucera et al., 2005; Dick et al., 2007), since this is the recording method established in the NCAA injury surveillance system. The duration in hours of one training g session or match is not taken into consideration when calculating exposure. Consequently, studies presenting data as the number of injuries per 1000 player hours of exposure vs. per 1000 athlete exposures is not fully comparable.

Injury prevention

So far only 14 injury prevention intervention studies have been carried out on a world-wide basis in football (Table 1) even though the first study was done as long as 25 years ago and with very promising results (Ekstrand et al., 1983). In this study, the intervention group sustained 75% fewer injuries than the control group. More recently, research groups tested different prevention approaches, such as or those (Tropp et al., 1985; Surve et al., 1994), balance training (Caraffa et al., 1996), eccentric hamstring strength training (Askling et al., 2003; Árnason et al., 2008), a video-based awareness program (Árnason et al., 2005), and multimodal exercise programs (Junge et al., 2002; Engebretsen et al., 2008; Hägglund et al., 2007). All prevention approaches except two (Árnason et al., 2005; Engebretsen et al., 2008) could report a reduction of injuries in the intervention period. We do not know if this knowledge of male football can be transferred to the females.

In female football, less scientific work has been done, and until now, there are only three studies published on female football players alone (Heidt et al., 2000; Söderman et al., 2000; Mandelbaum et al., 2005). Additionally, there are two studies which included both genders (Hewett et al., 1999; Johnson et al., 2005) and athletes from several sports, including football players (Hewett et al., 1999). These five studies have focused on the prevention of injuries in general (Söderman et al., 2000; Johnson et al., 2005) or on ankle and knee injuries (Hewett et al., 1999; Heidt et al., 2000; Mandelbaum et al., 2005). Hewett et al. (1999) evaluated the effect of a neuromuscular training program on the incidence of knee injuries in female team sport athletes, where 290 of 1 263 were football players.

They found a trend towards a higher incidence of ACL and MCL (medial collateral ligament) injuries in the control group compared to trained female players in the intervention group. In another non-randomized study, Heidt et al. (2000) examined the effect of a 7-week pre-season training program among 300 female football players at the high school level (aged 14-19 years). A total of 42 players went through a training program consisting of warm up exercises, plyometrics (jump training), strength and flexibility training. Players in the intervention group had significantly fewer injuries than those in the control group. However, the results must be evaluated with caution due to the low study power.

Söderman et al. (2000) examined the effect of balance board training among 221 senior female players at various levels. The players were randomized to train on a balance board daily for 30 days, then three times a week during the season, or to the control group, training as normal. In contrast to the results of Caraffa et al. (1996) who performed a similar study on male semiprofessional players, Söderman did not find any protective effect for ACL injuries in the intervention group. Again, the power of the study was low which suggests careful interpretation of the results in order to conclude that balance board training alone at least based on a home training program, is not sufficient to prevent ACL injuries in females. In five-month approaches with male and female elite football players in Sweden, Johnson et al. (2005) identified players at high injury risk by screening them with a questionnaire for psychosocial risk factors.

High-risk players (9 female and 7 male players) received intervention including relaxation and imagery training, which lowered the number of injuries within four months of intervention. Mandelbaum et al. (2005) conducted a neuromuscular and sports-specific training program over two seasons on about 3 000 14- to 18-year old female football players. The intervention consisted of education, stretching, strengthening, plyometrics and sports-specific agility drills. Their results showed an 88% decrease in ACL injuries in the enrolled players compared to the control group during the first year. In year two, the reduction was 74%. However, this study was not randomized. In conclusion, there is still a lack of well-designed studies on injury prevention among female footballers, most likely due to limited knowledge of the causes and mechanisms of injuries, which again makes it difficult to develop targeted preventive measures.

As shown in studies from football and team handball, several programs have successfully incorporated one or more exercise components to prevent injuries, e.g. plyometrics, strength, neuromuscular training, or running and cutting movement patterns, to prevent injuries in female (Hewett et al., 1999; Heidt et al., 2000; Myklebust et al., 2003; Mandelbaum et al., 2005; Olsen et al., 2005) and male athletes (Askling et al., 2003). However, as compliance is a concern in injury prevention (Myklebust et al., 2003), it may be difficult to motivate coaches and players to follow such exercise programs merely to prevent injuries, unless there is a direct performance benefit, as well.

Comprehensive neuromuscular training programs that combine plyometrics, core strengthening, balance, resistance or speed/agility training may improve several measures of performance concomitantly, and at the same time improve biomechanical measures related to lower extremity injury risk (Hewett et al., 2004; Paterno et al., 2004; Myer et al., 2005; Myer et al., 2006). FIFAs Medical Assessment Research Center (F-MARC) has recently developed a specific training program, the “11” in order to prevent the four most common injury types in football, i.e. Injuries to the ankle, knee, hamstring and groin. The exercises composing the “11” represent an evidence based rehabilitation exercises for lower limb injuries (F-MARC, 2005) and key exercises from other effective injury prevention programs. The “11” has been feasibility tested in a pilot study as “F-MARC bricks” (Jung et al., 2002) and thereafter been modified to the final “11”.

Table 1. Injury prevention studies designed to reduce the risk of injuries in female and male football players.

Study	**Level Number Age**	**Design Follow-up**	**Injuries**	**Intervention***	**Effect of intervention**
Male players Jung et al. 2002	Youth n=194 14-19 years	Prospective Cohort 1 Year	All	Multi-modal program	21% fewer injuries in the intervention group (n.s.)
Caraffa et al. 1996	Elite + amateur n=600 Age unknown	Prospective Cohort 3 years	ACL	Balance training	87% fewer ACL injuries per team in the intervention group
Surve et al. 1994	Elite + amateur n=504 Age unknown	RCT 1 season	Ankle sprains	Semirigid ankle orthosis	60% lower incidence of ankle sprains in the intervention group, no effect for players without previous ankle sprains
Tropp et al. 1985	Amateur n=439 Age unknown	RCT 6 months	ALL	Multi-modal program	75% fewer injuries in the intervention group

*The control groups were generally asked to continue their regular training habits and train as usual.
RCT=Randomized controlled trial.

Table 1. To be continued.

Study	Level Number Age	Design Follow-up	Injuries	Intervention*	Effect of intervention
Female players Mandelbaum et al. 2005	Youth n=2946 (1041 in the intervention, 1905 in the control groups) 12-18 years	Prospective Cohort 2 years	ACL	Neuromuscular training program flexibility, plyometrics, weight training	74-88% fewer ACL injuries in the intervention group
Söderman et al. 2000	Amateur n=221 (121 in the intervention, 100 in the control groups) x=20±5 years	RCT 7 months	Acute lower extremity	Balance board training at home; 10-15 min initially each day for the first 30 days, and then 3 times per week during the rest of the season	No injury reduction in the intervention group, but a significantly higher incidence of major injuries in the intervention group
Heidt et al. 2000	Youth n=300 (42 in the intervention, 258 in the control groups) 14-18 years	Prospective Cohort 1 year	ALL	7-week preseason Program of sport specific conditioning, Plyometric training, sport cord drills, strength and flexibility exercises; 1-2 times weekly	41% fewer injured players in the intervention group
Hewett et al. 1999	Youth n=290 (97 in the intervention, 193 in the control groups) 14-18 years	Prospective Cohort 1 year	ACL, MCL	Neuromuscular training program flexibility, plyometrics, weight training; 60-90 min 3 times weekly for 6 months in preseason	Trend towards fewer knee injuries in the intervention group
Female and male players Johnson et al. 2005	Elite n=32 (16 in the intervention, 16 in the control groups Females: 20.1 yrs Males: 22.9 years	RCT 6 months	All	Cognitive behavioral training with relaxation and imagery training	83% fewer injuries in the intervention group
Male players Hägglund et al. 2007	Amateur n=482 15-46 years	RCT 10 months	All	10-step rehabilitation program	66%-75% fewer re-injuries in the intervention group
Engebretsen et al. 2007	Elite + amateur n=508 Age unknown	RCT 8 months	Ankle and Knee sprains, hamstring and groin strains	Neuromuscular and/or strength training programs	No effect in the intervention group
Árnason et al. 2007	Elite n= ca. 600 Age unknown	Prospective Cohort 2 seasons	Hamstring strains	Stretching, Flexibility and/or Eccentric hamstring training	35% fewer hamstring strain in the group training with both eccentric strength and flexibility compared to that training flexibility alone
Árnason et al. 2005	Elite + amateur n= ca. 350 Age unknown	RCT 6 months	All acute	Educational video-based Awareness program	No effect in the intervention group
Askling et al. 2003	Elite n=30 24 years	RCT 11 months	Hamstring strains	Pre-season strength training	70% fewer injured players in the intervention group

*The control groups were generally asked to continue their regular training habits and train as usual.
RCT=Randomized controlled trial

The effects of injury prevention programs on performance

The programs that have been used for injury prevention, for example “The 11”, PEP and “The 11+” are also aiming at improving performance in soccer, but there is disagreement whether the programs actually can improve performance. According to Griffin et al. (2006), however, it seems logical that injury prevention programs may improve performance. Some studies have examined the effects on performance of injury prevention programs in children and adolescents (Table 2).

The studies by Vescovi & VanHeest (2010), Steffen et al. (2008) and Grandstrand et al. (2006) were performed on female soccer players between 9 and 18 years of age, the study by DiStefano et al. (2010) was performed on youth male and female soccer players and the study by Kilding et al. (2008) was performed on boys at the age of ten. The studies by Kilding et al. (2008) and DiStefano et al. (2010) showed improvements of some aspects of the soccer specific performance after completion of an injury prevention program, while the studies by Steffen et al. (2008) and Grandstrand et al. (2006) didn’t show any improvement at all and the study by Vescovi & VanHeest (2010) showed a temporary improvement of sprint times for longer distances.

The training is thought to work specifically on the functions trained and is not always observable when evaluating in a different way than the training was performed. All injury prevention programs for youth players except the program by Kilding et al. (2008) were used as part of the warm-up before soccer training. The program by Kilding et al. (2008) was used in connection with soccer practice once a week and was performed at home four times per week for six weeks. If the injury prevention program was given more time during training it was thought that it wouldn’t be used by many coaches for the program would interfere with the soccer training, which is the very reason for the players’ attendance.

In the study by DiStefano et al. (2010) two different injury prevention programs were used-one traditional and one pediatric program. Both programs included strength, plyometrics, core strengthening, balance and agility training with progression of the exercises and took 12-14 minutes to complete. The pediatric program had more gradual changes, which was assumed to be more suited for the children, however significant improvements were only seen in the group performing the traditional program. Kilding et al. (2008) showed improvements in jump height and sprinting performance, while agility and core stability didn’t improve after performing “The 11” five times per week. Steffen et al. (2008) also studied “The 11” but only three times per week and in connection with soccer training.

No performance improvements were seen. Much supervision was used in the performance studies by DiStefano et al. (2010) and Kilding et al. (2008) with the aim of improving compliance and correct performance, which may be one reason for the improvements seen in these studies. Vescovi & VanHeest (2010) evaluated the effect of the PEP-program on performance and minor improvements were seen in sprinting performance after six weeks of training. Grandstrand et al. (2006) evaluated the WIPP program (The Sports metrics Warm- Up for Injury Prevention and Performance program) by Cincinnati Sportsmedicine Research and Education Foundation.

The program included plyometrics, strength and flexibility exercises and was performed in youth female players as 20 minutes warm up before soccer practice. The kinematics of jumping and maximum vertical jumping height was evaluated. No significant improvements were seen after the intervention period, probably partly due to the inability of the players to perform all exercises correctly, which forced the authors to adjust some of the exercises in the program (Grandstrand et al, 2006).

Table 2. The results from five performance studies on injury prevention programs

Study	Population and age	Programs	Frequency and duration	Effect (* = no significant improvement, # = significant improvement)
DiStefano et al. (2010)	Girls and boys, 10 years	One traditional, one paediatric Program	2-3 times per week, 9 weeks	* balance, CMJ of the paediatric programme # balance, CMJ after the traditional programme
Vescovi & VanHeest (2010)	Girls, 16 vs. 17 years	PEP	3 times per week, 12 weeks	*CMJ, Illinois agility test, Pro-agility, 9.1 and 18.2 m sprint times # 27.3 and 36.6 m sprint Times over 6 weeks (not after 12 weeks)
Steffen et al. (2008)	Girls, 17 years	”The 11”	3 times per week, 10 weeks	* isokinetic torque, isometric hip strength, CMJ, vertical drop jump, rebound jump, video analysis of the former two jumps, 40 m sprint times, football tests
Grandstrand et al. (2006)	Girls, 10 years	WIPP	2 times per week, 8 weeks	* landing strategies
Kilding et al. (2008)	Boys, 10 years	”The 11”	5 times per week, 6 weeks	* Illinois agility test, core Stability #CMJ, 20 m sprint times, three step jump

CMJ = countermovement jumps

Conclusion

This suggests that the implementation of the programs due to low attendance to soccer training sessions resulting in low player compliance with the programs and lower training frequency than intended. The low compliance may be one reason for the lack of results, and another part of the lack of results may be due to the inability of the test measurements to truly measure training benefits from the previous programs. Therefore a couple of studies have investigated if injury prevention programs may improve performance at the same time, which theoretically will improve compliance with the program.

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