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Is a structured comprehensive warm up program effective in preventing injuries in female soccer players?

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Abstract

OBJECTIVE:

The objective of this systematic review is to determine whether or not a comprehensive warm up program is effective in preventing injuries in female soccer players.

STUDY DESIGN:

Review of three English language primary double blind cluster randomized controlled trial studies published between 1996 and the present.

DATA SOURCES:

Randomized controlled trial studies were found using Ovid MEDLINE.

OUTCOMES MEASURED:

Each of the three studies evaluated the number of players who were injured throughout the soccer season. Injuries were defined as a physical injury “causing the player to be unable to fully take part in the next match or training session.” Injuries were also further divided into the type and severity of injury.

RESULTS:

Three double blind cluster randomized controlled trials were included in this review. The study by Steffen, which analyzed the “11” program, did not show any difference in the incidence of injury between those who participated in the comprehensive warm up program and those in the control group. In the study by Gilchrist analyzing the PEP program, the overall incidence of all knee injuries did not meet significance. However, when analyzing late season ACL tears and ACL tears occurring during practices, they both met statistical significance and were reduced in the intervention group. Finally in the 11+ program, which was a combination of both the PEP and “11” program, the overall incidence of injuries was reduced with an absolute risk reduction of -0.68 and a p value of 0.041 meeting statistical significance.

CONCLUSIONS:

In analyzing three studies on the effect of comprehensive warm up programs on the incidence of injuries in female soccer players, two of the three studies showed a significant decrease in the injury rates. One study showed no difference in the incidence but this was more than likely due to low compliance. Overall, it can be concluded that if athletes are compliant in a comprehensive warm up program, they will indeed decrease their incidence of injury.

KEY WORDS:

Soccer, Injury

Introduction

Sports injuries are common in young female athletes. Injuries can have detrimental effects on athletes such as missing an entire season or ending the career of a young athlete far before their career has even begun. While some injuries may be unavoidable, others may be prevented with different modalities such as braces, warming-up, strength training, and limiting playing and practice time. This paper evaluates whether a comprehensive warm up before practices and games will in turn decrease the incidence of injuries in young female soccer players.

Over the years, soccer has been the most popular team sport in the world.⁵ The most common injuries are those to the knee or ankle ligaments and thigh strains.⁵ In 1999, there were 477,647 soccer injuries, which cost a total of 6.7 billion dollars.³ In 1997-1998, approximately 2.6 million emergency room visits were sports and recreation-related for people ages 5-24 years.² When including all medical care, 4.5 million annual sports and recreation-related injuries were reported in the same year.²

Anterior cruciate ligament tears in particular can be detrimental to an athlete's career. ACL injuries usually require surgery along with months of rehabilitation, in addition to increasing the risk for the development of degenerative arthritis.⁵ Furthermore, the price of an ACL rupture is costly, with conservative estimates of surgery and rehabilitation at \$17,000 to \$25,000 per injury.¹

Studies have shown that women are three to five times more likely than men to injury their anterior cruciate ligament, however it is still under investigation as to the reasoning and mechanism involved.⁵ In addition, it is unknown why certain athletes will never have an injury even without strength training or warming up, while other players

who meticulously train and warm up may still be predisposed to injuries.

Typically athletes use a variety of methods to prevent injuries. These can include methods such as splints, jogging, stretching, strength training, balance exercises, and core exercises. Many times these methods are used either alone or most often in combination.

Currently, warm up regiments are not standardized and many teams use one or more of the above approaches. The PEP program, the 11, and the 11+ program are comprehensive programs which incorporate strength training, jogging, stretching, balance and core training. It is proposed that by standardizing warm up programs and incorporating a variety of warm up modalities it will further prevent injuries in female soccer players.

Objective

The objective of this systematic review is to determine whether or not a structured comprehensive warm up program effective in preventing injuries in female soccer players.

Methods

In order to find articles for this paper, the author searched Ovid MEDLINE, by using the keywords “soccer” and “injury.” All articles were published in a peer review Journal in 2008 and were in English. In addition, all articles were based on outcomes that matter to patients known as POEMs, or Patient Oriented Evidence that Matters. All studies were conducted on female soccer players aged 13-23 years old. Studies were conducted using three different comprehensive warm up programs: the PEP program, the 11 program, and the 11+ program. These results were compared to a traditional team lead warm up, which varies according to the specific team and their routine warm up

plan. Injuries were defined as a physical injury “causing the player to be unable to fully take part in the next match or training session.” All studies were cluster randomized controlled trials and demographics of the studies can be found in Table 1. Athletes were included in the studies if they were female soccer players who voluntarily chose to participate and were either NCAA teams, 17 and under clubs, or in the 15 and 16 year old division in the Norwegian Football Association. Athletes were excluded if they participated in the pilot study of the PEP the previous year. Results were reported based on p values, rate ratio, number needed to treat.

Outcomes Measured

In the study by Gilchrist, athletic trainers reported weekly participation in the program along with the number of knee injuries. Knee injuries were defined as, “an injury to the area about the knee occurring in a game, practice, or conditioning activity that required medical care by ATC or physician, and caused one or more missed days of training.” Injuries were subdivided based on occurring during practice or games, the structure of the injury, specific injury diagnosis, number of days lost from practice and games, and whether the injury was a contact or non-contact injury. ACL injuries were only reported if they were confirmed via MRI, arthroscopy or direct visualization during surgical repair. In order to compare the warm ups of the control versus interventional teams, 4 interventional teams and 4 control teams were directly observed by those conducting the study.⁴

In the study by Soligard, all lower extremity injuries were recorded. This included those to the foot, ankle, lower leg, knee, thigh, groin or hip. All injuries were recorded beginning after the first prevention training session by coaches of the various

teams. In addition, coaches also recorded the extent to which the 11+ program was implemented. All injured players received a questionnaire to further assess their injuries. Injuries were only included if they occurring during a match or training session and subsequently caused the player to be unable to fully participate in the next match or training session. Injuries were subdivided into acute, “an injury with sudden onset associated with known trauma”, overuse, “an injury with gradual onset without known trauma”, and re-injury,” injury of the same type and location sustained previously.” Injuries were also subdivided into their severity, which was measured based on the number of days the patient was unable to participate. Minimal injuries occurred when a player missed 1-3 days, mild injuries occurred when a player missed between 4-7 days, moderate injuries were defined as a player missing 8-28 days, and severe injuries resulted in a player missing more than 28 days of games and or practices.⁵

Finally, in the study conducted by Steffen, 18 physical therapists were recruited to record injuries. All injuries were recorded starting after the first prevention training session. All injured athletes received a questionnaire to subdivide their injuries. An injury was recorded if it “caused the player to be unable to fully take part in the next match or training session.” Injuries were further divided into acute, an injury with sudden onset, and overuse injuries, which were gradual onset without known trauma. Injuries were also divided based on contact versus non-contact, as well as whether the injury was recurrent. The injuries were divided based on the duration of the player’s absence from participation in matches and practice. A minor injury caused the player to miss 1-7 days, a moderate injury caused the player to miss 8-21 days, and a major injury caused the player to miss more than 21 days.⁶

Table 1: Characteristics of studies included in Systematic Review in determining whether or not a structured comprehensive warm up program is effective in preventing injuries in female soccer players.							
Study	Type	#Pts	Age (yrs)	Inclusion Criteria	Exclusion Criteria	W/D	Interventions
Steffen et al., 2008	RCT	2020	13-17	Female soccer players in the 15-16 year divisions of the Norwegian Football association, 2-5 practices per week and 15-30 matches per season	Those not meeting the inclusion criteria. No specific exclusions criteria noted.	48	Patients randomized to warm up via their traditional warm-up programs or The 11+ warm up plan
Soligard, et al., 2008	RCT	34	16-18	Uninjured Female soccer players in the 17 and under division in the Southeast region of the Norwegian Football association	Those not meeting the inclusion criteria. No specific exclusions criteria noted.	3	Patients randomized to warm up via their traditional warm-up programs or The 11 warm up plan
Gilchrist, et al., 2008	RCT	1435	17-23	NCAA Division I women's soccer teams	14 teams who participated in the pilot study conducted the previous year	0	Patients randomized to warm up via their traditional warm-up programs or The PEP warm up plan

Results

Of the 2020 players included in Steffen's study of the "11" program, 396 players sustained at least one injury during the 8 month season, 57 players were injured twice and 15 players were injured three times. The total number of injuries was 483. 86% of injuries occurred to the lower extremities and 58% of the injuries occurred due to player-to-player contact. When the intervention group was compared to the control group, no significant difference was noted in the proportion of injuries (19% compared to 20.3%).

In addition, the intention-to-treat analysis also showed no difference in the overall injury incidence. The relative risk for the intervention versus the control group was 1.0 (CI 0.8–1.2, $p=0.94$) for all injuries. The study also did not find any significant differences in the distribution, type, location, or severity of injuries as noted in Table 2.⁶

	Control Injuries	Control Incidence	Intervention injuries	Intervention incidence	Rate ratio (INT vs CON)
All injuries	241	3.7 (3.2-4.1)	242	3.6 (3.2-4.1)	1.0 (0.8-1.2)
Acute injuries	210	3.2 (2.8-3.6)	211	3.2 (2.7-3.6)	1.0 (0.8-1.2)
Contact	124	1.9 (1.6-2.2)	118	1.8 (1.5-2.1)	0.9 (0.7-1.2)
Non-contact	86	1.3 (1.0-1.5)	93	1.4 (1.1-1.7)	1.1 (0.8-1.5)

The incidence is reported per 1000h of exposure with 95% CI.

In analyzing compliance, the 58 teams in the intervention group performed the “11” program a total of 23 times (SD 9, range 2-42) during the season which included an average of 44 training sessions (SD 16, range 19-90). This represents a use of 52%. None of the control groups were reported to have a comparable warm up program to the “11”. In determining if compliance may be a factor in determining the significance of the study, the intervention group was divided into two sub-groups: those who performed at least 20 prevention training sessions (compliant), and those who completed less than 20 sessions (non-compliant). When this analysis was done, the study still failed to show a difference in the injury incidence of overall and acute injuries between the compliant sub-group and the control group.⁶

In the second study, by Gilchrist, the PEP program was used as a comprehensive warm up program. 61 teams completed the study, which included 1435 athletes divided into 35 control teams of 852 athletes, and 26 intervention teams consisting of 583 athletes. When comparing non-contact ACL injury rates between the two groups, only 7

ACL injuries were reported in the intervention group compared with 18 in the control group (0.199 per 1000 athlete exposure vs 0.340; $P = .198$). When comparing non-contact ACL injuries, the interventional group only recorded 2 injuries compared to the control group reporting 10 (0.057 vs 0.189, $P = .066$). When specifically comparing practice injuries, no ACL injuries were recorded in practices in the intervention group, whereas 6 occurred in the control group (0.000 vs 0.148; $P = .014$). In the last 6 weeks of the season, the intervention group did not record a single ACL injury while the control group reported 5 ACL injuries (0.000 vs 0.249; $P = .025$). Results of this study can be seen in Table 3.⁴

	Intervention n	Intervention Rate	Control n	Control Rate	P Value
All knee injuries	40	1.136	58	1.096	.863
ACL	7	0.199	18	0.340	.198
Non-contact ACL	2	.057	10	0.189	.066
Practice ACL	0	0.000	6	0.148	0.14
Late Season ACL	0	0.000	5	0.249	.025

Rate per 1000 athlete exposure hours

Throughout the season, 4 intervention teams and 4 control teams were evaluated on their warm ups. The control teams did not use strength, plyometric training or agility drills routinely in their warm ups. When evaluating the compliance of the intervention teams, reports showed that they used the PEP program 26 times on average (range 12-37).⁴

In the study by Soligard, the 11+ program, included a final sample of 52 clubs (1055 players) in the intervention group, and 41 clubs (837 players) in the control group. The results of the study can be seen in Table 4. The intervention group included 49,899

hours of soccer, and the control group included 45,428 hours of soccer. The study was conducted over a period of 8 months and included a total of 376 injuries, 161 in the intervention group and 215 in the control group. When compared to the number of hours played, the overall incidence of injury was 3.9 per 1000 player hours (SD 0.2). When comparing the rate ratio for lower extremity injuries in the intervention and control groups the ratio was 0.71 (0.49 to 1.03, P=0.072). The study showed a significant reduction in overall injuries, as well as overuse injuries and severe injuries. However, when specifically comparing the risk of match injuries, training injuries, knee injuries, and acute injuries, the results were not significant. The number needed to treat ranged from 15-63 depending on the type of injury and severity. Overall for all injuries the NNT was 15 players. Significantly fewer players in the intervention group had two or more injuries (rate ratio 0.51, 95% CI 0.29 to 0.87). However the rate of re-injuries did not meet significance (0.46, 0.20 to 1.01).⁵

	Intervention group (n=1055)	Control group (n=837)	NNT	Rate ratio (95% CI)	P value
All injuries	135	166	15	0.68 (0.48 to 0.98)	0.041
Match injuries	96	114	22	0.72 (0.52 to 1.00)	0.051
Match injuries	50	63	36	0.68 (0.41 to 1.11)	0.120
Lower extremity injuries	121	143	18	0.71 (0.49 to 1.03)	0.072
Knee injuries	33	47	40	0.62 (0.36 to 1.05)	0.079
Ankle injuries	45	49	63	0.81 (0.50 to 1.30)	0.378
Acute injuries	112	130	20	0.74 (0.51 to 1.08)	0.110
Overuse injuries	27	48	32	0.47 (0.26 to 0.85)	0.012
Severe injuries	45	72	23	0.55 (0.36 to 0.83)	0.005

When assessing the compliance of the program, the 52 clubs in the intervention group performed the 11+ program an average of 44 sessions (SD 22, range 11-104).

None of the control teams performed a structured warm up plan comparable to the

intervention group. Those in the top one-third of the intervention group when considering compliance had a 35% lower incidence of injury (2.6 injuries/1000 player hours) when compared to the middle third of compliance (4.0 injuries/1000 player hours).⁵

Discussion

The “11” program failed to show any difference in the injury rates between those in the interventional group and those in the control study. This may be due in part or in whole to the lack of compliance with the program. Intervention teams on average only completed the warm up program an average of 15 times during the first half of the season. More than likely, players need a minimum number of training sessions for players to reap the benefits of the strength and proprioception.⁶

The results from the PEP program trial suggest that it is effective in reducing the number of ACL tears. There were very few adverse events with the trial as only one athlete was injured due to the program. This was due to an athlete tripping over a ball and resulting in a tibia/fibula fracture. After this event the program was revised to use short cones for hopping drills instead of a ball. In addition, athletes did complain of soreness from the PEP program the first few weeks of implementation. Athletes reported that it took approximately 6-12 repetitions of the program before it was no longer “physically challenging to complete.” Also due to the decrease in number of injuries later in the season compared with the beginning of the season, it may take at least a few weeks to benefit from the acquired strength, balance, and proprioception acquired from the program. For this reason, it may be a good idea to implement the program in the pre-season so the benefits can begin from the first match of the season.⁴

The 11+ program was developed as a combination of the “11” program and the PEP program, along with adding running activities at the start of the program. The 11+ program reduced the risk of injuries by one third and severe injuries by one half. As a whole, lower extremity injuries did not reach significance, however the reduction in the rate of severe injuries, overuse injuries, and injuries over all did meet significance.⁵

For all of the trials, researchers are unable to control the specific drills and exercises used by both the control as well as the intervention groups. Control teams could in theory do very similar warm ups to the intervention warm up programs. However, when observed by researchers and from reports from athletic trainers, it does not seem that any of the control groups did warm ups resembling the intervention programs.^{4,5,6} In addition, researchers are also unable to control compliance to the intervention programs. It was only by observing four teams directly and the reports of athletic trainers and coaches that it was assumed that the intervention groups were indeed compliant. The 11+ program, in order to increase compliance, revised the “11” program and expanded the program to include alternative exercises to decrease boredom with the program.⁵ In addition, they also incorporated more resources for teams and coaches such as instructional videos and pamphlets to increase compliance.⁵

The PEP program, although seemingly had a reduction in ACL tears for the intervention group, did not have enough injuries to be significantly significant. Only 25 injuries were reported in the 1435 athletes.⁴

Conclusion

Based on the above studies it appears that a comprehensive warm up program is effective in reducing the number of injuries in female soccer players. Although the PEP

program did not reach significance in the number of overall ACL injuries, it did reach significance in the number of late season ACL injuries, non-contact ACL injuries, and practice ACL injuries. It is also very likely that if the study were to be repeated with an increased number of participants, the study would indeed reach significance for the total amount of ACL injuries. The “11” program failed to show an effect in preventing injuries, but this is likely due to low compliance. If players were more compliant and incorporated the “11” program into all training session instead of only an average of 15 session, it is highly likely the program would indeed prevent more injuries. The 11+ program, which incorporate both the “11” program as well as the PEP program did meet significance in reducing the number of injuries and severe injuries. This shows that a comprehensive warm up plan if incorporated effectively into practices and matches will reduce injuries in athletes.

Future studies should include more variation in warm up programs to encourage compliance with the program. Studies should also encourage athletes to use the warm up programs during preseason training as well as during all practices and games. With an increased compliance and use of the program, it is likely that injury rates will decrease in the intervention groups and therefore lead to statistically significant results. In addition, younger age groups should be encouraged to participate in studies. Because many motion patterns are developed at a very young age. The younger an athlete begins to practice correct static and dynamic movements, the more likely they are to establish those movements into their subconscious.

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