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INJURY PREVENTION IN YOUNG SOCCER PLAYERS: RESULTS OF A PILOT STUDY

LA PREVENZIONE DEGLI INFORTUNI IN GIOVANI CALCIATORI: UNO STUDIO PILOTA

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Abstract

Risk factors for soccer injuries and prevention have been discussed by several authors, but only few have investigated the effectiveness of preventive interventions, in particular in the last few years. The aim of the present study was to evaluate the effects of a prevention program on the incidence of soccer-related injuries in three different categories of younger players (Allievi, Giovanissimi e Primavera).

The soccer teams took part in a prevention program to decrease injury risk, for two agonistic seasons (2005-06, 2006-07). Before identifying training programs, we valued the younger fitness status: each youth soccer players (aged 13 to 19) performed exercise tests of functional capacity: plyometric jump (explosive power) and Lèger test (aerobic resistance). Thus, the temporal connection in loads alternation 1:1 as applied.

During the two agonistic seasons all new injuries were registered. The incidence of injury per 1000 hours of training and playing soccer was 3.6 and 1.3 in 2005-06 and 2006-07, respectively. A very high percentage of soccer-related injuries occurred during a game, unlike those occurring during training. Our prevention program had greater effects overall in the last agonistic season taken into account since he injury incidence was significantly lower those reported in other studies.

In conclusion, the incidence of youth soccer-related injuries can be reduced by preventive interventions; and coaches and players need better education

regarding injury prevention strategies and should include such interventions as part of their regular training.

Riassunto

La prevenzione degli infortuni nel calcio giovanile assume un ruolo sempre più centrale. Alcuni AA hanno dimostrato come specifici programmi di prevenzione possano ridurre significativamente l'incidenza degli infortuni in calciatori d'elitè e sportivi praticanti altre discipline; pochi sono, ad oggi, i riferimenti letterari che hanno avuto come oggetto di studio il giovane calciatore. Lo scopo del seguente lavoro è stato quello di valutare gli effetti di uno specifico protocollo di allenamento sul rischio d'incidenza degli infortuni e sulle performance atletiche in giovani calciatori della Unione Sportiva Lecce Calcio (Allievi, Giovanissimi e Primavera). Sono state prese in esame le stagioni agonistiche (2005-06, 2006-07). Il protocollo di ricerca ha previsto una valutazione delle performance atletiche all'inizio ed alla fine della stagione agonistica (forza esplosiva, FCmax e test di Léger). In relazione ai risultati ottenuti nelle valutazioni di inizio stagione, sono stati formulati specifici protocolli di allenamento.

Nel corso delle due stagioni agonistiche sono stati registrati tutti i nuovi infortuni avvenuti in partita ed in allenamento. L'analisi statistica dei dati ci ha confermato il fatto che l'incidenza degli infortuni è stata maggiore in partita, rispetto alle sedute di allenamento; tale fenomeno si sovrappone ai dati registrati da altri AA negli adulti. La prima stagione 2005-2006 ha generato 3.6 infortuni ogni 1000 ore di attività calcistica contro il valore di 1.3 relativo alla stagione successiva (2006-2007). I risultati ottenuti sono significativamente inferiori sia ai valori medi (5-7 infortuni/1000H) sia ai valori relativi ai giovani calciatori frequentanti il club US Lecce negli anni precedenti (4.9/1000H).

In conclusione, sottolineiamo l'importanza della valutazione funzionale e della corretta somministrazione dei carichi di lavoro, al fine di poter programmare in maniera ottimale le attività calcistiche in relazione all'età, al talento, ai ruoli ed alle caratteristiche antropometriche dei giovani.

Key words: soccer, prevention, performance, injury

1. Introduction

Football is a sport with many variables and dynamics. During a soccer game, each player performs several dynamic movements (headers, cutting, tackling, sprints, kicks) which require a very good level of muscle strength, power and coordination. Strength in its various forms plays a critical role on performance of such skills[1,2]. Soccer practice suggests that a soccer player needs to develop a level of maximum strength and power, which is utilized effectively within the game[3]. In the last decades a number of studies investigated the physiological and notational (match analysis) features of the players' performance[4-12]. However, few studies can be found examining the effects of soccer training programs on injury incidence, during competitive season on different categories of young soccer players in Italy. Hrysomallis in 2007 found

out that poor balance ability is significantly related to an increased risk of injuries in different activities[13]. Other Authors reported that the risk of injuries appears to be more common in adolescent soccer (5.6 injuries per 1000 hours of soccer exposure, SE) than in other team sports like handball (4.1 per 1000 SE) or basketball (3.0 per 1000 SE)[14,15]. In soccer, many injuries occurred during tackling and contact with an opposing player, and most often in lower series and youths (45%)[14,15]. In fact, the youth section (16 to 18 years) had incidences that could be compared to the highest senior level (18.5 per 1000 SE)[16]. In a recent publication Brito et al reported that during the preseason training period, athletic trainers should expect a majority of muscle strains, especially in the thigh region of young players[17], Authors on this case found an incidence of match and training injuries of 6.7 and 1.8 per 1000 hours SE, respectively. The aim of our study was to evaluate the effects of a specific prevention program on incidence of Soccer-related injuries in three different categories of young soccer players of US Lecce soccer Team (Serie A, Italy).

2. Methods

Subjects

A group of young male soccer players (range 13–19 years; form agonistic seasons 2005-2006 and 2006-2007, respectively, Tab. 1), without a prior ankle injury, volunteered to participate in the study with the informed consent of their parents. All of them were soccer players from Lecce football club, attending competitions in three different national categories (Primavera, Allievi, Giovanissimi). All the subjects were familiarized with the testing protocol, as they had been previously tested on several occasions during the season with the same testing procedures.

Numers of young players

Table 1	Giovanissimi		Allievi		Primavera			
age (years)	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**Total**
agonistic season 2005-06	7	21	5	17	7	7	5	**69**
agonistic season 2006-07	22	23	5	15	11	7	4	**87**

Tabella 1. Numbers of young players, volunteered to participate in the study, grouped for age and agonistic season.

Experimental Design

The study was organized in four steps: (1) evaluation of individual performance, (2) individualisation of preventive training programs to decrease injury risk, 3) the training phases during both seasons (2005-06 and 2006-07), 4) evaluation of tendinous/muscular injuries, deriving from a direct and indirect traumatic events, occurred to players during both seasons.

Evaluation of individual performance

Each participant was tested it the beginning of the season and at the end of the season. Variables like strength, anaerobic power and maximum heart rate were collected.

The strength was evaluated by a test consisting in 3 series of 6 plyometric jumps. These jumps were performed using the horizontal leg press with a power control by which we measured the explosive strength expressed as Watt for kilograms of weight moved (W/Kg). The Leger Test was designed to measure maximum aerobic velocity (VAM) for each subject and for both agonistic seasons. Athletes performed 5 minutes of easy jogging followed by 5 minutes of stretching before starting the test. Each stage of the test is assigned a number – which is correlated to a predictive estimation of VAM. The participant start running in two parallel lines 20 meters apart, in sync with the "beeps" on a CD. The athlete should try to reach the highest possible stage as the predictive value is based on a maximal effort. When participants fall short of the line twice in a row, the test is terminated. The VAM for each soccer was recorded as Km/h. A Tanaka predictive formula was used to find the theoretical Maximal Heart Rate.

Training programmes

Then, training was carried out with an established explosive strength for each jump equal to 9-11 W/Kg. Each age class used a different load (Kg) and also the number of jumps for week was established proportionally to the explosive strength measured for each group. (Fig 1 A and B).

Fig. 1 A

Agonistic season 2005-06

age (years)	Power (W/Kg)	VAM (km/h)	Weight for 9-11 W/kg	N°jumps/ week	Running min/week (VAM 110%)	Strength time/week (% match time)	Match time (min)	
13	8.8 ± 0.20^{a}	11.4 ± 0.15^{A}	55 Kg	45 ± 15	12 ± 4	170 ± 30	60	Giovanissimi
14	9.4 ± 0.11^{b}	11.4 ± 0.07^{A}	55 Kg	60 ± 15	12 ± 4	170 ± 30		
15	9.1 ± 0.05^{c}	13.0 ± 0.13^{B}	55 Kg	50 ± 15	14 ± 4	160 ± 30	80	Allievi
16	9.5 ± 0.03^{b}	13.3 ± 0.10^{C}	70 Kg	60 ± 15	14 ± 4	160 ± 30		
17	10.0 ± 0.18^{d}	13.4 ± 0.08^{C}	70 Kg	60 ± 15	14 ± 4	155 ± 30	90	Primavera
18	11.6 ± 0.13^{e}	13.5 ± 0.16^{C}	85 Kg	70 ± 15	16 ± 4	155 ± 30		
19	11.4 ± 0.09^{e}	14 ± 0.18^{D}	85 Kg	70 ± 15	16 ± 4	155 ± 30		

Fig. 1 B **Agonistic season 2006-07**

age (years)	Power (W/Kg)	VAM (km/h)	Weight for 9-11 W/kg	N°jumps/ week	Running min/week (VAM 110%)	Strength time/week (% match time)	Match time (min)	
13	8.8 ± 0.11^{a}	11.4 ± 0.13^{A}	55 Kg	45 ± 15	10 ± 4	170 ± 30	60	Giovanissimi
14	9.4 ± 0.05^{b}	12.7 ± 0.17^{B}	55 Kg	55 ± 15	12 ± 4	170 ± 30		
15	9.4 ± 0.15^{b}	12.8 ± 0.03^{B}	55 Kg	55 ± 15	12 ± 4	160 ± 30	80	Allievi
16	9.3 ± 0.2^{b}	13.0 ± 0.20^{B}	70 Kg	55 ± 15	14 ± 4	160 ± 30		
17	10.6 ± 0.08^{c}	13.2 ± 0.16^{BC}	70 Kg	65 ± 15	16 ± 4	155 ± 30	90	Primavera
18	11.1 ± 0.11^{d}	13.1 ± 0.18^{B}	85 Kg	70 ± 15	16 ± 4	155 ± 30		
19	12.3 ± 0.09^{e}	13.4 ± 0.10^{C}	85 Kg	75 ± 15	16 ± 4	155 ± 30		

Figgura 1. Pre-season valuations and training planning.
Left panel: pre training individual performance evaluation for different group age of young soccer, for agonistic seasons 2005-2006 (A) and 2006-2007 (B). Strength was expressed as Watt for kilograms of weight moved (W/Kg). Anaerobic Power was calculated by Leger Test (see Methods) and reported as maximum aerobic velocity, VAM for each soccer and was annotated as Km/h.
The data are means ± S.D. of different values for each young soccer stratified for age groups. Values with shared letters are not significantly different according to Bonferroni/Dunn post hoc tests.
Right panel: Right panel: preventive training programmes for both agonistic seasons 2005-2006 (A) and 2006-2007.
Training was carried out with a established explosive strength for each jump equal to 9-11 W/Kg. Different load (Kg) and number of jumps for week was established proportionally to the explosive strength measured for the each group. For the aerobic power, the running time (min/week), performed at the 110% of the VAM, was adapted to VAM of each group.
planning intensity of training for the aerobic power and explosive strength, we considered the VAM and W/Kg values pointed out with previously tests. The specific training with ball, (matches in football pitch, short matches, sprint to ball, dribbling), was quantified as percentage of match time (% MT), different for each categories.

The amount of training during soccer drills was differentiated in consideration of different match time for each football categories (Giovanissimi, Allievi, Primavera); therefore, the specific training with ball, (matches in football pitch, short matches, sprint to ball, dribbling), was quantified as percentage of match time (% MT). The drill was performed varying the quantity of training load

[17]. Figure 2 show a example of this methodology applied to the "Primavera" group in the 2006-07 agonistic season. The temporal connection in loads alternation applied in our study has been: 1:1 [17].

Epidemiological approach

Epidemiological studies of overuse-related pathologies (tendinous/muscular injuries deriving from a direct and indirect traumatic event which caused players to be absent from following training or competition), occurred to players during both seasons, were collected by appropriate computer software (PRO.MO.S.E. Tarantini-Spedicato 2006). The incidence rate (injuries/1000 soccer exposure hours) was calculated as the number of soccer players injured in the two soccer seasons considered divided by the total number of hours of soccer match and training participation. Injury incidence rates were calculated for matches, practice sessions and by age group.

Statistical analysis

All experimental conditions were compared for group differences using a one-way repeated measures analysis of variance (ANOVA). In order to detect differences, a post-hoc Bonferroni test was applied when appropriate. For all comparisons, significance level was set at $p<0.05$. All analyses were performed using Stata version 8.0 (Stata Corporation, College Station, TX).

3. Results

In both seasons, parameters were significantly different ($p < 0.05$) among the distinct age classes (Fig 1, left panel). Primavera group presented significantly higher maximum aerobic velocity (km/h), explosive strength and plyometric jump, in comparison with Allievi and Giovanissimi groups. No significant differences were observed in strength and speed characteristics between the Allievi and Giovanissimi young soccer players. These measures were used for adequately designing training programs (Fig 1, right panel). The injury incidence for agonistic season 2005-06 was 3.6/1000 soccer exposure hours, with an injury incidence rate of 16.7 during games and 2.6 during practice sessions, thus a very high percentage occurred during a game (6.4-fold of incidence during training session), because in soccer many injuries occurred during tackling and contact with an opposing player. Soccer injury incidence rates were 0.96/1000 soccer hours for Giovanissimi, 6.49 for Allievi, 3.77 for Primavera categories (Fig. 2)

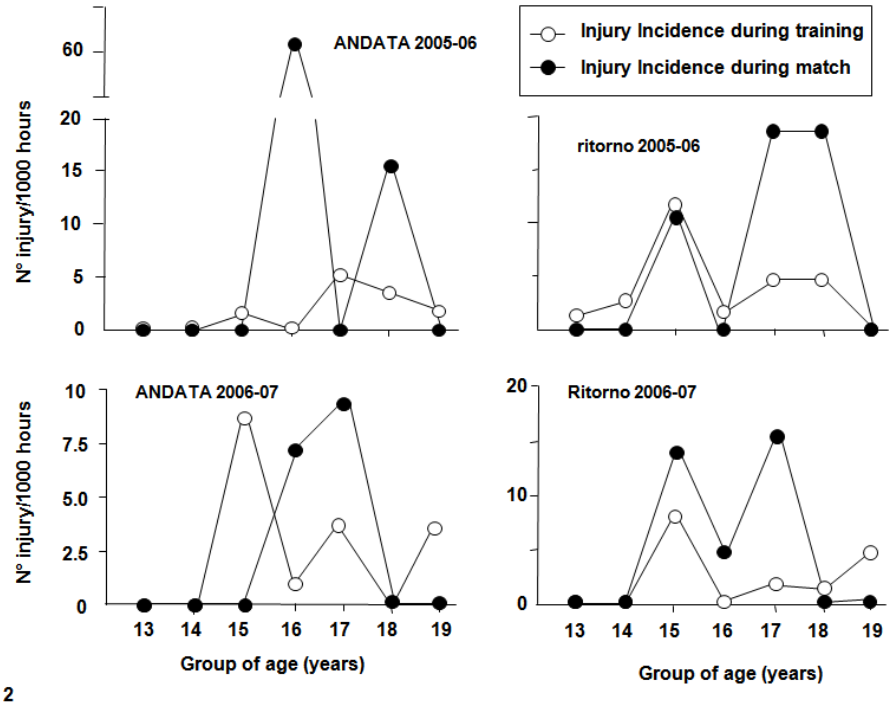

FIG. 2

These were the soccer injury incidences in 2005-06 season, stratifying by age: 0.64/1000 hours of 13-year-olds, 1.3 of 14-year-olds, 9.9 of 15-year-olds, 2.3 of 16-year-olds, 5.2 of 17-year-olds, 5,3 of 18-year-olds and 0.75/1000 of 19-year-olds. Match injury incidence was higher in the first part of agonistic season in soccer 16-year-olds. (63/1000 hours).

The cumulative incidence of soccer-related injuries in the 2006-07 season was 1.3/1000 hours; 2.1/1000 during games and 1.2/1000 during practice sessions. Also in this agonistic year the injury incidence was 1.75-fold higher during a game, compared to that during training. Soccer injury incidence was 3.1/1000 in Allievi category, 2.7 in Primavera categories, no injury occured in Giovanissimi category during 2006-07 soccer season (Fig.3).

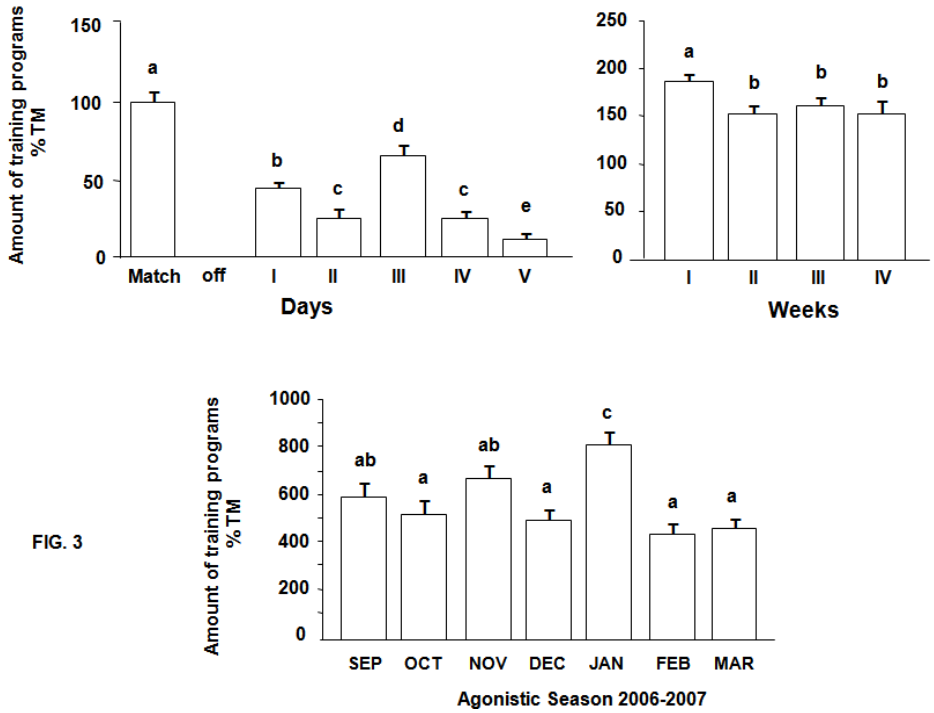

FIG. 3

Figure 4 shows the rates of traumatic injury during the last agonistic season. Match injury incidence was higher in the September-October period (beginning of agonistic season) in Allievi and Giovanissini categories, in December and January for Primavera category. The injury incidence was represented in correlation of the amount of training consisted in specific training with ball (min), Aerobic Power (min) and Explosive Strength (n° jumps). For all tree categories, the injury incidences were considerably higher during a training period characterized by a working load up 20% higher compared to the precedent training period.

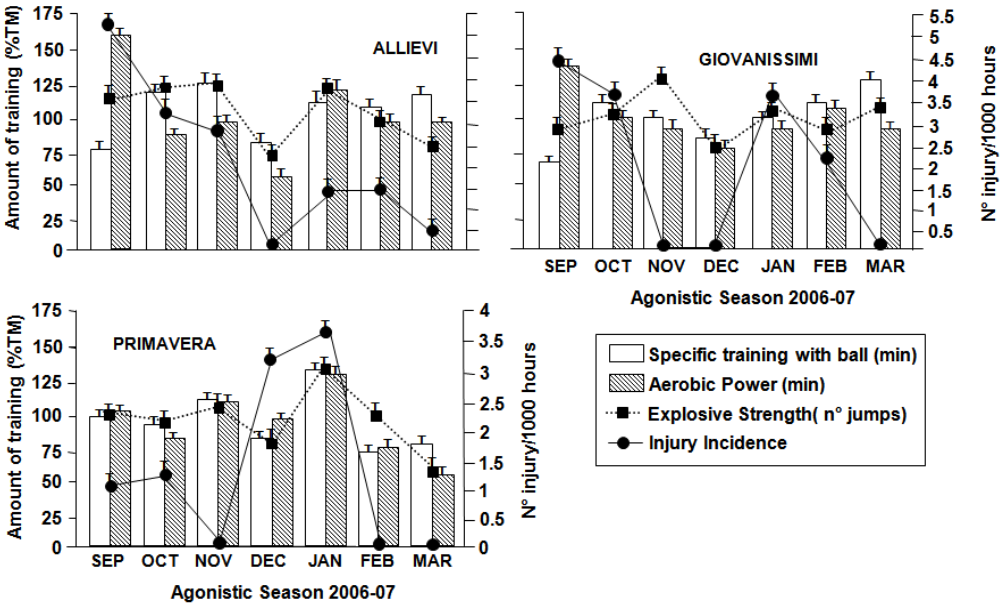

FIG. 4

4. Discussion

Soccer is the most popular sport worldwide [18]. Such popularity is due in part to the perception that it is a relatively safe sport for children and adolescents [19]. Despite this perception, several recent studies have found out that soccer is one of the most common sports resulting in injuries among youths [20]. Young athletes are not skeletally mature and are susceptible to growth plate injuries. Repetitive motion and vigorous activity can stress growth plates located near the ends of leg and arm bones, disrupting growth cartilage necessary to skeletal formation [21].

More recently, balance training has been adopted to try and prevent injuries to the ankle and knee joints during sport [22]. As a single intervention, balance training has been shown to significantly reduce the recurrence of ankle ligament injuries in soccer, volleyball and recreational athletes; however, it has not been clearly shown the reduction of ankle injuries in athletes without a prior ankle injury. Since injury risk should be assessed on an individual basis [23], it seems appropriate to individualise preventive training programmes, as is recommended for other training content. Evaluating the existing physiological condition of young soccer and their appropriate application may also help to decrease injury risk.

Training programmes were performed considering each group of age: the maximum heart frequency, aerobic power, explosive strength; the improvement of

our training lies in variability of load and exercise intensity amount, that can also be adapted to the needs of the individual. The time of special training should reflect the condition and age of the athlete. However, the coach should make improvements by altering the above variables, gradually and over a period of time. In fact, biological maturity status significantly influences the functional capacity of adolescent football players 13–19 years of age. Training is a significant contributor to aerobic resistance, whereas weight and height are significant contributors to the sprint and vertical jump, respectively [18].

Furthermore, the number and the match time exposes the different categories of young footballers to different work amount which has to be analyzed and to which it is required to refer to plan the total volumes of training in order to prevent overload pathologies.

Our methodology [17], characterized by the alternation of the intense and moderate amount of training program periods, during week, month or agonistic season planning, allows young soccer a better physical recovery, lasting performances and above all a decrease of injury. We verified that the injury incidence was considerably higher during a training period characterized by working loads up 20% higher compared to the precedent training period; probably because above these values, the young footballer's physiological adaptation capacity may result in distress.

The application of the working loads alternation, as training methodology aimed to decrease the overuse pathologies, allowed us to obtain significantly lower injury incidence compared to what reported in international literature, for the same group of ages [15, 24, 25-32] (Table 2).

Tab. 2 Author	Range age (years)	Total Injury Incidence (n°/1000 hours)
Schmidt-Olsen, et al. 1985	9 - 19	19.1
Schmidt-Olsen, et al. 1991	12-18	3.7
Backous , et al. 1988 [26]	6-17	7.3
Junge, et al. 2002	12 - 18	6.7
season 2005-06 (current work)	13 - 19	3.6
season 2006-07 (current work)	13 - 19	1.3

Tabella 2. Comparison of prevention of soccer injuries by Spedicato training program (see Method section) to what reported in international literature, in adolescent and preadolescent soccer.

5. Conclusion

A very high percentage of soccer injuries occurred during a game, compared to those occurring during training. Our prevention program had greater effects overall in the last agonistic season considered, since the injury incidence was significantly lower respect to what reported by other studies. In conclusion, the incidence of younger soccer-related injuries can be reduced by preventive interventions; and coaches and players need better education regarding injury prevention strategies and should include such interventions as part of their regular training. Since we observed very encouraging results, especially for the 2006-07 season, it seems appropriate to apply his individualised preventive training programme. This study may help to understand how to decrease injuries, particularly in contact situations (Game). We want to highlight that this is a pilot study. We are still working on some more data coming from many clubs even in this case. The results are very promising.

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