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A Prospective Study on the Relationship between Sports Injuries and some of the Physical Fitness Factors in Soccer Players

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Abstract

The purpose of this research was to study was the relationship between some of the physical fitness factors and sport injuries in soccer players. 69 senior soccer players (age: 22.83±3.06 yrs.), experienced (9.45±4.56 yrs.), that play in Guilan league participated in this study. Demographic information and sport activity were collected by questionnaire and interviews. Then muscle strength by manual muscle test, flexibility by sit & reach test and aerobic power by Bruce test were assessed. Hawkinz and Fuller questioner with validity of 87% was used for collecting information about risk factors. Correlation coefficient and chi square test were used to analyze data ($p \leq 0.05$). The results showed that most injuries were in lower extremity (63.8) and muscular tissue (62.3). Also significant relationship was found between hip flexors strength ($p=0.042$), trunk flexors strength ($p=0.044$), trunk extensors strength ($p=0.047$), flexibility ($p=0.022$) and aerobic power ($p=0.029$) with injury. But was no significant relationship between hip extensors strength with injury. There is also significant relationship between experience, dominant leg, non-dominant leg and injury rate ($p \leq 0.05$). However was no significant relationship between age with injury rate. With respect to relationship between strength, flexibility and aerobic power (in fact physical fitness) with injury, seems that coaches and players should pay more attention to factors such as strength, aerobic power and flexibility. Also skill and experience of players should be considered carefully.

How to Cite

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INTRODUCTION

Among all the existing sports, soccer is one of the most popular sports in different communities. In addition to a legion of fans attracted to soccer, a remarkable number of athletes enter this field. The soccer clubs in the world, which amount to 301 thousand, are expanding and turning into professionalism on a daily basis (Wong & Hong, 2005). Along with the developments in soccer, the injuries caused by this sport have also increased. Soccer is a complex physical sport and the risk of injury is noticeable in it. For instance, soccer players suffer from 710 injuries in every 100000 hours of match or training and the total injury level for professional soccer playershas been reported to be about 1000 times more than that for industrial workers (Hawkins, Hulse, Wilkinson, Hodson, & Gibson, 2001). In Europe, some 50 to 60 percent of sports injuries are due to soccer(Francisco, Nightingale, Guilak, Glisson, & Garrett Jr, 2000). Not only these injuries threaten the players' health, but also do they cause the waste of millions of Euros of the clubs' financial resources annually. It was stated that the therapeutic loss caused by soccer injuries in 1999-2000in England was 125 million Euros (i.e., on average, 1.4 million Euros per team) (Jan Ekstrand, Waldén, & Hägglund, 2004). In another report, the annual costs of treating the injured players were estimated to be approximately 1 billion pounds (Murphy, Connolly, & Beynnon, 2003). Furthermore, in a study on high-school athletes in the United States, these costs were estimated to be about 144.6 million dollars (Pritchett, 1980). Nevertheless, the number of individuals who choose this field as their professional activity is regularly becoming more and the corresponding costs are increasing as a result. Consequently, club officials and managers must assess the levels of risks or injuries and take precautions to prevent and mitigate them. Achieving the level of elitism and success in any sport requires all-inclusive information from the elite. Before designing any preparation or training program, the risk factors which may keep the athletes at any level away from their sport must be identified and the training programs should then be designed based on the acquired knowledge. In this way, one can succeed and reach the high levels of professionalism. In order to achieve these goals and avoid the risk of losing talents who have reached elite levels by spending time and money, there should be wide-ranging information about the likelihood of sports injuries and their relationship with physical fitness and preparation programs. The relationship between physical fitness levels.factors and athletes' physical injuries has been discussed most theoretically. In soccer, these discussions have rarely been made in terms of research or by means of semi-experimental or.and particularly prospective models.

In soccer, most injuries occur in the last fifteen minutes of the two halves, and this is due to the players' sense of fatigue and indicates the importance of physical fitness factors in avoiding the possible injuries. Since the tasks, physiological profile, type.intensity.level of physical activity, anthropometric characteristics, muscular strength, and flexibility of players vary in different posts(J Ekstrand & Gillquist, 1983) , it is expected that their injury incidence and patterns will also be different. Previous researches also support the assumption that players' posts in their soccer teams would affect their level of injury. Nonetheless, it is still a controversial issue for researchers to determine which players in a team are at a higher risk of injury. In a study conducted on the players of the American Premier League, Morgan et al. (2001) conclude that midfielders (37.6%) and defenders (29.6%) suffer from more injuries compared with other players(Tyler, Mchugh, Mirabella, Mullaney, & Nicholas, 2006) . Similarly, McGregoret al. (1995) believe that midfielders (39%) are at a higher risk of injury(Hawkins & Fuller, 1999). In another research, Hawkins and Fuller (1999) report that defenders are at a higher risk of injury compared with other players(Arnason et al., 2004). On the contrary, Anderson et al. (2003) state that forwards and midfielders (in time of attack) and also defenders and goalkeepers (in time of defense) suffer from more injuries (Hawkins et al., 2001).

Most researchers have reported that injuries occur more in the players' dominant side rather than in their non-dominant side. For example, Hawkins et al. (2001) report that 50 percent of injuries occur in the players' dominant side (37 percent of the injuries occur in the non-dominant side and the other injuries are reported in the players' trunks). According to Hawkins and Fuller (1999), 52.3% of injuries occur in the players' dominant side. Price et al. (2004) argue that 54 percent of injuries and Rahnama et al. (1386) state that 71.8 percent of injuries occur in the players' dominant side (Arnason et al., 2004; Price, Hawkins, Hulse, & Hodson, 2004; Nader Rahnama, Bambaeichi, & Daneshjoo, 2009; N Rahnama, Reilly, & Lees, 2002). However, Rahnama et al. (1385) argue that most injuries occur in the players' left (non-dominant) side(N Rahnama et al., 2002). Therefore, the present study inves-

tigates the relationship between "the subjects' strength, flexibility, aerobic capacity, age, experience, post, dominant.non-dominant legs" and "their injury incidence".

METHODS

The present research is semi-experimental and the statistical population includes the teams of Second and Third Divisions of the Iranian Soccer League and the statistical sample includes 69 soccer players. The soccer players were selected from three adult soccer teams in Guilan (Sepidrud Soccer Club, Municipality of Langarud Soccer Club, Rasht Pass Soccer Club) and were chosen in a purposive non-random way. The demographic features and personal information including dominant hand and leg, training hours per day, and training days per week were collected by means of questionnaire and interview and with the help of the teams' doctors and coaches. Measurements were made one week before the beginning of the tournament season.

Sit and Reach Test was employed in order to measure flexibility. The test was repeated 3 times for each subject and the best record was registered for them (Willson, Ireland, & Davis, 2006).

Nicholas hand-held dynamometer[3] was used in order to assess muscular strength and the measurements were made by the method described by Magnusson et al.[4] (1995). All the measurements for strength were repeated 2 times and the average of these two repetitions was registered (in kilogram) as the subjects' record (Jacqueline Montgomery, 2007).

Bruce Treadmill Protocol was used in order to assess aerobic capacity. The equation suggested by Foster et al. (1984) was employed in order to compute the information. Bruce Treadmill Protocol consists of a ten-step protocol which begins by 2.74 km.h and a ten-percent slope. The test continues until the subject has reached a stage of exhaustion and is unable to continue(Tyler, Nicholas, Campbell, & McHugh, 2001).

Maximum Oxygen Consumption (ml. kg.min)=14.8–(1.379*T)+(0.451*T^2)+(0.012*T^3)

T = test run time in minutes and a fraction of second

Hawkins and Fuller's risk factor evaluation questionnaire, which has a validity of 87%, was used in order to collect the relevant data to injury. This information was gathered during the season by the researcher and team's physician (Arnason et al., 2004).

Descriptive statistics (mean and standard deviation) and inferential statistics(Pearson Correlation Coefficient and Chi-square) were employed in order to analyze the findings. All the statistical calculations were done by SPSS software (SPSS 16) and at a statistical significance level of ($p \geq 0.05$).

RESULTS

Findings of the present study show that the most common type of injury was reported for bruise and contusion (44%) and muscle strain (35.8%), while rupture (0.7%) was the least common type of injury. The most injured regions were ankle (17.9%), shin (14.2%), and anterior. posterior hip (13.4%). On the other hand, the least injured regions were reported to be skull, forearm, elbow and wrist. Most injuries were reported in lower extremities (63.8) and muscular tissues (62.3). The findings demonstrate that defenders and midfielders were more exposed to injuries than other players (Table 1,2,3).

Movement	Organ or Joint Status	Dynamometer Position	Individual Stability
Hip Flexors	In sitting position at the bottom of the bed and knees with a 90 degree angle	Proximal part of the dominant leg's knee and on the quadriceps	Upper trunk region
Hip Extensors	Sleeping in a supine position with flat knees	Distal part of the dominant leg's shin	Pelvic region
Trunk Flexors	Sleeping in a supine position and holding the hands behind	2.5 centimeters lower than the sternal notch	Pelvic region
Trunk Extensors	Sleeping flatwise and holding the hands behind	Midpoint of the line which connects the two inner upper angles of the individual's scapula	Hips distal regions

According to the results presented in Table 2, there is a significant relationship between "the strength of trunk and hip flexors, trunk extensors, flexibility, aerobic capacity" and "injury incidence". On the other hand, the relationship between the strength of hip extensors and injury is not significant ($p \geq 0.05$).

According to the results presented in Table 3, it is observed that the relationship between "experience, post, the players' dominant leg" and "injury incidence"ismeaningful, while the relationship between age and injury is not significant ($p \geq 0.05$).

DISCUSSION

Following the objective of the present research – i.e. investigating the relationship between "strength, flexibility, aerobic capacity" and "injury incidence"– the results show that there is a relationship between the strength of hip flexors ($p = 0.042$), trunk flexors ($p = 0.044$) and trunk extensors ($p = 0.047$). However, no significant relationship is observed between hip extensors and injury incidence. These results are in line with the results of Timossi et al. (2001) and Soderman et al. (2001). Nevertheless, the results are not consistent with the results of Stenberg et al. (2000), Beynon et al. (2001) and Rafiei et al.(1388).

In a prospective research done on 81 hockey players with an average age of 23, Timossi et al. (2001) assess the muscular strength of hip joint's flexion, adduction, and abduction before the tournament season. According to the results of this research, those individuals whose hip adductor muscles strength is lower are more prone to injury. The injured individuals' adductor muscles strength is 18 percent lower than that of the uninjured ones. Moreover, itis reported in the research that studying the strength ratio of agonist muscles to antagonist muscles is the best predictor of injury. Muscular strength imbalance is a cause of injury for athletes. The strength ratio of hamstring muscles to quadriceps in the injured individuals is 55%, while this ratio is 66% in the uninjured ones (McGregor & Rae, 1995). Furthermore, in the study done on 123 female soccer players with an average age of 20 (32 elite players and 91 non-elite players – First and Second Division Leagues), Stenberg et al. (2000) come to this conclusion that there is no meaningful relationship between muscular strength and injury rate (Fousekis, Tsepis, Poulmedis, Athanasopoulos, & Vagenas, 2011). In order to justify this mismatch,

Table 1. Descriptive information and characteristics of subjects

Daily Activity (hour)	Weekly Activity rate (session)	Sport experience (year)	Height (centimeter)	Weight (kilogram)	Age (year)
1.72±0.63	3.93±0.247	9.45±4.56	178.04±4.55	74.61±4.98	23.8±3.9

Table 2. Relationship between strength, flexibility and aerobic power with injury incidence

meaningfulness	number	Correlation Coefficient	variable
0.042	69	0.74	hip flexors strength
0.095	69	0.44	hip extensors strength
0.044	69	0.71	trunk flexors strength
0.047	69	0.67	trunk extensors strength
0.022	69	0.81	flexibility
0.029	69	0.82	aerobic Power

Table 3. Relationship between subjects age experience, dominant led, and post with incidence rate

Meaningfulness	Degrees of freedom	The rate is two	variable
0.862	2	0.297	Subjects age
0.031	2	7.312	Subjects experience
0.019	6	15.629	Subjects post
0.017	4	11.318	Subjects dominant leg

it has to be mentioned that the subjects in the research were female soccer players. Studies have suggested that the prevalence of injury in female soccer players is lower than that of male ones. Moreover, muscular strength is different in men and women, which can be a reason for these contradictions. The research conducted by Timossi et al. (2001) is in line with the present study because the age of the players and the measurement tool are the same. Furthermore, in the study conducted by Rafiei et al. (1388), the subjects are martial artists whose injury mechanism and physical features are different from soccer players (Lu, Chien, Chang, & Hsu, 2012).

Injury factors'risks are generally divided into two groups: internal and external (Mjølsnes, Arnason, Østhagen, Raastad, & Bahr, 2004). Muscular strength is one of the main and influential factors in physical activities and particularly in soccer (Daneshjoo, Rahnama, Mokhtar, & Yusof, 2013). Muscularweakness is a major factor for injuries in athletes(Daneshjoo, Mokhtar, Rahnama, & Yusof, 2012). Therefore, the difference between the dominant and non-dominant sides' strength, particularly in lower extremities, causes inappropriate control of body movements and hence injury (Clark, 2008). This strength imbalance has a critical role in the sports which have asymmetric kinetic pattern, such as soccer (Orchard, 2001).

Findings of the present study demonstrate that there is a significant difference between flexibility ($p = 0.022$) and the subjects' injury incidence. This result is in line with the results of Beynon et al. (2001) and Soderman et al. (2001). However, this result is not consistent with the results of Stenberg et al. (2000) and Timossi et al. (2001). It seems that increasing one's flexibility is a fundamental requirement for preventing injury incidence (Murphy, 2007) (Bradley et al., 2008; Morgan & Oberlander, 2001). In a research on 221 female soccer players with an average age of 20, Soderman et al. (2001) assess the movement range of hamstring muscles, knee hyperextension, and ankle's plantar flexion muscles. Soderman states that there is a meaningful relationship between a more-than-10-degree increase of knee hyperextension and knee injury. He also argues that there is no significant relationship between plantar flexion muscles and ankle injury(Foss & Keteyian, 1998). The different tests employed by the researchers and the different regions of body which are assessed may be two reasons for this mismatch.

In the present research, a meaningful relationship is observed between aerobic capacity and the extent of injury ($p = 0.029$). The researcher did not observe any study conducted on the relationship between aerobic capacity and the extent of injury. However, various studies have referred to aerobic capacity as one of the factors related to injury (7,28,30). Soccer has been introduced as an aerobic exercise. During the 90-minute play, soccer players run around 6 to 12 kilometers in length. Definitely, a player who does not have the desirable aerobic capacity gets tired sooner and this sense of fatigue increases the possibility of injury. Early fatigue due to lack of aerobic capacity and physical fitnessmay cause the following disorders: disturbance in making the right decision, impairment of coordination and implementation of techniques, and disturbance in concentration. Each of these disorders may contribute to injury incidence (Bradley et al., 2008; McGregor & Rae, 1995).

No significant relationship is observed between age and the extent of injury ($p = 0.862$). Some studies have investigated the relationship between athletes' age and injury incidence and suggest that it is not a meaningful relationship. These findings are consistent with the present findings. Soderman et al. (2001), Shomiack et al. (2000), and Rafiei et al. (1388) are some of those researchers who dealt with this issue. However, some studies have suggested that there is a meaningful relationship between age and injury incidence. These results are not consistent with the present result. Some of these studies whose results are not in line with the present research are: Stenberg et al. (2000), Mackay et al. (2001), Stevenson et al. (2000), and Peterson et al. (2000). Aging is associated with a decrease in the elasticity of tissues and muscular strength. As a result, the tissues' resistance capacity decreases. Moreover, older players sometimes overestimate their abilities and this is one of the reasons that may cause injury. Furthermore, these players' muscles and ligaments are slower in terms of performance during long-term activities, which increases the likelihood of injury. Most importantly, the risk of muscle strain and tear increases at an advanced age (J Ekstrand & Gillquist, 1983). Perhaps the low age average of the subjects in the present study is the reason for this contradiction. Findings of the present research show that there is a meaningful difference between experience ($p = 0.031$) and injury incidence in the subjects. Since skilled and experienced players have better techniques, they are less exposed to other players' tackles and physical encounters. These players are able to control the ball very well and pass it to other teammates before any physical encoun-

ter or tackle. In a study done on 264 male soccer players, Peterson et al. (2000) state that young players with lower skills and experience are twice as likely to be injured as players with a higher skill level and that more than 79% of injuries occur in lower extremities. Moreover, in another study conducted on 398 soccer players, Chomiak et al. (2000) argue that players with lower skills are twice as likely to be injured as players with a higher skill level. Players with a low skill level have poorer technique and tactic than skilled and experienced ones and poor technique disrupts skill performance and causes the person to use more force in order to perform a skill better and this may cause early fatigue in the player and increase the likelihood of his injury (Foss & Keteyian, 1998). Furthermore, experienced athletes control themselves better in case of mental pressures which influence performance. These players are less affected by stress and decision-making and concentration disorders, which certainly affect the likelihood of injury incidence.

In the present research, a significant relationship is observed between the players' post and the extent of injury ($p = 0.019$). Most of the injuries are observed in defenders, midfielders, forwards, and goalkeepers. Previous studies also support the hypothesis that the players' posts in a soccer team contribute to their injury. Nonetheless, there is controversy among researchers over the idea that which players are more exposed to the risk of injury. In a study done on the American Premier League players, Morgan et al. (2001) find out that midfielders (37.6%) and defenders (29.6%) suffer from more injuries than players in other posts(Morgan & Oberlander, 2001). Similarly, McGregor et al. (1995) believe that midfielders (39%) are more exposed to injury(Olsen et al., 2004). Hawkins and Fuller(1999), report that defenders are more exposed to injury than other players (Arnason et al., 2004). On the contrary, Anderson et al. (2003) state that forwards and central midfielders (in time of attack) and defenders and goalkeepers (in time of defense) suffer from more injuries. Moreover, Deehan et al. (2007) state that midfielders are more likely to suffer from musculoskeletal injuries than other players(Nader Rahnama et al., 2009). Rahnama et al. (1386), Wood et al. (2002), and Price et al. (2004) believe that midfielders and defenders suffer from most injuries(Junge & Dvorak, 2004; N Rahnama et al., 2002).

Findings of the present research show that there is a meaningful difference between dominant.non-dominant legs ($p = 0.177$) and the subjects' injury incidence. Most researchers have reported that the players' dominant side is more likely to suffer from injuries than their non-dominant side. For instance, Hawkins et al. (2001) state that 50 percent of injuries are in the players' dominant side (37 percent of injuries are in the non-dominant side and the rest are in trunks). Moreover, Hawkins and Fuller (1999) believe that 52.3% of injuries, Price et al. (2004) argue that 54% of injuries, and Rahnama et al. (1386) state that 71.8% of injuries occur in the players' dominant side (Junge & Dvorak, 2004; Roos et al., 2018; Rössler, Junge, Chomiak, Dvorak, & Faude, 2016). However, Rahnama et al. (1385) report that most injuries occur in the payers' left (non-dominant) side (15). In the present study, most injury incidence is observed in the players' dominant leg. Since the players' dominant sideis more involved in times of kicking, tackling, being tackled, and jumping, this side is more likely to suffer from injuries (Arnason et al., 2004; Price et al., 2004; Roos et al., 2018).

CONCLUSION

Previous researches and the present study show that strength, flexibility, and aerobic capacity (physical fitness, in general) have essential roles in the likelihood of injury incidence. Furthermore, as mentioned earlier, the likelihood and severity of injury increase as players get older; however, this likelihood decreases as players get more skill and experience. It seems that coaches and players must pay more attention to strength, aerobic capacity, and flexibility. Moreover, players' skill and experience should also be taken into particular consideration.

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