



## QUANTITATIVE STUDY OF SPORTS INJURY AMONG MALE AND FEMALE ATHLETES IN SOME AEROBIC AND ANAEROBIC SPORTS

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### Abstract

Sports injury assessment and management are of paramount importance in the prevention of sports injuries. In this regard, the discussions related to this area are somehow associated with all sports sciences. Accordingly, the present study aimed to investigate the trend of injury rates, type of injuries, the injured limb, the time and conditions causing the injury, the rate of injuries in different seasons, the rate of injuries in different sports, the costs imposed to athletes, support costs of sports insurance, as well as the comparison of such factors between male and female athletes. The research method was retrospective that was conducted in the form of documents. For this purpose, the data related to sports insurance and accidents in different sports during 2016-2021 were obtained and analyzed in a case study from the sports medicine board of Kerman province the largest province in Iran. The data collection method included a combination of documentary and library methods, which was implemented by studying related sources and extracting information from different sports injury registration offices. After that, the data were analyzed with the help of SPSS version 26. The findings indicated that it is highly significant to know and teach safety tips for preventing sports injuries among adolescent athletes. In addition, considering sports nutrition and training intensity in various sports in terms of age, physical fitness, and sports history affect the reduction of injuries. Furthermore, the sports fields with the least collisions had the minimum injury while the most injuries occurred in the middle of summer. Thus, the consideration of sports officials to standardize sports venues in summer will significantly reduce the possibility of sports injuries. Further, the use of standard sports equipment in collision sports is inevitable and needs the consideration of athletes, coaches and sports authorities. It is of great importance to consider sports insurance which can reduce the costs for athletes in case of any injury.

**Keywords:** Sports injury, aerobic exercise, anaerobic exercise, quantitative comparison

## Introduction

Human advancement has resulted in the penetration of science in all dimensions of life, especially in the last century and sports is not an exception. Today, many advanced and even developing countries spend a huge amount of money on making sports scientific and developing sports in their countries. Nevertheless, the professionalization of sports and the intense willingness of athletes to become champions and sometimes the inclination to traditional training methods in sports training have discarded the main purpose of sports which is providing health in society. Participating in sports activities is considered a part of life for most people (1). Sports, as one of the secondary institutions of modern society, has some functions such as health, recreation, identity, economic well-being, etc. Like other phenomena in society, sports are affected by social and cultural factors and some researchers consider sports a cultural issue and a common language for global communication (2). Evaluating the reasons for participation and continuation of physical activities seems necessary due to the significance and role of mobility and physical activities in lifestyle and health (3). Recreation, relaxation, competition, socialization, and promotion of health and physical fitness are among the reasons for participation in physical activities (4). Sports are considered one of the necessities of human life. The lack of physical activity leads to an increase in all kinds of death and doubles the risk of cardiovascular diseases, stroke, etc. Nowadays, we witness the generalization and implementation of sports programs at all levels of the society (5). Different kinds of sports have been increasingly regarded for eliminating hypo-mobility and increasing physical and mental capabilities. The growth of sports in modern societies is due to several factors and it is somehow difficult to determine the contribution of each factor accurately. Obviously, the expansion of different kinds of sports improves health and individual abilities and is considered a means of social connections. According to Emile Dalcroze, the father of modern gymnastics, "Sports are the best and most suitable tool for establishing peace and harmony among different emotions and attitudes" (6). In addition, some researchers believe that sports indicate the values, structure, and driving force of society and reflect social characteristics (7). Physical activities are extensively considered part of global public health plans (8). Despite all the benefits considered for sports and physical activity, the phenomenon of physical injury has always been associated with sports (9). Sports injury currently forms a considerable part of social incidents (10). Injuries occur when force and energy are transferred to the body in an amount more than the human threshold (11). In general, sports injury refers to an injury caused by sports or similar physical activities that prevents a person from practicing or participating in a competition within a few days or any kind of injury which requires medical treatment (10).

The Sports Medicine Federation started working in Iran in 1947 and aimed to establish the physical and mental safety of athletes during training and sports competitions for maintaining their health and finding some ways to achieve the above-mentioned goals in June 1947. In this regard, the federation established a sports medical services committee to provide medical services to all athletes who undertake sports activities. Sports injuries and information obtained from related studies are one of the issues which have led to the development of new laws and changes in some sports techniques (12). Information about the prevalence of sports injuries and types of injuries is required while participating in sports activities since the required information about the specific types of injury in each sport and the occurrence rate strengthens the weak points and anticipates appropriate strategies for eliminating such injuries (13). Hence, studying the occurrence of sports injuries in sports fields is of high importance (14). All athletes experience injuries without a doubt in some way. In addition to the positive aspects of sports as gaining health, physical fitness, freshness, and vitality, the possibility of athletes' vulnerability during sports is one of the negative aspects threatening athletes (15). If the injury is acute, it can cause an inability to move, endanger physical and mental health, increase medical expenses, and decrease the motivation of athletes (16). The injured in sports accidents include amateur athletes, professional athletes, stadium spectators and volunteers. The occurrence of sports injuries is increasing among professional athletes and non-professional athletes due to the emphasis on beauty and fitness, as well as the prevention of cardiovascular diseases, leading to heavy training and incorrect pressures. In addition to the age, gender and physical condition of the individual, the

type of sport can contribute to the occurrence and severity of injuries (10). Based on the available statistics, 80 out of every 100 athletes are injured in different competitions that is a sign of the presence of injury in the field of sports, particularly at the championship and competitive levels (17). Injuries and potential risks should be expected in any kind of sport, especially in team sports. Any kind of sport which has more than five injuries per 1000 hours is considered among the high-risk sports with a high rate of injuries. Rugby and lacrosse are at the high level with 30 injuries per 1000 hours while basketball and squash are among the high-risk sports with 14 injuries per 1000 hours. Interestingly, athletics and aerobics are relatively high-risk sports with 11 injuries. (18) Many domestic and foreign studies on sports injuries have agreed that the highest amount of injury was related to the group of muscle-tendon injuries while bone injuries had allocated the lowest amount of injury (19). Morgan and Oberland introduced the lower limbs, especially the knees and ankles, as the most frequently injured parts of the body (20). Barners evaluated sports injuries in several sports and reported that brain injuries are very common among athletes. According to him, wrestling, gymnastics, soccer, basketball, martial arts, cycling, boxing, and hockey are the sports in which head injuries and concussions occur (25). Moreover, a study on baseball, basketball, soccer, volleyball, tennis, softball, football, handball, swimming, judo, gymnastics, shooting, and weightlifting athletes introduced t knees, ankles, shoulders, waist and wrists as the most common areas of injuries (26). Rajabi stated that the most common areas of sports injuries in soccer, handball, basketball, volleyball, wrestling, gymnastics and weightlifting are fingers, ankles, wrists, spine, toes and knees (39). In addition, Jalali introduced the fingers, ankles, and knees as the most common areas of injury (40). About 95% of sports injuries occur as soft tissue contusions and bone fractures constitute 5-6% of all sports injuries (21). Furthermore, spinal sports injuries are highly common among professional and amateur athletes (22). El Tago and J. Peek (2007) reviewed insurance reports for year to study the number of injuries and related costs in different age groups playing netball. They observed that lower body, upper body, neck, and spine injuries accounted for the maximum percentage of the total costs. Rajabi et al., studied the male volleyball players of the Premier League of Iranian clubs and stated that the lower limb of the players was the most vulnerable during training and competition. In addition, joint injuries were reported as the most vulnerable during training and muscle injuries were the most common types of injuries during competition. Moreover, sprain during training and competition was considered the most common type of injury (47). Khosrozadeh et al., conducted a study on the basketball players of the Premier League of Iranian clubs and claimed that the lower limb was the most commonly injured. Furthermore, they stated that the ankle and knee were the most common areas of injury, respectively (48). Recent studies in the US reported that hand injuries account for 5% of all sports injuries, among which finger fractures account for 40% (23). Lininger et al., introduced strain and sprain as the most common type of injury by allocating 34% of the total injuries to the body (24). Further, it should be noted that sport is responsible for 12% of all jaw and face injuries. In addition, jaw and cheek fractures are more common in collision sports such as boxing, wrestling, etc. and the jaw and face injuries constitute 18.74% of all sports injuries in Iran (10). The occurrence of sports injuries in collision sports, particularly combat types, is higher compared to non-collision sports (14). Walter et al. (2006) reported that 81.5% of injuries among athletes are of collision injuries type (41). According to Puya Daneshvar, injuries are more common in collision sports while most collisions occur in group sports. Nevertheless, serious injuries are more common in individual sports (46). Physical trauma is considered one of the inevitable injuries in sports competitions. The most trauma has been reported in football, futsal, tennis, volleyball, field hockey, skiing, and horse riding (27). According to Shahidi's research, a finger was the most common area of injury while gymnastics and basketball were the most harmful sports (28). Petersen et al. considered the knee as the most common area of injury among soccer players with 99 out of 558 injuries (29). In addition, Muhammad Razi, the head of the Knee Arthroscopy and Sports Injuries Association, reported that meniscus and cruciate ligament tears, ankle sprains, and cartilage injuries are the most critical injuries to soccer players (44). In the press conference of the second international congress of knee arthritis and sports injuries, he reported that knee injuries in ball and combat sports are more than in other sports so we witness more injuries in this area in sports such as judo, wrestling and soccer (45). Green (2007) reported the prevalence of

injuries at 3.43 in judo among males and 9.40 among females per 1000 athletes (30). Fuller (2002) introduced soccer as the most injured sport in England with more than 710 injuries per 100000 hours of activity (31). More than 200000 sports injuries occur to students annually in the US and approximately 75% of such injuries result from contact with the ground (32). Ebrahimi Atari et al. (2010) in a study related to the frequency of sports injuries in the sports Olympiad of students revealed that futsal and handball had the maximum injuries while basketball and volleyball had the minimum injuries (33). Nejati evaluated the prevalence of sports injury among female students and reported the highest rate of injuries in volleyball, basketball, handball, badminton, swimming, and table tennis, as well as the lower limbs, upper limbs, trunk, and spine as the most vulnerable parts of the body (50). During the past decades, the amount of sports activity among females has significantly increased and that is the reason for the increase in the occurrence of injuries among females (34). Based on previous studies, the rate of musculoskeletal injuries, especially lower limbs, is higher among female than among male athletes. Anterior cruciate ligament injuries are among the most common types of injuries, which are reported 2-8 times more often in women (35). A study was conducted on elite female volleyball players to determine the prevalence, causes, and mechanisms of sports injury. This study indicated upper limb injuries at 48%, lower limb injuries at 14.2%, and trunk, pelvis, head, and neck injuries at 38% (36). The results of a study on knee injuries among male and female gymnasts indicated that 52% of injuries were more in women's knees compared to 17% in men's knees (6). In addition, studies indicated that the occurrence of anterior cruciate ligament injuries is higher among female athletes than among male athletes. The rate of anterior cruciate ligament injuries among female basketball players is two times that of males. Such statistics among female soccer players are four times that of male soccer players (33). Nowadays, more than one million sports injuries occur per year, accounting for the society 10 million dollars per year (37). Paying for medical expenses caused by sports injuries covered by the Sports Medicine Federation of Iran was at least twice and five times the government tariffs up to 15,000,000 RIs for each athlete in 2006. Those who pay the membership fee and cover medical services in April every year will receive the maximum expenses (). A study on the occurrence of sports injuries indicated that 1 out of 40 insured professional athletes are injured, 1 out of 4000 athletes are disabled, and 1 out of 40000 injuries are deadly (43). Today, sports insurance plays a key role as a guarantor of the continuation of sports activities (3). Nowadays, the insurance of sports participants is considered a priority and a part of health insurance programs covering the expenses caused by sports injuries and disabilities (38). The long-term and follow-up assessment of sports injury has been rarely conducted because of operational difficulties and research limitations (42). Information about the prevalence of sports injuries and types of injuries is required while participating in sports activities (13). The underlying factors of injuries can be limited to reducing their vulnerability (13) by knowing the type of injury in each sport and finding the differences and similarities of the limbs involved in various sports (17). Then, a solution should be presented to minimize and prevent injuries. In this regard, the additional costs for the recovery of the injured can be avoided by having such information in the field of maintaining the health of the athletes. This shows the necessity of finding solutions to observe the scientific principles of training to prevent injuries and minimize treatment expenses. Accordingly, the present study aimed to analyze the trend of injury rates, type of injuries, the injured limb, the time and conditions causing the injury, the rate of injuries in different seasons, the rate of injuries in different sports, the costs imposed on athletes, and support costs of sports insurance during 2016-2021.

## **Method**

The method used in this study was retrospective that was conducted in the form of documents. To achieve the research objectives, the trend of injury rates, type of injuries, the injured limb, the time and conditions causing the injury, the rate of injuries in different seasons, the rate of injuries in different sports, the costs imposed to athletes, and support costs of sports insurance were studied. For this purpose, the data related to sports insurance and accidents in various sports fields during 2016-2021 were obtained and analyzed in a case study from the sports medicine board of Kerman province. The data collection method in this study included a combination of documentary and library methods

through a comprehensive study of related sources and information from different sports injury registration offices. The general framework of the study and the desired variables were identified after studying the sources related to the subject and reviewing the theoretical foundations and research literature in domestic and foreign studies. Then, some data were elicited from the offices, correspondence and published statistics through coordination with the sports medicine board. The intended data were inquired from the Sports Medicine Federation of Iran in case of some research variables which were not available in the provincial medical board. Then, the data were analyzed with the help of SPSS version 20.

In this study, soccer, volleyball, handball, softball, table tennis, skating, and chess were considered aerobic sports while karate, wrestling, wushu, kung fu, gymnastics, and archery were considered anaerobic sports.

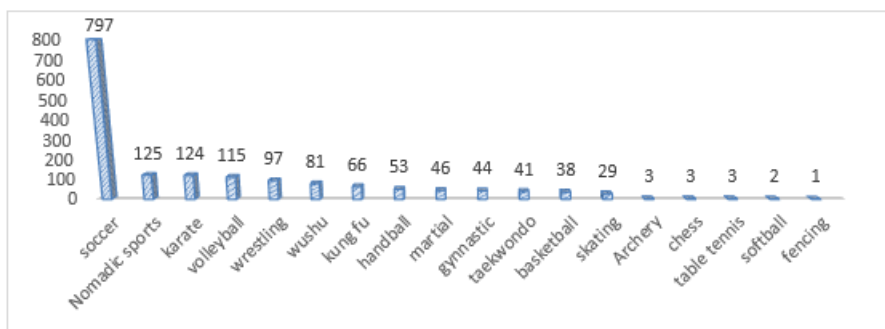
### Findings

Evaluating the information of 402829 insured sports during 2016-2021 indicated that 71% of the insured (N=285677) were male while 29% (N=117152) were female. In addition, reviewing the information of 1951 injured insured individuals registered in the sports medicine offices within six years showed that 83.4% of the injured insured individuals (N=1628) were male while 16.6% of the injured insured individuals (N=323) were female. As Table 1 shows, the increase in the total number of the injured during 2016-2021 has no regular growth rate, unlike the total number of the insured. In general, the growth rate of sports injuries is observed in the studied six years in terms of the number of the injured and the ratio of the injured to the insured.

Studied years	The total number of the insured by gender		The total number of the insured	The total number of the injured by gender		The total number of the injured	The ratio of the injured to the insured
	Male	Female		Male	Female		
2016	34697	13771	48468	179	45	224	0.0046
2017	41442	15328	56770	180	43	223	0.0039
2018	48759	18880	67639	282	49	333	0.0049
2019	48457	19547	68004	309	62	371	0.0054
2020	56851	24111	80962	384	57	441	0.0054
2021	55471	25517	80988	292	67	359	0.0044
Total	285677	117152	402829	1628	323	1951	0.0048
Percentage	71%	29%	100%	83.4%	16.6%	100%	

**Table 1.** The status of the insured and the injured during 2016-2021

Evaluating 13 different sports showed that soccer (N=105305), nomadic sports (N=47855), karate (N=34089), swimming (N=25685), volleyball (N=20803) and physical fitness (N=19188) have the highest insurance statistics. In addition, lifeguarding (N=100), fencing (N=114) and squash (N=193) have the lowest insured statistics within the studied years. Regarding the number of injuries in different sports, soccer, nomadic sports, karate, volleyball, wrestling, wushu, kung fu, and handball have the most injured. Furthermore, fencing, softball, archery, chess and table tennis have the least number of injuries during 2016-2021 (Fig. 1).



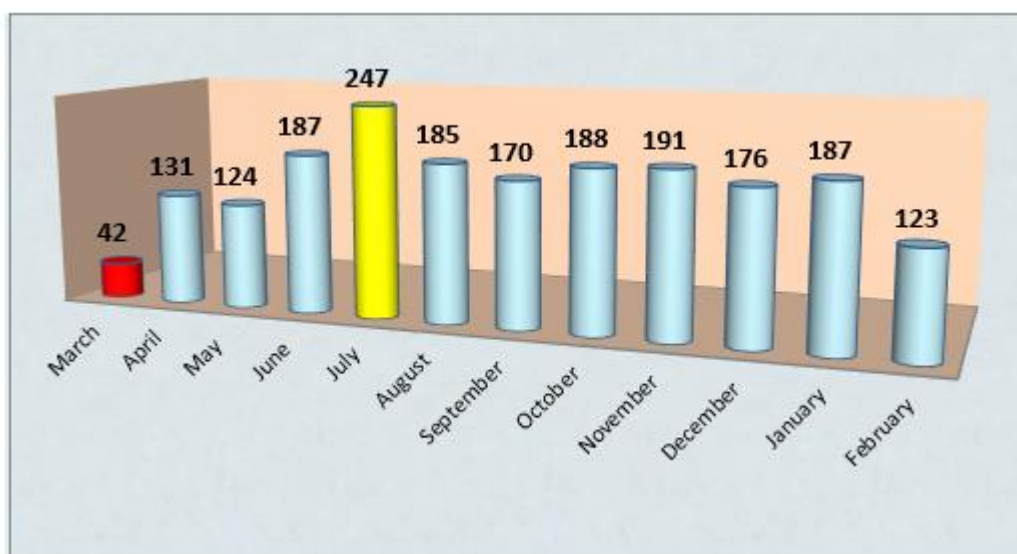
**Fig. 1.** The number of injuries in different sports during 2016-2021

Evaluating the number of injuries in different seasons of the year revealed that summer has the highest percentage (31.6%) and spring has the lowest percentage (15.2%) of injured athletes. In total, the injured male athletes have the highest percentage of injuries compared to injured female athletes (Table 2). Meanwhile, the information of the injured in terms of the time of membership in the Sports Medicine Board indicates that spring with 54.4% has the highest and winter with 2.9% has the lowest membership.

**Table 2.** The trend of injuries in different seasons during 2016-2021

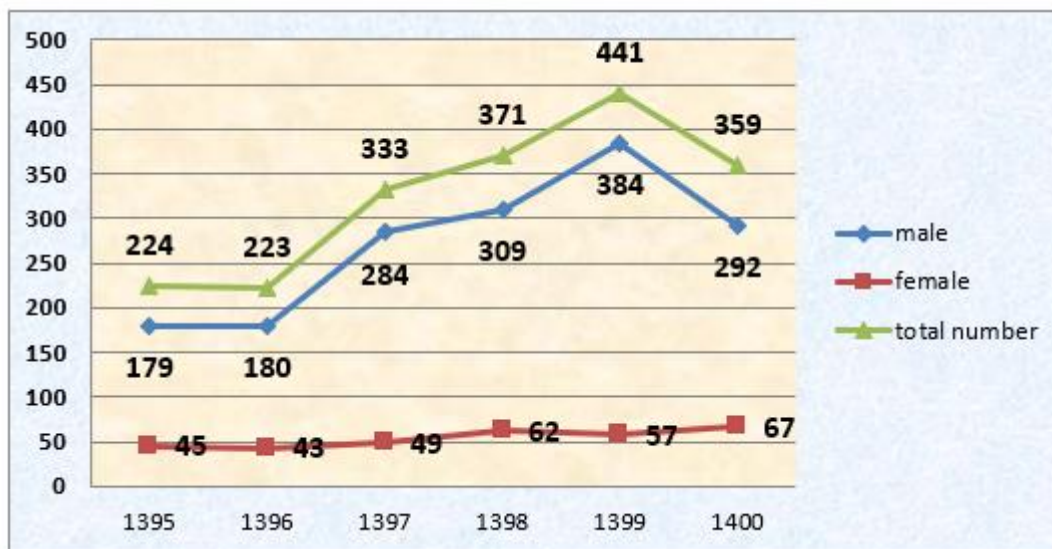
Total number and percentage	Injury season					
	Spring	Summer	Autumn	Winter		
1628	247	511	470	400	Number	Male
83.4%	12.7%	26.2%	24.1%	20.5%	Percentage	
323	49	106	82	86	Number	Female
16.6%	2.5%	5.4%	4.2%	4.4%	Percentage	
1951	296	617	552	486	Number	Total number
100%	15.2%	31.6%	28.3%	24.9%	Percentage	Total percentage

Fig. 2 displays the trend of injuries in different months of the year. Accordingly, August (N=247) has the highest number of injuries and April (N=42) has the lowest number of injuries in both women and men.



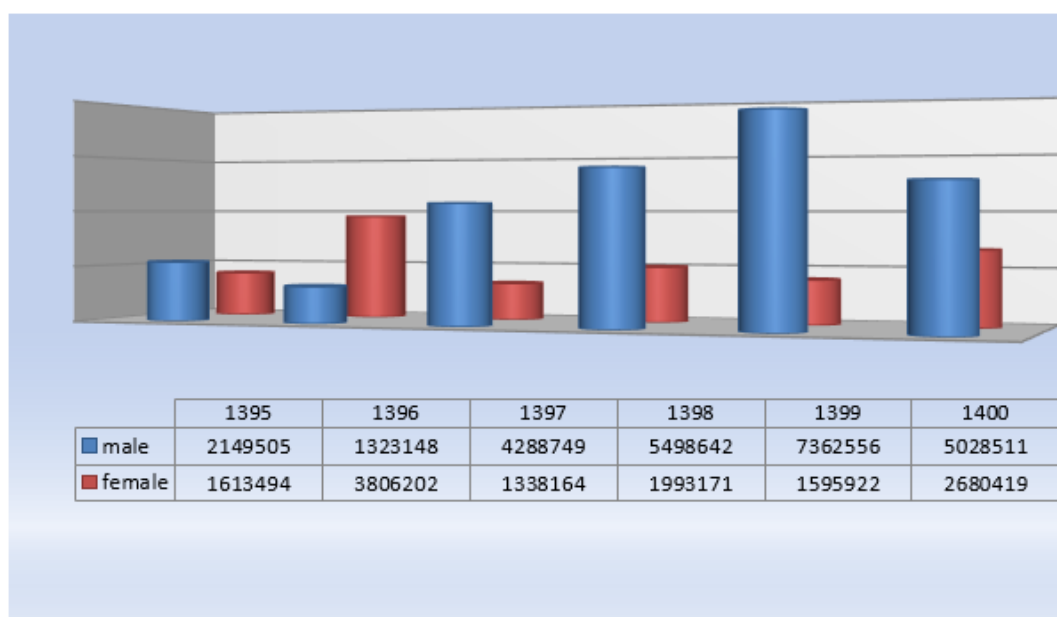
**Fig. 2.** The relative study of injuries by months of the year during 2016-2021

The information recorded in the offices of the sports medicine board during 2016-2021 indicates that the highest number of the male injured is in 2020 (N=384) while the lowest number of the male injured is in 2016 (N=179). Meanwhile, the highest number of the female injured female is reported in 2021 (N=67) while the lowest number of the female injured is reported in 2017 (N=43). In general, the year 2020 with 22.6% (N=441) has the highest number of injuries among the studied years (Table 3).



**Table 3.** The trend of injuries by the year of injury during 2016-2021

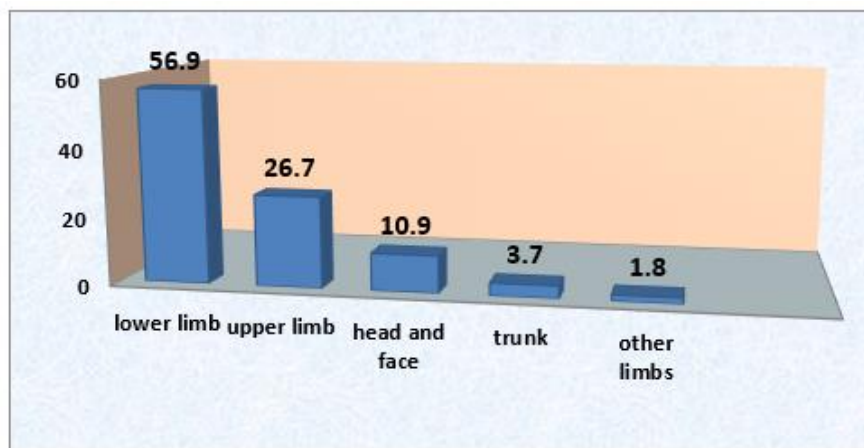
In addition, the findings showed that the amount of expenses imposed on the athletes of different sports was 8746735666 RIs, while the expenses paid by the insurance to the athletes was 3562946439 RIs. The per capita medical expenses for each person will be 4483206 RIs if we divide the amount of expenses by the total number of the injured. In addition, Fig. 3 shows the year 2020 as the highest expenses imposed on the male injured male and 2017 as the highest expenses imposed on the female injured.



**Fig. 3.** The expenses imposed on the injured athletes during the studied years

The findings indicate that the highest amount of expenses imposed on the injured is in soccer while the lowest amount of expenses is in fencing. Furthermore, the analysis of the findings indicates that

the knee bears the highest amount among the injured parts of the body while the cheek bears the lowest amount of cost to the injured athletes. In addition, the highest and lowest amount of expenses imposed on the injured in the treatment department is related to surgery, bandaging, and outpatient. Fig. 4 shows the frequency of injuries in different parts of the body. As the figure shows, lower limbs with 56.9%, upper limbs with 26.7%, head and face with 10.9%, the body with 3.7% and other parts of the body with 1.8% have the highest and lowest injuries, respectively.



**Fig. 4.** The percentage of different injuries in different parts of the body

In addition, the findings indicate that the amount of injuries in different parts is higher in male athletes than in female athletes. By extracting information from different sports injury registration offices of the provincial medical board, Regarding the injured limb, the information in Table 4 shows that most injury in the lower limb is in the knee. However, most injury in the upper limb is in the wrist and most injury in the head and face is related to nose. In the case of the injuries in the body, the most injury is in the waist while the testicles and genitals are the most injured parts in other limbs.

**Table 4.** The dispersion of injured areas in different parts of the body

Injured area	Injured limb	Frequency	Percentage
Lower limb	Knee	671	34.4%
	Ankle	242	12.4%
	Thigh	47	2.4%
	Leg	43	2.2%
Upper limb	Wrist	111	5.7%
	Fingers	79	4%
	Forearm	70	3.6%
	Elbow	65	3.3%
Head and face	Nose	103	5.3%
	Teeth	36	1.8%
	Head	19	1%
	Jaws	16	0.8%
Trunk	Waist	58	3%
	Chest	6	0.3%
	Abdomen	5	0.3%
	Thoracic spine	2	0.1%
Others	Testicles and genitals	7	0.4%
	Sacrum and coccyx	2	0.1%
	Heart attack	1	0.1%



Among different sports, ankle injuries in soccer and volleyball and knee injuries in soccer, nomadic sports, martial arts and gymnastics have the highest rates of injuries. The findings on the types of injuries indicate that rupture 15% in the group of muscle - tendon injuries, sprains with 8% in the group of joint injuries, and fractures 24% in the group of bone injuries have the highest amount of injuries. Further, the analysis of information obtained from the sports medicine board of the province showed that surgery, plastering, physiotherapy, outpatient, and drug therapy allocated 27.6, 22.3, 17, 9, and 5% of the highest amount of treatment, respectively. Regarding the conditions of injury, the findings show that soccer has the highest amount of injuries during training among different sports (Fig. 5).

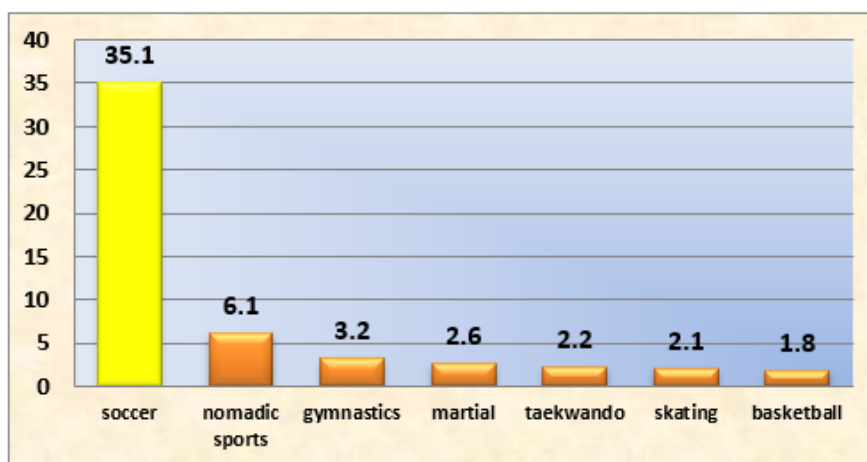


Fig. 5. The percentage of injuries during training among different sports

In addition, the analysis of data indicates that volleyball has the highest amount of injuries during competitions among different sports (Fig. 6). The lower limb shows the highest percentage of injuries in training and competition. However, soccer, karate and wrestling have the highest number of injuries. Accordingly, the findings show that the number of injuries in collision sports is more than in non-collision sports. The data analysis revealed that 81% of injuries among athletes are of collision type and 19% of injuries are related to non-collision injuries.



Fig. 6. The percentage of injuries during training in different kinds of sport

### Discussion and conclusion

In terms of number, the male injured were more than the female injured in all the studied years. In addition, the number of the male insured compared to the female insured accounted for a higher percentage within six consecutive years. These findings showed that less number of active female

athletes participated in sports activities compared to the male athletes. The number of the insured in any sport is one of the evaluation criteria for the number of athletes. Accordingly, one person was injured out of 206 insured people within six consecutive years of study. Moreover, one out of 175 insured male athletes and one out of 362 insured female athletes were injured, indicating an increase in the growth rate of sports injuries. Regarding the number of injuries in different sports, the findings showed that soccer, nomadic sports, karate, volleyball, wrestling, wushu, kung fu, and handball had the highest number of injuries. In addition, fencing, softball, archery, table tennis and chess had the lowest number of the injured. The findings of this study are consistent with Nelson's findings (49). Furthermore, it is consistent with Barner's study evaluating sports injuries in several kinds of sports (25). However, it is not consistent with the findings of Ebrahimi Atri et al. and Nejati regarding the frequency of sports injuries in different sports (33). The results indicated that the rate of injury occurrence among female athletes is increasing, so this rate has been increasing among females since 2016 compared to the number of the female injured in 2021. Such findings are consistent with the statistics published in Iran's Sports Medicine Portal (34). The increase in the number of female athletes in recent years might have been effective in this result. As a result, the amount of sports activity among females has increased significantly in recent years, which is a reason for the increase in the occurrence of injuries among females. In addition, the rate of injuries in males indicates that the highest number of the injured per year was in 2019 while the highest number of the injured was in 2020 during the studied years of 2016-2020. Nevertheless, these injuries had a downward trend in 2021 that could be due to the awareness of athletes on health and safety tips and the observance of safety tips by athletes, coaches and sports officials. The results showed that the most injuries occurred in summer that could be probably due to the increase in the number of athletes and more use of sports venues by the youth, university students, and school students. In addition, the increase in temperature and more sweating in summer causes the loss of water and electrolytes. The possibility of muscle injuries such as muscle and tendon strain, muscle tear and joint injuries such as sprained joints increases if no measure is taken for recovering the lost minerals and vitamins of the athlete's body through proper nutrition. In conclusion, it is highly important to identify and teach safety tips for preventing sports injuries among young athletes. In addition, considering sports nutrition and the intensity of training in various sports are effective in reducing injuries in terms of age, physical fitness, and sports history. It was shown that the sports with the least collisions had the least injury. Further, most injuries occurred in the middle of summer, the hottest season of the year. Thus, the consideration of sports officials to standardize sports venues in summer will significantly reduce the possibility of sports injuries. The use of standard sports equipment in collision sports is inevitable and requires the consideration of athletes, coaches and sports officials. Finally, paying attention to sports insurance is of paramount importance that reduces a lot of expenses for the athlete in case of injury.

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