Original Article

Epidemiology of school fractures: a 1-year experience in Greek facilitation classes

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ABSTRACT

Tyflidis A, Kipreos G, Tripolitsioti A, Stergioulas A. Epidemiology of school fractures: a 1-year experience in Greek facilitation classes. *J. Hum. Sport Exerc.* Vol. 7, No. 2, pp. 589-598, 2012. The purpose of this study was to record bone fractures that were sustained by student-athletes of the Greek Athletic Facilitation Classes (AFC) during a 1-year period. The researchers examined 7455 male and 4921 female student-athletes from September 2006 until May 2007. All fractures were recorded by the Physical Education Teachers of the AFC with the cooperation of orthopaedic doctors, were entered into SPSS and were analysed with the Chi Square non-parametric test. In one year, 129 fractures in total were recorded, and this figure accounted for 11.4% of all injuries sustained by student-athletes of the Greek AFC. Results showed that male student-athletes sustained more fractures than females (67.4% vs. 32.6%, $p<0.001$). The highest rate of fractures occurred in soccer and basketball, where male student-athletes sustained more fractures than females (78.3% vs. 21.8%, $p<0.05$). Most injuries occurred in male student-athletes who were residence of the urban region (78.4% vs. 21.6%, $p<0.05$). Results showed that most fractures occurred during the month of February ($\chi 2=13.12$, $df=8$, $p<0.05$). The training surfaces on which most fractures occurred was the parquet and the synthetic floor. Overall, fractures of the wrist; metacarpal bones-fingers, and medial-lateral malleollus were the most common injuries observed. Fractures did not require expensive, medical, diagnostic imaging examinations and the total rehabilitation cost in most cases did not exceed 100 Euros. **Key words**: FRACTURES, ATHLETIC FACILITATION CLASSES, INJURIES, ACCIDENTS

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INTRODUCTION

In 1990, the Hellenic Ministry of National Education and Religious Affairs (HMNERA) established the Athletic Facilitation Classes (AFC) within the middle and high school curriculum. In each AFC, seven student-athletes are selected for individual sports and ten student-athletes participate in team sports. Each school selected to be involved in the AFC registers its students after specific evaluations in various athletic activities.

The AFC was developed in order to ensure more training and competition opportunities for talented student-athletes in team or individual sports. The daily participation in sports is important for the physiological growth and socialization of students. At times, the excessive training and participation in competitive sports puts students at greater risk of injury than the one taken by their peers in regular schools (Stergioulas, 2003; Stergioulas & Mandilas, 2003; Tyflidis et al., 2009a; 2009b).

The main difference between regular and AFC classes is that in addition to the scheduled school program, AFC students participate in extra training and competition according to their selected team or individual sports.

In the case of competitive athletic activities such as soccer, basketball and volleyball, the strain on the muscle/tendon unit can exceed the unit's biological functional limit (or capability). Thus, the muscle/tendon unit fails to achieve its role of absorbing energy. As a result, the strain is carried by the bones, and this leads to fractures (Bergström et al., 2008).

In the current literature there are many studies on the epidemiology of school, sport-related injuries (Schelp et al., 1991; Sørensen et al., 1996; Stark et al., 1996; Weir & Watson, 1996; Di Scala et al., 1997; Menckel & Laflamme, 2000; Vorko-Jovic et al., 2001; Abernethy & MacAuley, 2003; Sumilo, 2006).

The result of Hassan and Dorani study (2001) confirm that the fractures appear to be a third type of injury in high school athletes.

Research in fractures related to school age populations who participating in sports, include single sports and have a limited sample size (Swenson et al., 2010).

However, no epidemiological study has investigated the details of fractures in AFC. Therefore, the purpose of this study was to record: (a) the rate of fractures in the AFC; (b) the rate of fractures in relation to the place of residence, sport, class, and training surface, (c) the type of bones that sustain a fracture, and (d) the differences in all the above mentioned parameters between male and female students-athletes.

MATERIAL AND METHODS

This study was carried out by the Lab of Health, Fitness & Disability Management, Faculty of Human Movement and Quality of Life, University of Peloponnese from September 2006 until the end of May 2008. After permission from the Central Committee of AFC, HMNERA, the researchers sent a package to the Director of Physical Education (PE) at HMNERA that included a cover letter, a questionnaire and the injury report form. In the cover letter the researchers described the study details. At the beginning of the school year 2006-07, the director of the department of PE informed all PE teachers of AFC by e-mail about the research project and their duty to record and send weekly injury reports to the department of PE at

HMNERA. This study involved the participation of all students-athletes that attended A.F.C. at a national level during the 2006-07 school year. During the study period, 1302 AFC were functioning and 12376 students-athletes were attending the program in 39 different sports. Certified PE teachers (n=1302) participated in the study as data reporters.

The Final Report Form used in this study, was constructed after an extensive literature review. Furthermore, injury report forms developed by previous researchers were taken into consideration. Specifically, our form was based on (a) the Incident Report Form developed by Stark et al., (1996), (b) the Student Injury and Incident Report forms used in Swedish schools Laflamme et al., (1998); Laflamme & Eilert-Peterson, (1998); (c) the Student Accident Report Form used by Yang et al., (1998) and (d) the Student Accident Report Form used by Sun et al., (2006). In the final report from the researchers included: (a) information about fractures (month of fracture, pattern, severity, preliminary diagnosis and first aid); (b) treatment (plaster cast or surgery, time of rehabilitation, time of absence from school and time absence from training and competition); (c) information regarding the sport (training surface, supplements of diet, kind of athletic shoes worn, preventive taping, number of matches played), and (d) demographic & anthropometric characteristics of male and female students-athletes of AFC (region of residence, class, sex, age, height, body mass, body mass index).

For the purpose of this study, fracture is defined as a contusion or complete or incomplete break in a bone resulting from the application of excessive force. The fracture is: a) diagnosed by x-ray, b) has occurred during participation in a sport (training, competition), and c) limits the student-athlete's ability to participate in sports activities following the day of injury (Swenson et al., 2010).

The concentration of data in weekly batches and their transmission via e-mail to the Department of Physical Education in the HMNERA minimised the possibility of forgetting recordings of student-athletes. Moreover, the Physical Education teachers filled a second form that gave all the information related to the rehabilitation process of the students-athletes and their return to School.

Statistical Analysis

The Statistical Package for Social Sciences was used to carry out the statistical analyses (version 17, SPSS inc. Chicago) software. Frequencies of fractures were calculated for the aforementioned categorical variables. Statistical significance of differences among the variables was estimated using the non-parametric Chi Square test (applying Fisher's exact test where appropriate). Statistical significance was set at $p<0.05$ for all analyses (Kabitsis, 2004).

RESULTS

From September 2006 until the end of the School year (May 2007), 1,135 injuries were recorded. One hundred and twenty nine of the injuries (11.4 %) were found to be fractures. Eighty seven fractures (67.9 %) were sustained by male student-athletes and forty (32.1%) were sustained by female student-athletes ($p<0.05$).

Male student/athletes were found to be more likely than females to sustain a fracture in January (54.5 % vs. 45.5 %, $\chi 2 = 5.85$, df = 1, $p<0.01$, Table 1), while female students/athletes were more likely than males to sustain a fracture in November (70.0% vs. 30.0%, $\chi 2=3.84$, df=1, $p<0.05$).

Most of the fractures were sustained by male students/athletes, who attended the AFC that operated in the urban regions (78.4% vs. 21.6%, $\chi 2=3.98$, df=1, $p<0.05$), (Table 2). Also, the males students/athletes who attended the first, second and third class were more likely than females to sustain a fracture (65.4% vs. 34.6%, $\chi 2=3.59$, df=1, $p<0.05$, 69.5% vs. 30.5%, $\chi 2=4.16$, df=1, $p<0.04$, and 67.7% vs. 32.3%, $\chi 2=3.97$, df=1, $p<0.05$, respectively, Table 3).

Male student/athletes were more likely than females to sustain a fracture in basketball (78.3% vs. 21.7%, $\chi 2=3.62$, df=1, $p<0.05$), while female students/athletes were more likely than males to sustain a fracture in volleyball (18.8% vs. 81.9%, $\chi 2=16.11$, df=1, $p<0.001$), and handball (43.7% vs. 56.3%, $\chi 2= 8.13$, df=1, $p<0.004$), (Table 4).

Most of fractures occurred on playing surfaces such as synthetic floor, natural grass, parquet and dirt fields. Male students/athletes were more likely than females to sustain a fracture in the dirt field (71.4% vs. 28.6%, $\chi 2=4.17$, df=1, $p<0.04$ (Table 5).

Our study found that most of the fractures were of the upper extremities. Most of the fractures occurred in the bones of the wrist (68.4% in males vs. 31.6%, in females students/athletes $\chi 2=6.52$, df =1, $p<0.001$), and fingers (65.5% vs. 34.5%, $\chi 2=4.15$, df=1, $p<0.05$), (Table 6).

Additionally most fractures did not require expensive medical diagnostic examinations such as x-ray and the total rehabilitation cost in most cases did not exceed 100 Euros.

Table 1. *Frequencies of fractures according to recording month.*

Month	Males N (%)	Females N (%)	Total N (%)
September 2006	4 (4.6)	1 (2.4)	5 (3.9)
October 2006	16 (18.4)	6 (14.2)	22 (17.0)
November 2006	3 (3.4)	7 (16.6) †	10 (7.8)
December 2006	12 (13.8)	2 (4.8)	14 (10.9)
January 2007	12 (13.8)	10 (23.8) ††	22 (17.0)
February 2007	19 (21.9)	10 (23.8)	29 (22.5)
March 2007	8 (9.2)	1(2.4)	9 (7.0)
April 2007	4 (4.6)	2 (4.8)	6 (4.7)
May 2007	9 (10.3)	3 (7.2)	12 (9.2)
Total	87 (100.0)	42 (100.0)	129 (100.0)

†=p<0.05, ††= p<0.01.

Table 2. *Frequencies of fractures according to place of residence.*

Place of residence	Boys N (%)	Girls N (%)	Total N (%)
Rural region	22 (25.3)	18 (42.9)	40 (31.0)
Urban region	40 (46.0)	11 (26.2) †	51 (39.5)
Capital of Prefecture	17 (19.5)	12 (28.5)	29 (22.5)
Athens/Thessaloniki	8 (9.2)	1 (2.4)	9 (7.0)
Total	87 (100.0)	42 (100.0)	129 (100.0)

†=p<0.05

Table 3. *Frequencies of fractures according to attending class.*

Classes	Boys N (%)	Girls N (%)	Total N (%)
First	34 (39.1)	18 (42.8) †	52 (40.3)
Second	32 (36.8)	14 (33.3) ††	46 (35.6)
Third	21 (24.1)	10 (23.9) †	31 (24.1)
Total	87 (100.0)	42 (100.0)	129 (100.0)

†=p<0.05, ††= p<0.04.

Table 4. *Frequencies of fractures according to sport.*

Fractured bone	Boys N (%)	Girls N (%)	Total N (%)
Track & field	6 (6.9)	6 (14.1)	12 (9.3)
Wrestling & Boxing	7 (8.0)	2 (4.8)	9 (7.0)
Soccer	35(40.3)	0 (0.0)	35 (27.1)
Basketball	18 (20.7)	5 (11.9) †	23 (17.8)
Volleyball	3 (3.5)	13 (31.0) †††	16 (12.4)
Handball	7 (8.0)	10 (23.8) ††	17 (13.2)
Tennis	4 (4.6)	2 (4.8)	6 (4.7)
Other	7 (8.0)	4(9.6)	11(8.5)
Total	87 (100.0)	42 (100.0)	129 (100.0)

†=p<0.05, ††= p<0.004, †††= p<0.001

Table 5. *Frequencies of fractures according to playing surface.*

Playing surface	Boys N (%)	Girls N (%)	Total N (%)
Natural grass	21 (24.1)	0 (0.0)	21 (16.2)
Tartan	4 (4.6)	4 (9.5)	8 (6.2)
Synthetic floor	23 (26.4)	13 (30.9)	36 (28.0)
Parquet	20 (23.0)	16 (38.1)	36 (28.0)
Dirty field	10 (11.5)	4 (9.5) †	14 (10.8)
Other	9 (10.4)	5 (12.0)	14 (10.8)
Total	87 (100.0)	42 (100.0)	129 (100.0)

†=p<0.04

Table 6. *Frequencies of fractures according to type of bone fractured.*

Fractured bone	Boys N (%)	Girls N (%)	Total N (%)
Clavicle	4 (4.6)	2(4.7)	6(4.6)
Ulna-radius	8 (9.2)	4 (9.4)	12(9.3)
Wrist (colle's & smith)	26 (29.9)	12(28.6)	38(29.4)
Metacarpal-fingers	19 (21.8)	10(23.8)	29(22.6)
Tibia-fibula	7 (8.1)	3 (7.1)	10(7.7)
Medial-lateral malleollus	15 (17.2)	7 (17.0)	22(17.1)
Other	8 (9.2)	4 (9.4)	12(9.3)
Total	87 (100.0)	42 (100.0)	129 (100.0)

DISCUSSION AND CONCLUSIONS

The purpose of this study was to record the fractures that were sustained by student/athletes of the Greek Athletic Facilitation Classes (AFC) during a 1-year period. Fractures included in our study accounted for 11.4% of all injuries sustained by AFC school student/athletes and our results are comparable with previous studies that were conducted in school populations. The percentage of fractures found in the total amount of injuries in our study is slightly higher than those reported in the Swenson et al. study (2010), where a fracture incidence of 10.1% was found. It must be noted that other researchers found higher fracture percentages. For example, Maitra (1997), found a 15% occurrence rate of fractures; Bergström et al. (2008), analysed 307 cases registered at the hospital during one school year and found that 17% of these cases sustained a fracture, and the classic study of Landin (1983), in Malmö, Sweden in 1975-1979, showed an incidence of 21.2/1000/year. Furthermore, Sorensen et al. (1996), investigated 6,096 children aged 6-17 a 5-year-period 1988-1992, and they found that fractures accounted for 22.0% of total injuries; Abernethy & MacAuley (2003), found a percentage of 23.3%; Burt & Overpeck (2001), came up with a 20.5%, Schelp et al., (1991), showed a 24% result, and Leininger et al. (2007), found a 24.5%.

This variance in % shows that the rate of fractures varies between countries and depends on the type of sports in which school age children participate. In the AFC of our country, most student-athletes participated in sports that generally present low risk in causing fractures in contrary to other countries where students participate in high risk sports such as skiing, snowboarding, rugby and in-line skating (Lyons et al., 1999; Lyons et al., 2000a; Hassan & Dorani, 2001; Brudvik & Magne, 2003).

Results showed that male student/athletes sustained 67.9% of all fractures, while females 32.1%; the males outnumbered females more than twice (2.12: 1). These results are in line with previous publications (Deakin et al., 2007; Rennie et al., 2007).

However, in some studies this difference between sexes may not be so obvious (Tandon et al., 2007). Several authors have described the variations of school fractures in the different seasons (Landin, 1983; Lyons et al., 1999; Tiderius, 1999; Lyons et al., 2000a). An interesting finding of the present study is that the highest incidence of fractures sustained by male student-athletes of AFC occurred during the month of February. The high incidence of fractures that were sustained during February, may be due to the championship's evolution and to the more vigorous activities student/athletes participate in? Also, the high number of fractures in December was expected, since the weather conditions at this time of year deteriorate.

Male student/athletes appear to have suffered more fractures than females during January, while female student-athletes have shown increased fracture cases during November. The differentiation between the sexes can be related to the increased participation in team sports, such as basketball and handball, mainly by female student/athletes during the winter months. In several schools that are located in urban regions, there are no indoor gyms and the training and games are undertaken outdoors.

According to our results, male student/athletes who attended the AFC that operated in the urban regions, sustained more fractures than females. One explanation for the increased fracture risk may be the more frequent participation in sports such as soccer; basketball, and handball. However, the increased participation in these sports seem to increase injury rates (Stergioulas & Mandilas, 2003), therefore, the aforementioned results of our study should be further investigated.

Although all male student/athletes participating in our study sustained more fractures than females irrespective of the class they belonged to (1st, 2nd & 3rd), there was an equal contribution of injuries to all classes. It is possible that males of all classes participate in high-intensity physical activities and so the risk of fracture is increased in relation to females.

Student/athletes sustained more fractures in the sports of soccer, basketball, volleyball and handball. Our results were slightly different from school studies conducted in countries where there is an increased participation in sports such as skiing, snowboarding, rugby and in-line skating. Researchers argue that these sports can cause more fractures (Lyons et al., 1999; Lyons eta al., 2000a; Hassan & Dorani, 2001; Brudvik & Magne, 2003).

For example Brudvik & Magne (2003) found a double risk of fractures during rollerblading/skating or snowboarding (60%) compared with playing soccer (38%) or bicycling (33%). Several other studies confirm these findings (Tiderius et al., 1999; Deakin et al., 2007; Rennie et al., 2007).

Male student/athletes of our study sustained more fractures in soccer and basketball, while female student/athletes sustained more fractures in the sport of volleyball and handball. We can argue that the massive participation of males student/athletes in soccer and basketball (2701 subjects vs. 44 & 1587 vs. 562), is a possible explanation for the higher number of fracture incidents in the male population. The reason for the predominance of fractures in females versus males in volleyball and handball is probably due to a combination of biological factors and gender-related differences which are related to activity (Hedström et al., 2010).

Natural grass, synthetic floor and parquet were the surfaces on which 64 % of the fractures occurred both in male and female athletes. A possible explanation for this increasing rate is that most of the team AFC sports are conducted on these grounds. Proper measures should be taken in order to decrease this high rate of fractures on playing surfaces (Loder, 2008).

Also, we found that most of the fractures in our sample 65% (n=57) and 66 % (n=28) occurred in upper extremities. Taking into consideration the anatomical distribution, we found that most fractures were sustained by both sexes; occurred in the wrist, and in the metacarpal bones & fingers, and female student/athletes sustained more fractures than males. These results are similar to those previously reported by Konstantynowicz et al., (2005) and Lyons et al., (1999; 2000a; 2000b).

The strengths of our study are the reliability and the validity of data collection by PE teachers of AFC. These professionals gathered the data on a weekly basis and transmitted them via e-mail to the Department of Physical Education in the HMNERA. Thus, they minimized the possibility of errors regarding recordings of student-athletes. Additionally, PE teachers used a second form that recorded the information related to the rehabilitation process of the student-athletes and their return to School.

The authors of this study believe that PE teachers are the most appropriate authorities to record fractures, as in our country there are no school nurses or school doctors. This is due to the fact that PE teachers are dutiful, responsible, trained experts who interrelate with the student-athletes every day throughout the entire academic year.

The weaknesses of the present study were that the authors did not consider the following: a) the possible impact of the type of sport on the location of fractures; b) the variable of mechanism of fracture and c) at what point of training were the fractures sustained, ie., while warming up, training or during games.

In conclusion our study in AFC revealed that fractures were the third most common type of injury and male student-athletes suffered more from fractures than females. Also, more fractures occurred in organized sports such as soccer, basketball, volleyball, and handball. These fractures of AFC male and female student-athletes are a crucial matter of concern. Preventative actions should concentrate on specific target areas; use schemes based on separate athletic schools, and construct a credible system of monitoring their effectiveness.

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