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Br. J. Sports Med. 2003;37;137-139
doi:10.1136/bjasm.37.2.137

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ORIGINAL ARTICLE

Occurrence of acute lower limb injuries in artistic gymnasts in relation to event and exercise phase

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Br J Sports Med 2003;**37**:137–139

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Accepted 12 June 2002

Objectives: To record the incidence of lower limb injuries (acute and overuse syndromes) in Greek artistic gymnasts in relation to the event and exercise phase.

Methods: A total of 162 gymnasts (83 male and 79 female athletes) participating in the Greek artistic gymnastic championships were observed weekly for the 1999–2000 season.

Results: Ninety three (61.6%) acute injuries and 58 (38.4%) overuse syndromes were recorded. The most common anatomical location was the ankle (69 cases, 45.7%), followed by the knee (40 cases, 26.5%). The rate of mild injuries was 26.6% (25 cases), that of moderate injuries was 44% (41 cases), and that of major injuries was 29% (27 cases). The incidence of injury to the ankle and knee was significantly higher in the floor exercise, especially during the landing phase, than in the other events.

Conclusions: By its nature, gymnastics predisposes to acute injuries, but up to 75% are mild or moderate. Special attention should be paid to the floor exercise, especially the landing phase.

Although artistic gymnastics is still performed on the same apparatus as about 50 years ago, it has undergone great changes: increased competition, growth in rates of participation,¹ the development of sport science in general and biomechanics in particular, and development of the creative forces of gymnasts themselves.¹ This has led to an increase in injury risk factors.^{1,2}

With the increased risk, the incidence of acute injuries has increased, and, as the skill level has increased, the load during training has increased, providing more opportunity for chronic injuries.

A number of researchers have reported that injuries in gymnasts are anatomically widely distributed.^{3–5} However, others have reported that the lower limbs, especially the ankle^{6–8} and knee, are the most injured areas.¹

In addition, many authors have reported that the greatest number of acute injuries occur in the floor exercise,^{1,9} especially during landing.^{6,10–13} Specifically, 40% of acute injuries happen then.

The main goal of sports medicine is the prevention of injury. Preventive medicine is best approached by analysing injury epidemiology.¹⁴ In the case of sports injury, the agent (immediate causative factor), the host (the athlete sustaining the injury), and the environment (situation or conditions that may predispose to or inhibit the injury) must be analysed.¹⁴

The purpose of this epidemiological study is to analyse the occurrence of acute lower limb injuries in artistic gymnasts in relation to the event and exercise phase.

MATERIALS AND METHODS

A total of 162 Greek gymnasts (83 boys and 79 girls) participating in the Greek artistic gymnastic championships involving all categories were observed weekly during the period 1999–2000. This was almost half of the gymnasts participating. Table 1 gives the age and anthropometric characteristics of the participants.

An orthopaedic surgeon, a physiotherapist, and a trainer made up the injury assessment team. Personal consultations with the authors were carried out twice a week to register any injury occurring during scheduled competitions or training which caused the athlete to miss the next competition or practice session.¹⁵ The characteristics, anatomical location, event, and exercise phase (landing, take off, fall) of musculo-skeletal injuries were recorded.

Table 1 Age and anthropometric characteristics of gymnasts

Characteristic	Male (n=83)	Female (n=79)
Age (years)	13 (3.3)	11.5 (2.1)
Weight (kg)	38.8 (13.8)	32.4 (8.6)
Height (cm)	144.8 (17)	138.2 (13.1)

Values are mean (SD).

Injury was defined as “any mishap occurring during scheduled games or practices that cause an athlete to miss a subsequent game or practice session”.³ Injuries were classified into three grades of severity: minor (absence from training or competition for less than one week); moderate (absence from training or competition for one week to one month); major (absence from training or competition for more than one month). This classification has been used in much research.^{15–18}

RESULTS

The statistical test used was the χ^2 test (SPSS statistical package), and the level of significance was set at $p < 0.05$.

A total of 151 injuries were reported for the 12 month experimental period; 93 (61.6%) were acute injuries and 58 (38.4%) overuse syndromes (table 2).

The severity of acute lower limb injuries is shown in terms of absence from competition or training after the injury. The rate of mild injuries was 26.8% (25 cases), that of moderate injuries was 44% (41 cases), and that of major injuries was 29% (27 cases) (no significant difference between them).

Eighty nine cases were analysed in terms of event occurrence and exercise phase. Tables 3 and 4 show that the incidence of knee and ankle injury was highest in the floor exercise, especially during landing. The increased incidence during the floor exercise compared with the other events was significant ($\chi^2 = 108.44$, $p < 0.05$ for the ankle; $\chi^2 = 22$, $p < 0.05$ for the knee). The increased incidence on landing compared with the other exercise phases was also significant for both sexes (boys: $\chi^2 = 46.97$, $p < 0.05$ for the ankle, $\chi^2 = 29.273$, $p < 0.05$ for the knee; girls: $\chi^2 = 36.379$, $p < 0.05$ for the ankle, $\chi^2 = 27.4$, $p < 0.05$ for the knee).

Table 2 Acute and chronic injuries in terms of anatomical location

Location	Acute injuries (n=93)	Overuse syndromes (n=58)	Total injuries (n=151)
Ankle-foot	48* (52)	21* (36)	69* (45.7)
Knee-thigh	23 (25)	17 (29)	40* (26.5)
Wrist-hand	12 (13)	2 (3)	14 (9.3)
Elbow-forearm	5 (5)	4 (7)	9 (6.0)
Shoulder	3 (3)	4 (7)	7 (4.6)
Lower back	2 (2)	10 (17)	12 (7.9)

Values in parentheses are percentages.
*Significantly higher than in other locations.

Table 3 Number of injuries in male gymnasts in relation to event and exercise phase

Joint	Event	Landing*	Take off	Fall
Knee	Floor*	9	0	0
	Vault	1	2	0
	Horizontal bars	1	0	0
	Parallel bars	1	0	1
	Others	1	1	0
Ankle	Floor*	11	0	3
	Vault	1	0	0
	Horizontal bars	2	0	0
	Parallel bars	11	1	0
	Others	1	0	2

*Significantly higher rate of injury than for the other events and phases.

Table 4 Number of injuries in female gymnasts in relation to event and exercise phase

Joint	Event	Landing*	Take off	Fall
Knee	Floor*	6*	0	0
	Vault	4	2	0
	Asymmetric bars	2	0	1
Ankle	Floor*	7*	5	1
	Balance beam	0	3	0
	Vault	2	0	1
	Asymmetric bars	2	0	0
	Others	1	1	2

*Significantly higher rate of injury than for the other events and phases.

for the knee). The increased incidence during the landing phase of floor exercises was significant for the girls ($\chi^2 = 66.978$, $p < 0.05$ for the ankle, $\chi^2 = 31$, $p < 0.05$ for the knee).

DISCUSSION

From the statistical analysis, the incidence of injuries to the gymnasts in our study is either higher^{19, 20} or lower^{2, 21} than found previously. These differences in injury incidence have been explained by differences in age and duration of training sessions.³

The different injury incidence rates in our study could be due to several differences from the other studies. Firstly, the higher rate compared with the results of Garrick and Requa¹⁹ and Bale and Goodway²⁰ could be due to the difference in competition level of the cohorts (elite in our study). In contrast, the lower rate compared with the results of Caine *et al*²¹ and Kolt and Kirby² could be due to lower weekly training loads.

Our findings agree with previous reports^{6, 19, 21} that the greatest number of acute injuries occurs during the floor exercise. This could be expected, as much more time is spent on training for the floor exercise than for the other events.²¹

No previous research has investigated the incidence of acute lower limb injuries. This study confirms that most acute lower

Take home message

Coaches and sports medicine personnel should develop and implement injury prevention programmes for the floor exercise element of gymnastics, especially the landing phase.

limb injuries occurred in the floor exercise (boys and girls) especially on landing (girls). This high incidence, which is due to the large strain placed on lower limb joints, especially the knee and ankle ligaments, increases the risk factor.¹³

These findings are worrying and should be considered by coaches and sports medicine personnel involved in developing and implementing injury prevention programmes directed at gymnasts.

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