

# Musculoskeletal Disorders among Greek National Gymnastics team

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**Abstract—** Background. Gymnastics, being one of the oldest Olympic sports, is technically difficult and physically highly demanding, requiring long hours of practice in explosive and complex movements. Gymnastics injuries are frequent particularly among advanced level female gymnasts. Today's gymnastic stunts require a high degree of skill in acrobatics, whole body strength and static as well as dynamic balance. The best way to identify possible risk factors and to suggest injury preventive measures is to determine injury rates. Physicians who treat gymnasts must be aware of the most common problems.

**Objectives:** The aim of the present study was to investigate the prevalence of injury rates among professional elite gymnastic athletes in the Greek National team.

**Methods.** A sample of 33 Greek elite competitive gymnasts were administered a questionnaire to collect personal and training data as well as information concerning the number, location, and type of musculoskeletal disorders sustained in the previous 12 months. All athletes were gymnastics in the Greek National team. Ethical approval was provided by the ethics committee of the School of Health and Welfare-Technological Educational Institute of Western Greece.

**Results.** A total of 33 gymnasts (men: 16; women: 17) with a median age 20.45 (range 11-40 years) years participated in the present cross-sectional study. 62% of elite reported at least one musculoskeletal injury during the last year. In total, 108 injuries were registered. The most common anatomic areas involved, were the ankles (60.2 %) followed by the shoulders (54.5%) and the wrists (54.5%). There were differences between genders regarding the main areas of pain and discomfort, with the ankles being more prevalent in women compared with men (11 cases vs 9 cases;  $p = 0.97$ ), while men tended to complain mostly about pain in shoulders (15 vs 3 cases;  $p=0.8$ ) and wrists (12 vs 6 cases;  $p=0.17$ ).

**Conclusions.** Gymnasts are high-performance athletes with high prevalence of injuries and disorders. Further research should investigate in depth the profile of musculoskeletal disorders in Greek elite gymnastics athletes and the effectiveness of focused prevention programmes.

**Index Terms—** athletes, gymnastics, musculoskeletal disorders, injuries.

## I. INTRODUCTION

Highlight Sports injuries are a side effect of sporting activity [1]. The origins of gymnastics go back to ancient Greek and Egypt, where it was used as a means of discipline and physical conditioning for young men being trained for warfare. Today, it is both a recreational and organized sporting activity. There are six major disciplines: men's artistic gymnastics, women's artistic gymnastics, rhythmic sportive gymnastics, sport aerobics, trampoline sports, and general gymnastics [2]. In the past years gymnastics has become very popular. The increased participation exposes a greater number of athletes to potential injury. In addition to the difficulty of the sport, the increased amount of practice starting at a very early age is a decisive factor for the increased risk of injury [3].

Gymnastic injuries vary among overuse injuries, overstrain or traumatic [2]. Most competitive gymnasts, and especially those who progress to elite levels, usually incur at least one injury through their sports careers [2]. The risk of gymnastic injuries seems to be proportional to the level of the athletes; the higher the level of gymnastics, the more hours are spent in practice, with a greater exposure time [3].

Prospective and retrospective studies in gymnastics injuries (especially for women artistic gymnastics) have reported injury rates ranging from 0.5 to 5.3 injuries per 1000 hours of exposure (training and competition) [4,5,6]. The anatomic regions particularly affected by injury vary by sex, most likely both due to anatomic and hormonal differences and the diverse events in which male and female gymnasts train and compete. [7,8,9]. As far as Greece is concerned, there is no scientific epidemiological evaluation of injuries in elite gymnasts. The pre-national team was observed for a year on a weekly basis by Kirialanis et al. [10]. The most common anatomical location of injury was the ankle (110 cases, 46%), followed by the knee (63 cases, 26.2%).

The aim of the present study was to investigate the prevalence of injury rates among professional elite general gymnastic athletes in the Greek National team. Secondary, possible differences between genders were investigated. The importance of such information could assist in targeting prevention strategies and hopefully reducing the risk of injury.

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II. METHODS

In this cross-sectional study a questionnaire survey was carried out among the national team of gymnastic athletes in Greece. Responders were eligible for inclusion if they were gymnasts competing for the Greek national team. The study population comprised both male and female athletes.

A total of 50 questionnaires were distributed in the Greek general gymnastic national team. A total of 33 questionnaires were returned (response rate 66%) and were used for data analyses.

The questionnaire was a modified Greek-language version of the Standardized Nordic Questionnaire and had three sets of questions. The first set was about demographics (age, gender, weight, height) and information about their training routine (hours per week, years of training). The second set of questions comprised the Greek validated version of Nordic Medical Questionnaire [11]. The third set of questions was based on personal opinions of the participants about the mechanism of injury (e.g. in landing), the days of absence in training and/or due to musculoskeletal disorders and injuries.

One of the authors delivered questionnaires to training room and was present during the data collection. All the participants were informed about the procedure prior to the completion of the questionnaires and consented to their inclusion in the study. Ethical approval was obtained by the ethics committee of the School of Health and Welfare, Technological Educational Institute of Western Greece. The students' t-test for independent samples was used for inter-gender comparisons with SPSS (version 20).

**Participants characteristics**

The athletes in the Greek national gymnastics team had a median age 20.45 years. The proportion of female athletes was 51.5% (n=17) while men were 48.5% (n=48.5) (Table 1).

**Table 1. Characteristics of Greek gymnastic athletes in National team**

		Frequency (N)	Percentage (%)
<b>Sex</b>	Men	16	48.5%
	Women	17	51.5%
<b>Age (years)</b>	11-20	20	60.8%
	21-30	11	33.4%
	31-40	2	6.0%

**The prevalence of musculoskeletal injury**

Sixty-two percent (62%) of elite athletes reported at least one musculoskeletal injury during the last year. In total, 108 injuries were registered. Prevalence rates of musculoskeletal disorders were higher in the ankles (60.2%), wrists (54.5%) and shoulders (54.5%) (Table 2). There were differences

between genders regarding the main areas of pain and discomfort, with the foot/ankle area being more prevalent in women compared with men (64.7% vs 56.2 %; p = 0.97), while men tended to complain mostly about pain in the wrist area (75%).

**Table 2. Annual Prevalence rates of musculoskeletal disorders among Greek gymnastic athletes in National team**

Body region	Women N=17 (51.5%)	Men N=16 (48.5%)	Total N=33 (100%)	P value
Neck	5 (29.4%)	5 (31.2%)	10 (30.3%)	0.92
Shoulder/s	3 (17.6%)	15 (93.8%)	18 (54.5%)	0.80
Elbow	3 (17.6%)	4 (25%)	7 (21.2%)	0.07
Wrist/hands	6 (35.3%)	12 (75.0%)	18 (54.5%)	0.17
Thoracic area	2 (11.8%)	6 (37.5%)	8 (24.20%)	0.32
Low back area	6 (35.3%)	6 (37.5%)	12 (36.4%)	0.17
Hip/s	4 (23.5%)	3 (18.85%)	7 (21.2%)	0.38
Knee/s	7 (41.2%)	8 (50%)	15 (45.5%)	0.87
Foot/ankle	11 (64.7%)	9 (56.2%)	20(60.6%)	0.97

**Table 3. 7days prevalence rates of musculoskeletal disorders among Greek gymnastic athletes in National team**

Body region	Women N=17 (51.5%)	Men N=16 (48.5%)	Total N=33 (100%)	P value
Neck	5 (50%)	2 (14.3%)	7 (29.2%)	0.05
Shoulder/s	1 (10%)	9(64.3%)	10 (45.7.5%)	0.08
Elbow	2 (20%)	4 (28.6%)	6 (25%)	0.63
Wrist/hands	0 (0%)	10 (71.4%)	2 (8.3%)	0.00
Thoracic area	0 (0%)	2 (14.3%)	6 (25%)	0.21
Low back area	3 (30%)	3' (21.4%)	2 (8.3%)	0.63
Hip/s	1 (10%)	1 (7.1%)	6 (25%)	0.8
Knee/s	1 (10%)	5 (35.7%)	2 (8.3%)	0.15
Foot/ankle	3 (30%)	5 (35.7%)	6 (25%)	0.77

**Table 4. Type of musculoskeletal injuries among Greek national gymnastic team**

Type of injury	Total N=33 (100%)
Bone injuries	2 8.3%
Muscle injuries	8 33.3%
Tendon	5 20.8%
Articulation	3 4.2%
Ligament /strain	6 25%

The highest weekly prevalence rate of musculoskeletal disorders in Greek elite athletes was the shoulder area (45.7%) followed by the neck (29.2%) (Table 3). Statistically difference regarding disorders between men and women was found in the wrist region ( $p=0,001$ ).

The majority of the athletes (79.2%) had an injury during training hours while 16.7% had an injury during an official game. 37.5% of the total participants had an injury during floor exercises and 20.8% during exercises in different equipment (parallel bars, uneven bars, balance beam etc).

Injuries led to time-loss from sport for 31 Greek athletes. The number of work days missed ranged from 2 to 180. The majority of injuries were in muscles (33.3%), followed by the ligaments (25%) and tendons (20.8%) (Table 4). The majority of the gymnastic athletes (30.3%) did not receive any form of therapy while 29.2 receive physiotherapy for their injury/disorder.

### III. DISCUSSION

The aim of the present study was to investigate the prevalence of musculoskeletal injuries and/or disorders among elite gymnastics athletes competing for the Greek national team.

At the highest competitive level, the high volume, intensity, frequency and duration of training (6 days/week, 4-6 hours/day) leads athletes to exhaustion and injuries [12]. In the present study injuries to the ankle joint (60.2 %) were the most frequent followed by the shoulder (54.5%) and wrist (54.5%). The findings were in agreement with those reported from other countries [8,13,14,15] although direct comparisons are difficult because of methodological variations.

The lower extremity is a site of tremendous physical loading in gymnastics. This involves the repetitive jarring impact of vault take offs and landing from a variety of heights and during tumbling activities. The wrist is a frequently injured site. Unlike most other sports, in gymnastics, the upper extremities are used as weight-bearing limbs causing high impact loads to be distributed through the elbow and wrist [8,9]. Participation in gymnastics and other upper extremity weight-bearing sports frequently requires athletes to bear significant loads through their wrists. This requirement makes wrist pain and injury of significant concern to

competitive gymnasts [16]. In a study conducted in pre-national gymnastics athletes in Greece, the most common anatomical location of injury was the ankle (110 cases, 46%), followed by the knee (63 cases, 26.2%) [10].

There were differences between genders regarding the main areas of pain and discomfort, with the ankle (64.7%) being more prevalent in women compared with men ( $p =0.61$ ), while men complain mostly about pain in wrists (75%;  $p=0.001$ ). In this study, men suffered more injuries to the hand and wrist when compared with women. This may be, in part, representative of the different events male and female gymnasts participate in. Specifically, the high bar is associated with significant hand and wrist injuries in male gymnasts [7,15]. During gymnastic activities, the wrist is exposed to many different types of stresses, including repetitive motion, high impact loading, axial compression, torsional forces, and distraction in varying degrees of ulnar or radial deviation and hyperextension [17]. Almost all investigators studying women's gymnastics reported that most injuries were incurred in the ankle and foot [8,18]. The balance beam, which is an exclusive discipline for female gymnasts, may subject those athletes to higher rates of lower extremity injury [15,19].

Gymnasts constantly land from great heights while twisting and rotating, leading to the high rates of both initial and recurrent ankle injuries. Floor exercises was associated with the greatest number of injuries [20]. In the present study 37.5% of the total participants had an injury after landing on the ground. The most prevalent types of injury were muscle injuries and sprains (33.3%), which is in agreement with other studies [8,10,18].

It is not surprising that more injuries occur during competition. This finding may also be explained by the fact that gymnasts are better protected in training practice than in competition because of landing in foam pits, spotting, and softer mats [8].

The primary limitation of the present study was the low number of the participants. However, this is exclusively a sample of elite international gymnasts, which inherently keeps numbers low. Previously reported injury rates, in studies with bigger samples, demonstrate high variability due to variable level of the athletes. The current study is descriptive and it does not investigate the mechanism of those injuries.

### IV. CONCLUSIONS

Gymnastics are high-performance athletes with high prevalence of injuries and disorders. The present study found that the most frequently reported area for injuries was the foot/ankle (60.6%).

This, to our knowledge, is the first study exploring the prevalence rates among Greek gymnastic athletes competing in the national team. The current results indicate the need for

preventive programs especially focused on training, in order to limit the high prevalence of musculoskeletal disorders in Greek gymnastic athletes and prevent them from becoming chronic or more severe. Further research should investigate in depth the profile, the risk factors and the mechanisms of musculoskeletal disorders in elite gymnastics athletes, guiding the planning of focused prevention programmes.

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