

# ANALYSIS OF INCIDENCE OF INJURY IN SPANISH ELITE IN AEROBIC GYMNASTICS



ORIGINAL ARTICLE

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## ABSTRACT

**Introduction:** Aerobic Gymnastics (GA) is a gymnastic discipline that requires specific physical needs and proper training to prevent or minimize the occurrence of sports injuries. **Objective:** To analyze the incidence of injuries in the GA and its relationship with training factors. **Methods:** A study with 40 Valencian athletes aged between 9 and 17 years was performed. Data was collected through a questionnaire of morbidity. The dependent variable was the injuries during the 2009-2010 season and the main independent variables were the training load, the protective equipment, training surface, technical movements and type of injury and body part injured. **Results:** The most recurrent injuries were the ones related to ligaments, affecting both the upper and lower limbs. Half of the injuries occurred after performing jumps, despite the use of protective equipment and took place at the beginning of the season. Significant correlation was found between the number of injuries and the experience, training days and number of competitions ( $p < 0.05$ ). **Conclusions:** the number of injuries has decreased and the use of protective equipment has increased, with special attention to wristbands. Half of the injuries occurred during the learning period of technical difficulties.

**Keywords:** prevention, training, sports, athletic injuries.

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## INTRODUCTION

Aerobic gymnastics (AG) is a relatively modern discipline, with no more than three decades of history. Since its inclusion in the IFG and until these days, it is object of continuous regulatory reviews with the aim to reach better functional, harmony and coherence structure among its judges<sup>1</sup>.

It is a sport with great technical demand and requires specific characteristics from its practitioners: anaerobic endurance, relative strength, explosive power or strength and flexibility<sup>2,3</sup>. Moreover, due to the current high sports level and the alterations of the sport itself, constant higher difficulties are imposed to the gymnast, increasing hence the risk for injuries<sup>4</sup>.

The few studies found concerning to types of injuries in this sport are epidemiological and were carried out with Spanish<sup>5,6</sup> and Australian gymnasts<sup>7</sup>.

Detailed observation about the issues related to training and the sports characteristics, we can collect information about injuries incidence. Additionally, in sports sciences, the recording of injuries associated with their causality factors may be a valuable prophylactic method and influence on performance<sup>8</sup>. Thus, the aim of this investigation was to analyze the incidence of injuries in AG and their connection with training factors in Valencian athletes in the 2009-2010 season.

## METHOD

### Sample

This study was carried out with AG athletes from the Valencian Community. The total sample was of 40 athletes, mean age of 12 ( $\pm 2.52$ ), height of 1.46 ( $\pm 0.16$ ) and weight of 40.59 ( $\pm 12.33$ ).

The Valencian athletes were chosen due to their largest number of gymnasts in this community in all categories. Moreover, 12 of them belong to the Spanish team of AG and are successful in national and international levels.

Data collection occurred with consent from the Spanish Gymnastics federation, the clubs, coaches, parents and athletes, and were treated according to the Organic Law of Data Protection of Personal Character 15/1999 from December 13th. The investigation also respected the Declaration of Helsinki.

### Material

Data collected used the inquiry of referred morbidity based on preceding studies in other sports<sup>9,10</sup>, but adapted to AG, and therefore, the interview-questionnaire validated by Navarro has been considered<sup>5</sup>. However, the Galician Community was visited to detect any possible error.

### Variables

The independent variables and the object of analysis were about personal data, training characteristics and information concerned with sports injuries.

Personal data of the athletes such as sex, age, height, weight and category were collected. Concerning training, experience in the sport, hours of daily training, number of days and competitions and the level, besides the use of safety equipment and the training surface were collected. Concerning injuries, the type of injury, its anatomic site, training phase in which it occurred and the technical gesture which caused it were collected. The dependent variable were the injuries in the 2009-2010 season. Injury was understood as damage, accident or incident which occurs during competition or

training and which causes time away from competition or in two or more days of training, or which implies in decrease of training load in two or more consecutive sessions<sup>11</sup>.

## Procedure

First, all participants and individuals in charge (parents, coaches and federations) were informed about the aim of the investigation. Subsequently, in the end of the season, the inquiry in which the data were collected was given out. The entire process was conducted by the same person to avoid errors in the answers and hence speed the organization process, data processing and analysis, which was later done in the SPSS, version 18.

## RESULTS

### Anthropometric characteristics

Table 1 presents the descriptive measurements of the anthropometric variables per category. Student's *t* test only found statistically significant differences ( $p < 0.05$ ) of the injured athletes per category between the variable weight in the junior category and between having or not injury during the season.

**Table 1.** Descriptive measurements of the anthropometric characteristics.

		Minimum	Maximum	Mean	Standard deviation
Alevin	Age	9	11	9.80	0.696
	weight	20.90	49.50	32.0650	8.16348
	Height	1.12	1.54	1.3405	0.11808
		Minimum	Maximum	Mean	Standard deviation
Youth	Age	12	14	12.90	0.876
	weight	33	54.10	42.0300	6.05366
	Height	1.45	1.61	1.5400	0.05185
		Minimum	Maximum	Mean	Standard deviation
Junior	Age	15	17	15.50	0.707
	weight	47.40	67.70	56.1900	6.83463
	Height	1.54	1.69	1.6360	0.04326

### Training characteristics

In the sample total we can find the Pearson correlation in the number of injuries, experience in the training days and the number of competitions in which they participated. However, by category and in the sample of injured athletes, we only observe this correlation in the juniors in the variables days of training, number of injuries and competitions.

There is significant correlation between the experience in this sport and the days of training with injured athletes ( $p < 0.05$ ). Thus, the ones who injured the most are the ones who take 6.6 years ( $\pm 2.71$ ) and train 6.9 days per week ( $\pm 0.31$ ).

The only training surfaces which did not cause injuries in both groups were parquet, tatami and wooden stages. There is no conclusion about which surface is more harmful due to the variety of materials available for training flooring. Additionally, no significant differences have been found.

The participants who used any type of safety equipment and got injured are those who applied many types of safety gear (five injured, 12.5%) and wrist guards (five injured, 12.5%). Nevertheless, there are no significant differences ( $p > 0.05$ ) (table 2).

**Table 2.** Injuries per category and use of safety equipment.

Safety equipment	Alevin		Youth		Junior		Total	
	No	Yes	No	Yes	No	Yes	No	
Wrist guard	13 32.5	25%	0	3 7.5	1 2.5	5 12.5	14 40%	
Ankle guard	0	0	0	0	0	0	0	
Knee	0	0	1 2.5	0	1 2.5	0	2 5%	
Bandages	0	0	0	0	1 2.5	0	1 2.5	
Many	2 5%	3 7.5%	4 10%	2 5%	1 2.5%	5 12.5%	7 17.5%	
No	5 12.5%	0	0	0	1 2.5%	0	6 15%	
Total	20 50%	5 12.5	5 12.5	5 12.5	5 12.5	10 25%	30 75%	

### Injuries in the 2009-2010 season

There were 10 injuries in the 2009-2010 season (table 3). Significant differences have been found between categories and injured athletes ( $p > 0.05$ ).

When the relationship between the injured athletes in that season and in the previous ones is analyzed, it is observed that only 17.5% (seven injured) were recurrent. When the Chi-square test is applied between these two variables, significant differences could be found ( $p < 0.05$ ).

The injuries presented in the athletes were of three types, as presented in table 4; however, there is no significance among them (Chi-square  $p > 0.05$ ). The injuries occurred in different body parts observing and differences between the two analyzed groups were observed, without significant differences, though (table 5).

All injuries were produced during the training of the specific technique, specifically, the jumps (figure 1) static strength.

The most harmful technical gesture was the performance of jumps of many types (pike with fall to arm flexion, grouped jumps with twist, and others).

Comparing the injured with the number of competitions in which they participated, it is proved that the subjects who got injured more often were the ones who compete four to five times a year (four out of one injured, 40%), and the ones who got the least injured are those who participate in six competitions a year (two injured, 20%). There are significant differences between the injured and not injured athletes with the number of competitions in which they participate ( $p < 0.05$ ).

**Table 3.** Injuries in the 2009/2010 season.

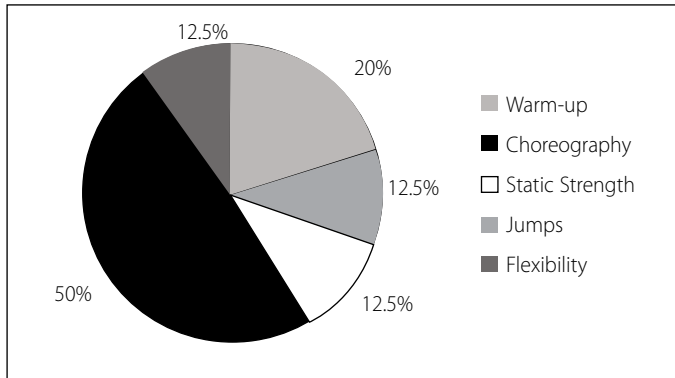
Have you got injured this season?		Alevin	Youth	Junior	Total
	Yes		0	5 12,5%	5 12,5%
No		20 50%	5 12,5%	5 12,5%	30 75%
Total		20 50%	10 25%	10 25%	40 100%

**Table 4.** Injury typology per category.

	Injury typology				
	Ligamentous	Tendon	Muscular	Articular	Total
Alevin	0	0	0	0	0
Youth	2 20%	2 20%	1 10%	0	5 50%
Junior	2 20%	1 10%	2 20%	0	5 50%
Total	4 40%	3 30%	3 30%	0	10 100%

**Table 5. Injury typology per category.**

Category	Injury typology			
	Upper limb	Lower limb	Trunk	Total
Alevin	0	0	0	0
Youth	3 30%	2 20%	0	5 50%
Junior	2 20%	3 30%	0	5 50%
<b>Total</b>	5 50%	5 50%	0	10 100%



**Figure 1.** Work phase and injuries of AG.

## DISCUSSION

### Sample characteristics

In the assessed studies<sup>5-7</sup> there is similarity between percentage of participation of the female sex, but we cannot compare it with the male sex due to its small participation. In this sample, the same fact has occurred, since it only had four male subjects.

Such results do not agree with other investigations<sup>5,6,12</sup> in which the highest number of injured athletes is in the maximum category, since this sample has a gap with senior athletes. Studies related to artistic gymnastics also present lower indices concerning the lower categories<sup>8,13</sup>.

### Training characteristics

In order to know the factors which may influence on the time away, we decided to study all the conditions which surround this time away due to an injury. It is considered that any kind of physical activity leads to a real intrinsic injury risk level; it is easy to think that this correlation is directly proportional to the time of practice. The Pearson correlation was used for this analysis. In this investigation, the training characteristics (experience, hours and days) presented similar results to the ones found by Navarro<sup>5</sup> in AG.

In general, we can state that the higher the level of the athlete, the higher the training load (days and hours); increasing hence the number of opportunities to injury. Previous investigations have also presented such situation<sup>5,12</sup>. Concerning the training surface, there is no predominance of any of them which relates to the onset of injuries. However, in the Australian study<sup>7</sup> the most injury-prone surface was the wooden floor, the same manner as in Spanish studies<sup>6,14</sup>.

Many authors<sup>14-16</sup> concluded that hard and not very flexible flooring in the reception of the difficulty elements does harm the recruited articulations due to the kind of material. Therefore, the use of reliable flooring should be strongly encouraged, and it should be a surface which absorbs energy of the impact and restore it.

The protection material applied in the AG may be used to avoid

fear, perform optimum progression in the performance of exercises and even in the prevention of injuries. The use of mats, wrist guards, knee pads, ankle guards, bandages and others (girdles, elbow pads, and so on) was also analyzed.

The use of safety equipment has changed in comparison with previous published work<sup>5,17</sup>, since it increased its application in up 85%.

Concerning the kind of material, the data found corroborate the results by Navarro<sup>5</sup>, being wrist guards the mostly used material by gymnasts, meaning 47.50%, followed by 30% which use many safety options (mats, knee pads and wrist guards) at the same time. Such fact supposes decrease in injuries suffered by the athletes in relation to the study by Navarro<sup>5</sup>.

Although the material used by the athletes is not a 100% efficient prophylactic measure, its use decreases the onset of injuries. Nevertheless, the type, characteristics and conditions of the safety equipment should be considered<sup>18</sup>, since when they are misused<sup>19</sup> injuries appear anyway. Thus, Navarro<sup>5</sup> found that the gymnasts who injured the most were those who used many types of safety equipment.

### Injuries in aerobic gymnastics

The commonest type of injury in previous studies<sup>5-7,12,14</sup> were muscular, followed by articular and in smaller proportion, bone injuries. Such information agrees with the investigation in rhythmic gymnastics<sup>19-21</sup>. Nonetheless, in this sample, the most recurrent injuries were ligamentous. Equal situation was found in rhythmic gymnastics, in which sprains and strains are the most recurrent injuries<sup>22</sup>.

The existing injuries may be classified according to the different body parts, being the lower limb the most injured in the studies carried out with the CP<sup>5,7</sup>. With the following code, the injuries on the lower extremity are more persistent, but there is important decrease on the upper extremity by the restrictions of push-up landings. However, with the current CP we count the same number of injuries on the extremities.

Concerning the most injured body part, it has changed over the years from the wrist<sup>5,12</sup> to the ankle<sup>6,7</sup>. Despite of that, there is no predominance of any structure in the Valencian athletes.

In other modalities such as dance<sup>15,23-25</sup> or rhythmic gymnastics, the majority of injuries are on the lower extremities<sup>8</sup>, differently from in the artistic gymnastics, in which injuries on upper extremities due to overload of their structures in the performance of some exercises, since this is the body part which is not adapted to bear heavy loads such as body weight<sup>26</sup>.

In all studies the highest percentage of injuries is in the specific technical part with different quantities in each of their work goal<sup>5-7</sup>. Such data highlight the importance of the technique in this sport.

During the specific technical phase, through repetitive techniques, the mandatory elements and the difficulty in the competition routine are learned, developed and mechanized. Thus, the automatization of these gestures or elements is the cause of the high percentages of injury in this phase of the work. Injuries on the specific part may be due to the manner through which the training method used in AG is based on repetitions, rare variability of exercises and non-individualized programs<sup>4</sup>. The same fact occurs to contemporary ballet<sup>15</sup> or dance due to the performance of repetitions of incorrect biomechanical patterns<sup>27</sup>.

In AG, the jumps elements are the ones with the highest injury

incidence<sup>5,6</sup> as in dance<sup>15</sup> and artistic skating<sup>28</sup>. This fact indicates in these sports technical gestures of great relevance in the routines and with high index of injury. In AG, its relevance was confirmed by the studies in which the group of jumps is the one with the most number of group of elements and with the highest possibility of difficulty in all editions of the different codes of punctuation; hence, the frequency of its use by the gymnasts<sup>1,6,29</sup>.

In the population of this analysis, all injuries occurred during training and the month most recurrent was September, adding up to 50%. The difference was in Fetterplace<sup>7</sup> where two gymnasts got injured during competition. It is important to mention that the month of September to these gymnasts is a crucial period of technical learning of new difficulties, in which the repetitive loads during assimilation of the specific technique of the gesture to be acquired by the gymnast may lead to higher risk of injury. In this flow of thinking, there is agreement with the results by Navarro<sup>5</sup>, in which the persistence of successive repetitions of specific technical gestures is an evident factor of risk and injury; therefore, the need to control their volume and intensity. More frequent injuries during training occur due to technical demands of this sport which requires anaerobic endurance, relative strength, explosive power or strength and flexibility from its practitioners<sup>2,3</sup>. Additionally, due to the current sports high level, the great evolution of the sport itself, demanding from the gymnasts constant inclusion of higher-level difficulties<sup>4</sup>, they dedicate many hours to training, hence, the possibilities of injury increase.

The limitations of this investigation include obtaining a more

numerous male sample, since it was so small here that comparisons between sexes became impossible.

The following step of this investigation is to evidence the data for coaches and athletes. Moreover, it would be highly useful to develop a prevention program for injuries which should integrate athletes in their training. Thus, when incidence or severity of injuries is decreased, the gymnasts will be able to improve performance and sports success.

The results obtained were able to produce decrease in injuries in aerobic gymnastics. Such fact may occur as consequence to the increase in the prevention measures use and/or alterations in CP. There is no predominance of one body part injured, but the most recurrent type of injury was ligamentous. The work phase in which the highest percentage of injuries is produced was the specific technique, namely in performance of jumps. All injuries have occurred during training and the highest number of injuries is found in the beginning of the seasons.

## CONCLUSION

It can be concluded that although the use of safety material is not definite to decrease the injury index in this sport, there are some other influential factors such as: lack of physical fitness, inadequate technique and fatigue in the athlete, to name some. The use of suitable safety equipment as well as specific recommendations could decrease the incidence of injuries.

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All authors have declared there is not any potential conflict of interests concerning this article.

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