# Spectrum of lesions observed by computed tomography and magnetic resonance imaging scans in young athletes that participated in the 2018 Youth Olympic Games in Buenos Aires

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**ABSTRACT**
**Objectives:** To describe the sports-related injuries observed in young athletes that participated in the 2018 Youth Olympic Games in Buenos Aires. **Materials and Methods:** This was a descriptive study including 39 [XX 38 XX] athletes that participated in the 2018 Youth Olympic Games in Buenos Aires and who were evaluated using imaging techniques. Athlete's distribution was analyzed by sex, age, sports activity and pathologic findings. **Results:** There were 4012 athletes that participated in the 2018 Youth Olympic Games in Buenos Aires, and, surprisingly, the number of male and female athletes was exactly the same. Injuries in female athletes were the most common (61.53 %), most of them occurring in athletes of South American origin (33.33%). Athletics was the sport practiced by most patients (7 studies). Soft tissue injuries were most common in female athletes and mostly involved the lower limb (79.41%). **Conclusions:** The number of imaging studies carried out was higher in young female athletes, and the most common injuries were soft tissue injuries of the lower limb.
**Keywords:** Sports-related injuries; computed tomography scan; magnetic resonance imaging.
**Level of Evidence:** IV

**Espectro de lesiones en imágenes de tomografía computarizada y resonancia magnética, en deportistas que participaron en los Juegos Olímpicos de la Juventud Buenos Aires 2018. Nuestra experiencia**

**RESUMEN**
**Objetivo:** Describir las lesiones evaluadas por imágenes de los atletas que participaron en los Juegos Olímpicos de la Juventud Buenos Aires 2018. **Materiales y Métodos:** Se llevó a cabo un estudio descriptivo con una serie de 38 deportistas que participaron en los Juegos Olímpicos de la Juventud Buenos Aires 2018 y se sometieron a estudios por imágenes. Se analizaron los siguientes datos: distribución por sexo, edad, país, disciplina deportiva y hallazgos patológicos. **Resultados:** Se atendió a más deportistas mujeres (63,15%), la mayoría (31,57%) era de América del Sur. El atletismo fue la disciplina que más pacientes aportó (7 estudios). Predominaron las lesiones de los tejidos blandos de los miembros inferiores (51,51%). **Conclusiones:** Las atletas fueron quienes más se realizaron estudios por imágenes, y las lesiones más frecuentes fueron las de los tejidos blandos de los miembros inferiores.
**Palabras clave:** Lesiones deportivas; tomografía computarizada; resonancia magnética.
**Nivel de Evidencia:** IV

## INTRODUCTION

Sports practice is not without risk of injuries, even for professionals who are highly trained or have a vast experience in a specific activity.

Received on January 16th, 2019. Accepted after evaluation on June 16th, 2019 • PABLO M. SARTORI, MD • pablomsar@yahoo.com.ar
**How to cite this paper:** Sartori PM, Viña A, Arcos A, Roberts F, Barasatián P, Yampolski B. Spectrum of lesions observed by computed tomography and magnetic resonance imaging scans in young athletes that participated in the 2018 Youth Olympic Games in Buenos Aires. *Rev Asoc Argent Ortop Traumatol* 2019;84(4):372-385. http://dx.doi.org/10.15417/issn.1852-7434.2019.84.4.955

The great amount of kinetic and muscular energy involves a risk of suffering musculoligamentous injuries or other soft tissue injuries, whether while training or competing.[1]

The repetitive movements innate to programmed exercise training or the unexpected contact during the competition may trigger skeletal-muscle or soft tissue injuries in professional and trained athletes as well as in amateur athletes.

In October 2018, the city of Buenos Aires hosted the third edition of the Youth Olympic Games (YOG) with the participation of 4012 athletes from 206 countries (Figure 1).[2,3]

The Administration of the Ciudad Autónoma de Buenos Aires chose our Center (Diagnóstico Mediter, Sanatorio Dr. Julio Méndez) to perform the imaging studies (CTs and MRIs) to any injured athlete who may require assessment through these tests,[4] which provided the unique opportunity to participate in the quick diagnosis of the injuries sustained by these patients.


**Figure 1.** Poster of the Buenos Aires 2018 Youth Olympic Games.

## MATERIALS AND METHODS

We conducted a cross-sectional descriptive study in the athletes who participated in Buenos Aires 2018 YOG, from the 6th to the 18th of October,[2] and who sustained injuries while training or competing, and required a CT or an MRI scan.

The study period covered the period of the YOG plus two following days (from October 6th to 20th, 2018).

The study included 38 athletes between 15 and 18 years who sustained sports-related injuries and required imaging studies for diagnosis.

The operative data—nationality, age, sex, type of study, body region and type of injury—were collected from the case history, the medical order, and the imaging report.

The Olympians' injuries were characterized according to sex (male/female), age (15-18 years), affected anatomical structure (upper/lower limb), side of occurrence (left/right), sports activity, type of injured tissue (bone, muscle, soft tissue, mixed).

The imaging reports were produced by highly experienced imaging specialists trained in musculoskeletal system and neuroradiology report drafting.

We present our results as absolute numbers and percentage values.

The exams were conducted using a Philips 16-slice EVO2 CT scanner and a Philips Ingenia 1.5T MRI scanner.

## RESULTS

The study population was comprised of 38 athletes (14 males [36.84%] and 24 females[63.15%]) from 29 different countries (Table 1). Figure 2 shows the patients' place of origin, grouped by continent. The patients' ages ranged from 15-18 years (mean 16.81).

**Table 1.** Countries and number of observed athletes

| Countries | Observed athletes | Percentage values |
|---|---|---|
| Antigua and Barbuda | 1 | 2.63% |
| Argentina | 4 | 10.52% |
| Bolivia | 1 | 2.63% |
| Brazil | 1 | 2.63% |
| Chile | 1 | 2.63% |
| Colombia | 3 | 7.89% |
| Congo | 2 | 5.13% |
| Czech Republic | 1 | 2.63% |
| Dominican Republic | 1 | 2.63% |
| Estonia | 1 | 2.63% |
| France | 1 | 2.63% |
| Gambia | 1 | 2.63% |
| Great Britain | 1 | 2.63% |
| Guatemala | 1 | 2.63% |
| Hungary | 1 | 2.63% |
| Republic of Ireland | 1 | 2.63% |
| Kazakhstan | 2 | 5.26% |
| Latvia | 2 | 5.26% |
| Morocco | 1 | 2.63% |
| North Macedonia | 1 | 2.63% |
| Oman | 1 | 2.63% |
| Peru | 1 | 2.63% |
| Russian Federation (Russia) | 1 | 2.63% |
| South Africa | 2 | 5.26% |
| Spain | 1 | 2.63% |
| Thailand | 1 | 2.63% |
| Trinidad and Tobago | 1 | 2.63% |
| Turkmenistan | 1 | 2.63% |
| Venezuela | 1 | 2.63% |
| **Total** | **38** | **100%** |

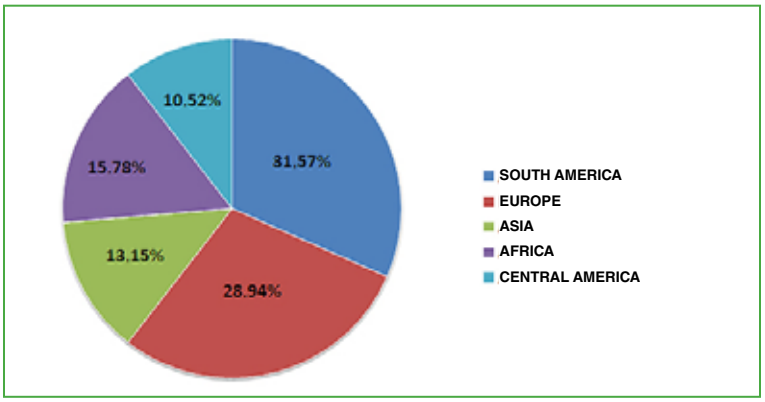


**Figure 2.** Athletes' place of origin, grouped by continent.

There were a total of 44 imaging orders (regions): 6 (13.63%) CT and 38 (83.36%) MRI scans. Only five athletes (13.15%) required double studies (two different or similar regions, studied through CT or MRI) (Table 2, Figure 3).

**Table 2.** Scanned regions

| Region | CT | MRI | Right | Left | Percentage values |
|---|---|---|---|---|---|
| **Central Nervous System** | | | | | |
| Brain | | 2 | | | 4.5% |
| Cerebral MR angiography | | 1 | | | 2.2% |
| **Spine** | | | | | |
| Low lumbar spine | | 2 | | | 4.5% |
| **Upper Limb** | | | | | |
| Sternoclavicular joint* | | 1 | 1 | 1 | 2.2% |
| Shoulder | | 1 | 1 | | 2.2% |
| Elbow | | 1 | 1 | | 2.2% |
| Wrist | 2 | 2 | 1 | 3 | 9.09% |
| Hand | | 1 | | 1 | 2.2% |
| **Lower Limb** | | | | | |
| Hip** | 1 | 1 | 2 | 2 | 4.5% |
| Thigh | | 1 | 1 | | 2.2% |
| Knee | | 14 | 7 | 7 | 31.8% |
| Lower leg | 2 | 1 | 2 | 1 | 6.6% |
| Ankle | 1 | 9 | 5 | 5 | 22.7% |
| Foot | | 1 | | 1 | 2.2% |
| **Totals** | **6** | **38** | **21** | **21** | **100%** |

CT = Computed Tomography; MRI = Magnetic Resonance Imaging. *Both sternoclavicular joints. **Both hips.

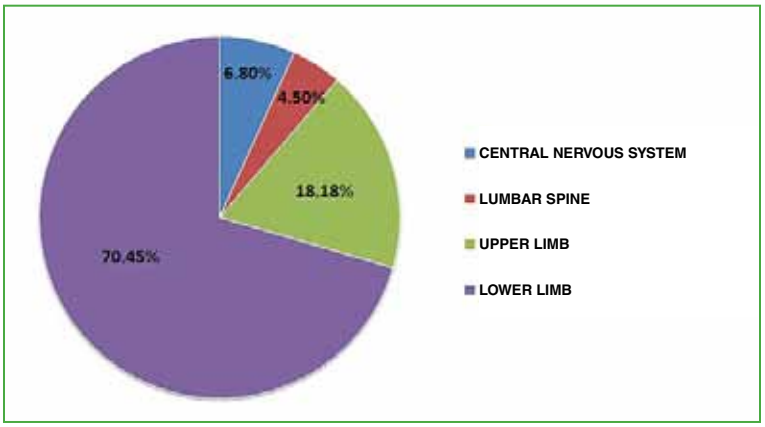


**Figure 3.** Scanned regions.

Our Center evaluated athletes from 17 out of the 32 sports activities featured in the YOG (Table 3).

The analysis in terms of the side of occurrence (right/left) of the 42 limb studies (leaving out the central nervous system and the spine cases, and taking into account that hips and sternoclavicular joint studies involve both sides) shows: 21 (50.00%) right (lower and upper) limb studies and 21 (50.00%) left limb studies.

**Table 3.** Observed athletes according to sports activity

| Sports activity | Observed athletes | Percentage values |
|---|---|---|
| Artistic gymnastics | 6 | 15.78% |
| Athletics | 7 | 18.42% |
| Basketball 3x3 | 1 | 2.63% |
| Beach handball | 1 | 2.63% |
| Beach volleyball | 2 | 5.26% |
| Boxing | 2 | 5.26% |
| Cycling | 3 | 7.89% |
| Futsal | 4 | 10.52% |
| Hockey 5s | 1 | 2.63% |
| Judo | 1 | 2.56% |
| Pentathlon | 1 | 2.63% |
| Roller speed skating | 1 | 2.63% |
| Rugby 7s | 2 | 5.26% |
| Swimming | 1 | 2.63% |
| Taekwondo | 1 | 2.63% |
| Tennis | 2 | 5.26% |
| Wrestling | 2 | 5.26% |
| **Total** | **38** | **100%** |

Figure 4 shows the distribution according to left/right and upper/lower limb studies.

Out of the total number of studies (44 regions), 11 (25.00%) were reported as normal: 2 (18.18%) CT scans and 9 (81.81%) MRI scans (Table 4).

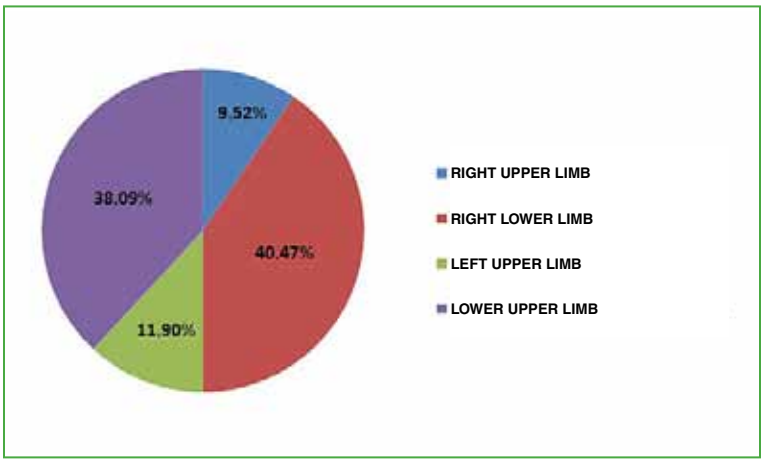


**Figure 4.** Differences according to left/right and upper/lower limbs.

**Table 4.** Reported normal findings

| Region | CT | MRI | Right | Left |
|---|---|---|---|---|
| CNS | | | | |
| Brain | | 2 | | |
| Intracranial MR angiography | | 1 | | |
| Spine | | | | |
| Lumbar spine | | 1 | | |
| Upper limb | | | | |
| Shoulder | | 1 | 1 | |
| Elbow | | 1 | 1 | |
| Lower limb | | | | |
| Hip* | 1 | 1 | | |
| Thigh | | 1 | 1 | |
| Knee | | 1 | 1 | |
| Ankle | 1 | | 1 | |
| **Totals** | **2** | **9** | **5** | **0** |

CT = Computed Tomography; MRI = Magnetic Resonance Imaging. * Both hips.

All normal upper and lower limb studies were of right limbs. The remaining 33 (75.00%) studies were reported as pathological: 4 (12.12%) CT scans and 29 (87.87%) MRI scans.

Thirteen (39.39%) out of the 33 studies with pathologic findings were of male athletes and 20 (60.60%) were of female athletes.

The classification of the pathologic injuries according to the anatomical region shows 6 (18.18%) in the upper limb and 27 (81.81%) in the lower limb; upper limb: 1 (3.03%) in the costoclavicular joint, 4 (13.13%) in the wrist, and 1 (3.03%) in the hand; lower limb: 13 (48.14%) in the knee, 3 (11.11%) in the lower leg, 9 (33.33%) in the ankle, and 1 (3.70%) in the foot. Table 5 shows the correlation of the different types of injury with the affected limb.

Finally, in the lumbar spine assessment, 1 (3.03%) study was reported as pathological.

The injuries were classified as: bones, muscle, soft tissue (tendons, meniscus, ligaments, and cartilages), and mixed (affecting al least two of the other types). Findings are shown in Table 5.

Bone injuries: 3 (9.09%) upper limb, and 9 (27.27%) lower limb.

The only (3.03%) muscle injury found affected the lower limb.

Soft tissue injuries: 2 (6.06%) upper limb, 13 (39.39%) lower limb, and 1 (3.03%) lumbar spine. Mixed injuries: 1 (3.03%) upper limb, and 3 (9.09%) lower limb.

Table 6 and Figures 6-12 show the reported conditions.

**Table 5.** Classification of the pathologic findings according to the affected structure

| | Bone injury | Muscle injury | Soft tissue injury | Mixed lesions | Totals |
|---|---|---|---|---|---|
| Upper limb | 3 | -- | 2 | 1 | **6** |
| Lower limb | 9 | 1 | 13 | 3 | **26** |
| Spine | -- | -- | 1 | -- | **1** |
| **Totals** | **12** | **1** | **16** | **4** | **33** |

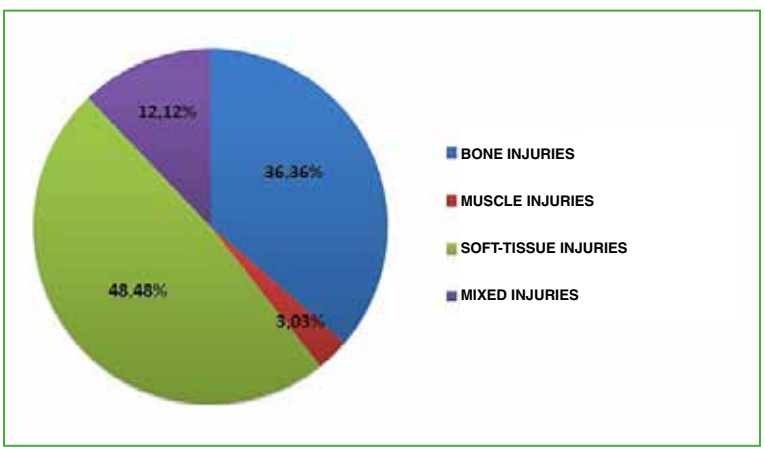


**Figure 5.** Injuries classification.

## DISCUSSION

This is the first study on sports-related injuries sustained during the Buenos Aires 2018 YOG and allowed the collection of imaging study results from sports-related injuries sustained while training or competing.

The result analysis shows that there were 38 patients: 14 male and 24 female (1.7:1 proportion in favor of females).

There was a total of 44 imaging orders (regions): 6 CT and 38 MRI (6.3:1 proportion in favor of MRI); which was not an unexpected proportion since the MRI has better spatial resolution and tissue differentiation to identify soft tissue injuries.

**Table 6.** Reported injuries

| Injury | Upper limb | Lower limb | Spine | Totals |
|---|---|---|---|---|
| Osteoid osteoma | | 2 | | 2 |
| Ossifying fibroma | | 1 | | 1 |
| Sternoclavicular joint swelling | 1 | | | 1 |
| Wrist fractures | 3 | | | 3 |
| Finger extensors injury | 1 | | | 1 |
| Triangular fibrocartilage complex injury | 1 | | | 2 |
| L5/S1 prolapse | | | 1 | 1 |
| Muscle tear | | 3 | | 3 |
| Knee bone marrow edema | | 1 | | 1 |
| ACL isolated injury | | 4 | | 4 |
| ACL injury associated with meniscal injury | | 6 | | 6 |
| Ankle fracture | | 1 | | 1 |
| Ankle bone marrow edema | | 4 | | 4 |
| Ankle ligament tear | | 3 | | 3 |
| Foot bones fracture | | 1 | | 1 |
| **Totals** | **6** | **27** | **1** | **34** |

The patients participated in 17 different sports activity, with most of them practicing: athletics (7 athletes; 41.17%), artistic gymnastics (6; 35.29%) and futsal (4; 23.52%).

Cohort studies on several reports found that the sports-related injury rate ranges from 0.8 to 90.0 for every 1000 hours of training and from 3.1 to 54.8 for every 1000 hours of competition.[1,5]

The Centers for Disease Control and Prevention report that half of the 7 million injuries suffered by youth aged 5 to 24 years on a yearly basis are related to recreational and elite sports activities.[1]

We define sports-related injury as the tissue damage that affects a structure functioning sustained while practicing a sport.[5]

In terms of sex distribution, females presented more minor injuries, such as sprains, while males presented more severe injuries, such as tears and fractures.[5] Some authors report that female professional athletes are more susceptible than male professional athletes to suffer knee injuries at the same level of high-performance competition.[5]

In our studied group of athletes, the female:male injury proportion is 1.5; with a pathologic finding distribution of 20 (60.60%) in females and 13 (39.39%) in males.

Osorio *et al*. report that sports activities with the highest injury incidence rate are judo, football, basketball, hockey and volleyball, as they are contact activities, involving with sudden pivoting movements, accelerations and decelerations, as well as sliding tackles and pulling and holding opponents.[1,5]

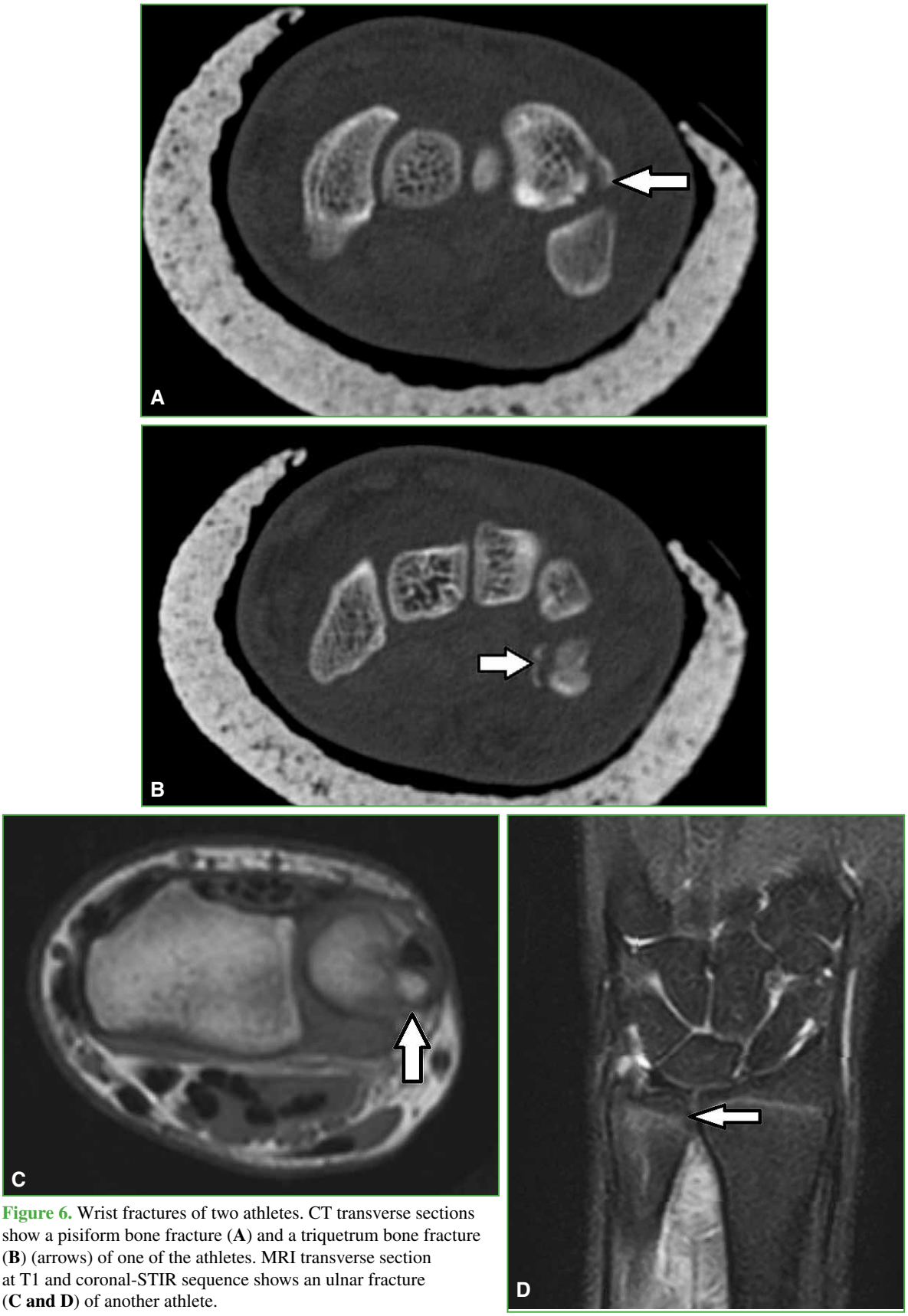


**Figure 6.** Wrist fractures of two athletes. CT transverse sections show a pisiform bone fracture (**A**) and a triquetrum bone fracture (**B**) (arrows) of one of the athletes. MRI transverse section at T1 and coronal-STIR sequence shows an ulnar fracture (**C and D**) of another athlete.

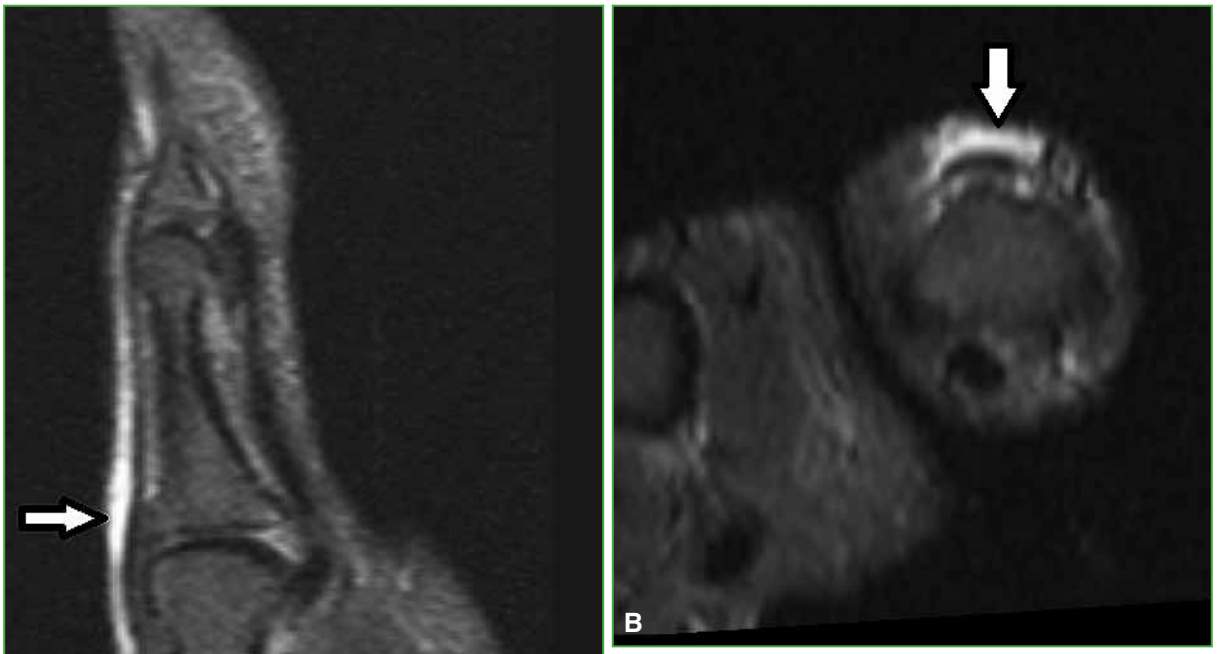


**Figure 7.** Finger extensors injury. MRI sagittal (**A**) and axial (**B**) STIR sequences. Arrows show the signal change adjacent to common extensor of the fingers.

**Figure 8.** MRI sagittal section T2-weighted image. The arrow shows the L5-S1 prolapse.

**Figure 9.** Knee MRI. Images of the anterior cruciate ligament injury in different athletes.

**Figure 10.** Osteoid osteoma. The sagittal CT sections of the lower leg show hypodense subcortical lesions (arrows) involving the tibia periosteum. Two athletes had these lesions in the tibia.


**Figure 11.** Knee MRI, axial (**A**) and sagittal (**B**) STIR sequences. Focal injury in the distal insertion of the semimembranosus muscle, resulting from effort during competition (arrows).

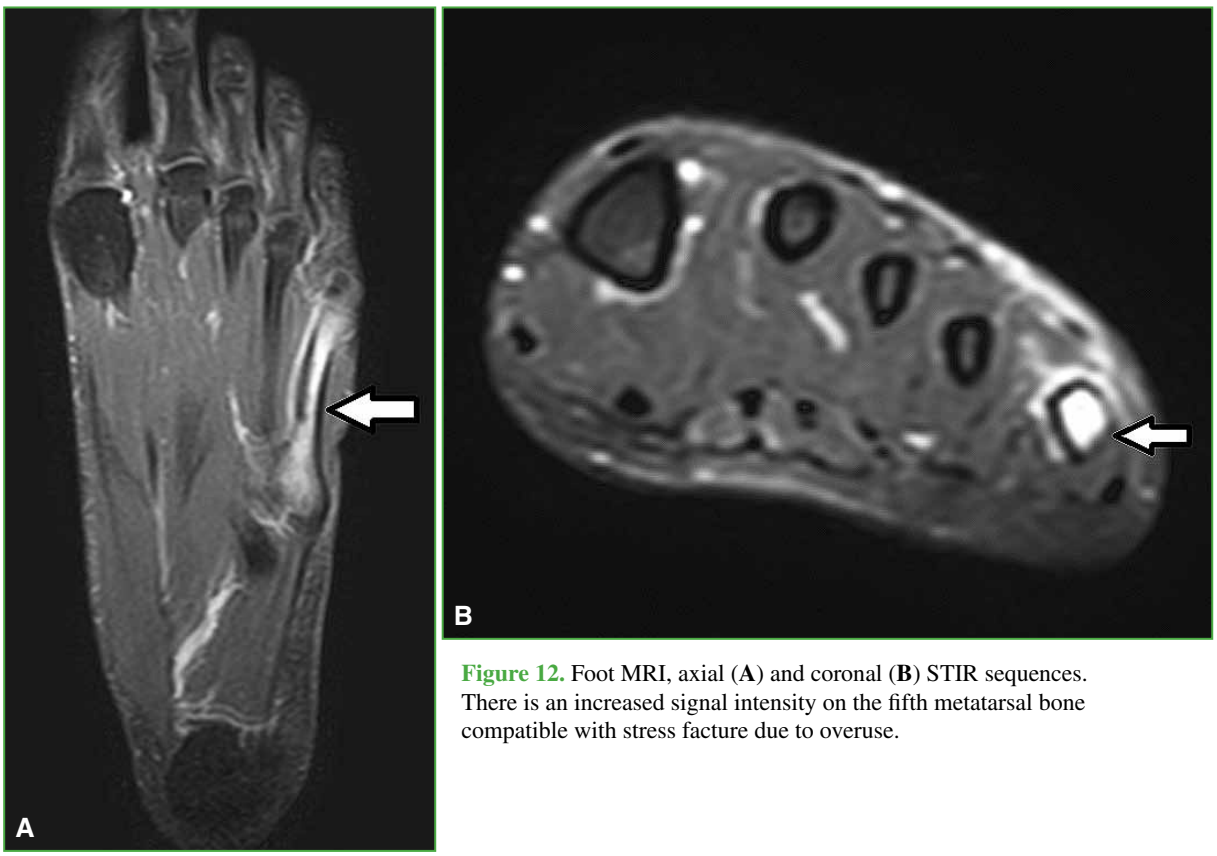


**Figure 12.** Foot MRI, axial (**A**) and coronal (**B**) STIR sequences. There is an increased signal intensity on the fifth metatarsal bone compatible with stress facture due to overuse.

Typically, the injury site is in close relation to the sports activity.[5]

Most sports-related injuries affect the lower limbs.[5] García Garcés reports that the most common injuries sustained by judokas are upper limb tendon injuries and lower limb ligament injuries.[1,5,6]

Some studies report that 80% of injuries involve soft tissues (tendons, muscles, ligaments) and the remaining 20% involve fractures and internal organs.[5]

In relation to the type of injury, Osorio *et al*. published that the most common injuries treated in the 1968 and 1974 Olympic Games were sprains, tears, and bruises.

In our case series, the most common injuries were of soft tissue (16 cases, 48.48%) followed by bone injuries (12 cases, 33.33%) and there was a clear majority of injuries sustained in the lower limbs (26 cases) over the ones in the upper limbs (6 cases), with a 4.3:1 proportion.

The most common reported injuries were anterior cruciate ligament tear, whether isolated or associated with a meniscal tear (9 cases, 27.27%), followed by ankle bone marrow edema with or without ligament tear (8 cases, 24.24%) and wrist fracture with or without associated ligament injuries (5 cases, 15.15%).

Our results are similar to that of international case series.

Limitations of the study include the limited number of injured athletes and our inability to document the mechanism of injury of each case.

## CONCLUSION

We share our experience of working with young elite athletes and with the most common injuries that occurred during the Buenos Aires 2018 YOG.

We hope our results be useful for further studies and a source of data for future analysis.

**Acknowledgments**

We expressed our acknowledgment to Melina Gualtieri for her collaboration with graphic designing, and to Jonathan Curcio, Matías Morillo and Eliana Rodríguez for their collaboration with the administrative data collection.

Conflict of interest: Authors claim they do not have any conflict of interest.

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## REFERENCES

1. Villaquirán A, Portilla Dorado E, Vernaza Pinzón P. Caracterización de la lesión deportiva en atletas caucanos con proyección a Juegos Deportivos Nacionales. *Rev Univ Salud* 2016;18(3):541-9. http://dx.doi.org/10.22267/rus.161803.59
2. Todo lo que tenés que saber de los Juegos Olímpicos de la Juventud Buenos Aires 2018. Disponible en: https://www.infobae.com/deportes-2/2018/08/26/todo-lo-que-tenes-que-saber-de-los-juegos-olimpicos-de-la-juventud-buenos-aires-2018/. Consulta: 2 de enero de 2019
3. Buenos Aires 2018. Disponible en: https://www.buenosaires2018.com/sports?lng=es. Consulta: 30 de octubre de 2018
4. Atletas en el Sanatorio Julio Méndez. Disponible en: https://www.lapoliticaonline.com/nota/115942-atletas-en-el-sanatorio-mendez/. Consulta: 9 de enero de 2019
5. Osorio Ciro J, Clavijo Rodríguez M, Arango E, Patiño Giraldo S, Gallego Ching I. Lesiones deportivas. *IATREIA* 2007; 20(2):167-77. https://www.redalyc.org/articulo.oa?id=1805/180513859006
6. García Garcés E. Lesiones en el judo de alta competición, actuación del deportista ante las mismas y valoración de los tratamientos de fisioterapia. *Fisioterapia* 2008;30(2):79-86. http://dx.doi.org/10.1016/S0211-5638(08)72961-4