

1-1-2022

## **Circus-specific extension of the International Olympic Committee consensus statement: Methods for recording and reporting of epidemiological data on injury and illness in sport 2020**

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[10.1136/bmjsem-2022-001394](https://doi.org/10.1136/bmjsem-2022-001394)

Greenspan, S., Munro, D., Nicholas, J., Stubbe, J., Stuckey, M. I., & Van Rijn, R. M. (2022). Circus-specific extension of the International Olympic Committee 2020 consensus statement: Methods for recording and reporting of epidemiological data on injury and illness in sport. *BMJ Open Sport & Exercise Medicine*, 8(3), Article e001394.

<https://doi.org/10.1136/bmjsem-2022-001394>

This Journal Article is posted at Research Online.






<https://ro.ecu.edu.au/ecuworks2022-2026/1434>

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# Circus-specific extension of the International Olympic Committee 2020 consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport

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**To cite:** Greenspan S, Munro D, Nicholas J, *et al*. Circus-specific extension of the International Olympic Committee 2020 consensus statement: methods for recording and reporting of epidemiological data on injury and illness in sport. *BMJ Open Sport & Exercise Medicine* 2022;**8**:e001394. doi:10.1136/bmjsem-2022-001394

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/bmjsem-2022-001394>).

Accepted 7 August 2022



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## ABSTRACT

In-depth knowledge of injury and illness epidemiology in circus arts is lacking. Comparing results across studies is difficult due to inconsistent methods and definitions. In 2020, the International Olympic Committee (IOC) consensus group proposed a standard method for recording and reporting epidemiological data on injuries and illnesses in sports and stated that sport-specific extension statements are needed to capture the context of each sport. This is the circus-specific extension to be used with the IOC consensus statement. International circus arts researchers in injury and illness epidemiology and performing arts medicine formed a consensus working group. Consensus statement development included a review of literature, creation of an initial draft by the working group, feedback from external reviewers, integration of feedback into the second draft and a consensus on the final document. This consensus statement contains circus-specific information on (1) injury definitions and characteristics; (2) measures of severity and exposure, with recommendations for calculating the incidence and prevalence; (3) a *healthcare practitioner report form*; (4) a *self-report form capturing health complaints with training and performance exposure*; and (5) a *demographic, health history and circus experience intake questionnaire*. This guideline facilitates comparing results across studies and enables combining data sets on injuries in circus arts. This guideline informs circus-specific injury prevention, rehabilitation, and risk management to improve the performance and health of circus artists.

## INTRODUCTION

Circus arts is practised globally in various contexts, including professional companies, freelance performance, preparatory schools, recreational training centres, social circus and physical education.<sup>1 2</sup> Circus arts has similar skill and physical demands as sports such as gymnastics as it often requires high

## Key messages

### What is known

- ⇒ The International Olympic Committee (IOC) published a consensus statement for recording and reporting of epidemiological data on injury and illness in sports and recommended the development of extension statements to provide sport-specific guidance.
- ⇒ Circus arts is an athletic performing art with increasing scientific study of injury related to participation, yet there are no guidelines to inform data collection and reporting of this complex activity.

### What are the new findings

- ⇒ The Surveillance of Injuries in Research on Circus consensus group developed an extension statement to be used in partnership with the IOC statement to guide the recording and reporting of injury data in circus arts.
- ⇒ A comprehensive discipline classification system is presented to categorise disciplines with similar risk factors for injury.
- ⇒ The extension statement includes guidance for researchers and healthcare practitioners to design studies and maintain consistent records of care provided to artists so that data can be better used to inform future research and healthcare practices (such as treatment and prevention).

levels of strength, balance, flexibility, agility and motor coordination.<sup>3–6</sup> However, circus is unique in that one of its central competencies is creativity, which involves challenging the physicality of performance from an artistic perspective to imagine, create and perform new tricks to construct an engaging, and often novel, aesthetic outcome. Creative circus practice also introduces a unique element of risk not often present in other sports and



performing arts. Circus arts encompasses several disciplines, including aerial acrobatics (eg, trapeze), ground acrobatics (eg, handbalancing), manipulation (eg, juggling), character (eg, clowning) and music, which have different physical requirements that carry specific risks of injuries.<sup>4,7</sup> Circus artists often train and perform multiple disciplines. For professional artists, work may be seasonal and intermittent, different from sports with predictable, competitive seasons. The complexity of circus arts participation challenges the study of injury in this field.

Circus arts has proven artistic and cultural relevance to contemporary society and holistic health, social and educational benefits.<sup>8–15</sup> As with any physical activity, its practice presents a risk of injury. A literature review reported injury rates ranging from 7.4 to 9.7 per 1000 performances or athlete-exposures in professional circus artists,<sup>3,16,17</sup> and injury incidence estimates in circus arts students ranging from 0.3 to 3.3<sup>5,18</sup> injuries per 1000 exposure hours. Comparison among and consolidation of research studies are limited due to lack of studies and variation in injury definitions, methodologies, target groups, discipline classification systems and reporting. Therefore, a guideline to encourage consistent reporting methods, including research in all circus arts contexts, is needed.

In February 2020, the International Olympic Committee (IOC) released a consensus statement on the methods for recording and reporting of general sports injuries and illnesses.<sup>19</sup> This statement serves as the standard for injury surveillance in sports, but the authors indicate the need for sport-specific extensions of the statement to be written by scientists and clinicians with in-depth knowledge and experience to account for sport-specific activities and contexts. The aim of the Surveillance of Injuries in Research on Circus (SIRC) consensus working group was to create an extension statement to be used as a companion document to be referred to in conjunction with the 2020 IOC consensus statement.<sup>19</sup>

## METHODS

The methods in this first circus-specific consensus statement were informed by those in the IOC consensus statement on injury and illness surveillance<sup>19</sup> and the extension statements that followed.<sup>20–22</sup> Our process included three stages.

In the first stage, working group members were selected from circus arts researchers in injury and illness epidemiology, performing arts medicine practitioners, circus artists and coaches from around the world who presented at the International Association for Dance Medicine and Science (IADMS) Annual Conference in October 2019 and the American Circus Educators Conference in October 2020. SG invited JS, RMVR, MIS, JN and DM to a virtual meeting in December 2020. This meeting aimed to propose an SIRC working group to develop an international consensus statement for circus injuries. The SIRC working group convened at a first virtual meeting

in January 2021. Members included those with significant expertise regarding circus artists' health monitoring in Europe, North America and Australia. Specifically, members represented various backgrounds, including academic teaching and research, circus arts physical therapy, and circus coaching, training and performance (online supplemental appendix 1). Members of the working group had experience working with circus artists from different ages, genders, circus disciplines and recreational through professional levels. The working group appointed SG to chair the consensus group.

The second stage involved reviewing and discussing pertinent literature, including the IOC consensus statement,<sup>19</sup> sport consensus statements<sup>20–31</sup> and the technical report of the IADMS Standard Measures Consensus Initiative.<sup>32</sup> The working group decided to provide recommendations for injury recording and reports specific to circus arts, as an extension of the 2020 IOC consensus statement. All working group meetings were virtual due to the COVID-19 pandemic and geographical distance between members. Across four meetings between January and June 2021, the SIRC working group identified circus-specific additions needed for each IOC consensus statement subsection. Then working group members were assigned to draft the sections based on their content expertise. The section drafts were presented and discussed during the virtual meetings and revised according to feedback until there was a completed initial draft of the circus-specific statement.

During the third stage, five external reviewers, Marco Bortoleto, Agathe Dumont, Chris Gatti, Evert Verhagen and Kathy Yu, were invited to join the overall SIRC consensus group (online supplemental appendix 1) to review and provide feedback on the initial draft. The reviewers included representatives from circus organisations and circus networks, including the European Federation of Professional Circus Schools and the Circus Arts Research Platform, and individuals with expertise in sports injury epidemiology, sports medicine, circus arts research and coaching. The SIRC working group integrated the external reviewer feedback into a second circus-specific statement draft. The second draft was circulated among the working group members. All feedback and remarks were incorporated into the final draft. The working group approved and accepted this final version of the circus-specific extension statement, which provides circus-specific additions to be used alongside the IOC 2020 consensus statement.<sup>19</sup>

## CONSENSUS RECOMMENDATIONS

Since there were no illnesses specific to the circus context, illnesses in circus arts should be recorded and reported in the same manner as recommended in the IOC consensus statement.<sup>19</sup> Mental illness has important implications for participation in circus and potential for injury and the working group plans to address this at a later stage.

## Defining and classifying health problems

### Terminology for health problems

To adapt the definition of a health problem defined by Clarsen *et al*<sup>33</sup> and described in the IOC consensus statement,<sup>19</sup> we define a circus artist's health problem as any physical condition that reduces a circus artist's normal state of full health, irrespective of its consequences on the circus artist's participation or performance, or whether the circus artist sought medical attention.

### Relationship to circus activity

The classification of the relationship of health problems to circus activities into three groups is deemed appropriate in the circus context. We only rephrased the wording to make it more suitable for the circus context. Health problems may result:

- ▶ *Directly* from circus participation in performance, rehearsal or training (eg, acrobat falls from a rope, faulty landing after a jump or overuse from repetitive training).
- ▶ *Indirectly* from participation in circus activities that relate to performance, rehearsal or training, but not during a performance, rehearsal or training (eg, slipping, falling and sustaining an injury when in the dressing room or air conditioning sickness during a stay in the hotel after a performance).
- ▶ Activities that are *not at all related to circus activities*, that is, would occur in the absence of circus participation during a performance, rehearsal or training (eg, car crash or sudden cardiac arrest at home).

We recommend reporting all health problems and their relationship to circus activities to get a complete view of the spectrum of problems encountered by circus artists. However, depending on the purposes of the study, researchers may want to report health problems in these categories separately or focus on specific categories only.

## Defining injury

The definition of injury proposed by the IOC consensus statement was adapted to better suit the circus-specific context. We define injury as follows: injury is tissue damage or another derangement of normal physical function due to direct or indirect participation in circus activities, resulting from the rapid or repetitive transfer of kinetic energy.

### Mode of onset

The IOC consensus statement recommends reporting injury onset as either sudden or gradual, along with the underlying or assumed mechanism of onset as acute (single traumatic event), repetitive (repetitive use or cumulative trauma) or a combination of both. These classifications are deemed appropriate in the context of circus arts, and circus-specific examples are provided in [table 1](#).

### Classifying the mechanism of injury

The IOC consensus statement recommends additional injury mechanism subclassifications to allow researchers and healthcare practitioners to gain a deeper understanding of the potential circumstances that may be related to causation. The mechanism subclassifications according to the type of contact (direct contact, indirect contact or non-contact) outlined in the IOC consensus statement are suitable in the circus context. Further, we recommend the inclusion of 'no single identifiable event', where it is not possible to determine the type of contact ([table 2](#)). For injuries resulting from direct and indirect contact, we recommend reporting the source of contact as either from the ground, object (to include mats) or another circus artist.

We also recommend recording the circus arts skill (which we define as a specific movement, manoeuvre, or component of the movement or manoeuvre), the discipline involved at the time of injury, and relevant

**Table 1** Examples of circus-specific injury mode of onset

Mechanism	Presentation	Example
Acute	Sudden onset	<ul style="list-style-type: none"> <li>▶ An aerial acrobat loses hand grip while inverted on a trapeze and falls, hitting their head on an 8-inch crash mat, resulting in a concussion.</li> <li>▶ A ground acrobat inverts their ankle when landing from a back tuck on the trampoline, resulting in a lateral ankle sprain.</li> </ul>
Repetitive	Sudden onset	<ul style="list-style-type: none"> <li>▶ A contortionist experiences sudden onset of low back pain related to end-range spinal extension when training. Radiographs show an L4/L5 pars interarticularis fracture with spondylolisthesis.</li> <li>▶ A ground acrobat has been complaining of soreness in the Achilles tendon over the last few weeks. After a tumbling pass, the acrobat has sudden onset of sharp posterior ankle pain. Imaging reveals rupture of the Achilles tendon.</li> </ul>
Repetitive	Gradual onset	<ul style="list-style-type: none"> <li>▶ An aerial acrobat has been intensively rehearsing new choreography, including dynamic beats on a rope, over the last month. Over the last 2 weeks, she developed shoulder pain related to rotator cuff tendinopathy.</li> <li>▶ A juggler experiences gradual onset of neck pain that progresses into numbness in his thumb after an increased workload related to more performances per week and is diagnosed with cervical radiculopathy.</li> </ul>



**Table 2** Mechanism of injuries in circus arts

Type of contact	Examples
No single identifiable event	<ul style="list-style-type: none"> <li>▶ An acrobat who trains in handbalancing and a Chinese pole has gradual onset of wrist pain over 3 weeks.</li> <li>▶ A juggler has gradual onset over 4 weeks of neck pain radiating into the arm, which he relates to working on a new act.</li> </ul>
Non-contact (single event)	<ul style="list-style-type: none"> <li>▶ A banquine base feels sudden elbow pain after tossing the flyer into the air.</li> </ul>
Indirect contact through an object	<ul style="list-style-type: none"> <li>▶ A musician rolls their ankle after being thrown off balance by a stage prop bumping into them during a transition between acts.</li> <li>▶ A trapeze artist overturns during a release manoeuvre and mismatches the trapeze (contacts with the hands but late in the turn), resulting in a rotator cuff strain.</li> </ul>
Indirect contact with the ground	<ul style="list-style-type: none"> <li>▶ A stilt walker steps into a hole while doing an outdoor roaming act and has acute knee joint pain from a meniscus tear.</li> <li>▶ A Chinese pole artist slips and falls on an outstretched hand, resulting in a fractured clavicle.</li> </ul>
Indirect contact through another artist	<ul style="list-style-type: none"> <li>▶ A ground acrobat contacts another acrobat's shoulder while performing ensemble dance choreography, causing the second acrobat to lose balance and twist their knee, resulting in a meniscus tear.</li> </ul>
Direct contact with an object	<ul style="list-style-type: none"> <li>▶ A ground acrobat is struck in the forearm by a spinning cyr wheel, resulting in a fracture of the radius.</li> <li>▶ An aerial acrobat has a skin abrasion following training on a rope.</li> <li>▶ An aerial acrobat loses hand grip while inverted on a trapeze and falls, hitting their head on an 8-inch crash mat, resulting in a concussion.</li> </ul>
Direct contact with the ground	<ul style="list-style-type: none"> <li>▶ A tightwire artist has a fall from the apparatus, which results in hitting their knee on the ground, causing a patellar fracture.</li> <li>▶ An aerial acrobat performing without a mat misjudges height with a drop, hitting their head on the ground and sustaining a concussion.</li> </ul>
Direct contact with another artist	<ul style="list-style-type: none"> <li>▶ Two hoop divers collide as they dive through the hoops going in opposite directions. One hoop diver kicks the other diver in the thigh, resulting in muscle contusion.</li> <li>▶ A trapeze base's wrist is forced into hyperextension when catching the flyer from a dynamic release move, resulting in a wrist sprain.</li> </ul>

training patterns or factors that appear related to the injury (eg, participation in a workshop or drilling a new skill repeatedly).<sup>5 6 34 35</sup> Injuries are often multifactorial,<sup>36</sup> particularly gradual-onset injuries. Therefore, collecting additional information can assist in identifying *potential* factors related to the mechanism of injury.<sup>22 37</sup>

### Classifying circus arts injury diagnoses

The IOC consensus statement provides recommendations for classifying injuries based on body area, tissue and pathology type.<sup>19</sup> We support the IOC statement for using sport-specific coding systems such as the Sport Medicine Diagnostic Coding System and the Orchard Sports Injury and Illness Classification System in relation to circus arts injury and illness classification.<sup>19</sup> Injury recording should include as much detail as possible to allow for the most accurate classification level. Examples of circus-specific injury categorisation are provided in [table 3](#). As noted in the IOC consensus statement, some injuries will be reported by the healthcare practitioner, while others may be reported by non-medically trained staff, coaches, parents or athlete self-reporting. In instances of 'non-expert' reporting, Gabbe *et al*<sup>38</sup> suggested that reporting be limited to body area as their reporting of tissue type and pathology is unreliable. We recommend that additional information about the side of the body part

injured should also be recorded if applicable. Examples of reporting forms are provided in online supplemental appendices 2 and 3.

When one incident results in more than one specific body part being injured, the IOC consensus statement suggests that each diagnosis should be recorded and classified separately. However, for actual incidence and prevalence reporting, such examples should be recorded as one injury. Severity, if being recorded, should be reported based on the most severe/significant injury.

Given the unusual nature of some circus acts, the potential for unique circus-specific injuries exists, for example tracheal burns sustained during a fire breathing performance or oesophageal injuries resulting from sword swallowing acts. New codes may need to be added to classify certain circus injuries.

### Severity of health problems

The IOC consensus statement recommends using the duration of time lost, clinical assessment and severity score to quantify injury severity.<sup>19</sup> Time-loss from all participation may not accurately describe circus-specific injury severity as participation is often modified, for example participating in some but not all disciplines, without complete cessation. To be more comprehensive, we recommend reporting full and partial time-loss, no

**Table 3** Proposed standard reporting format for an ankle injury in circus arts

Body part/medical system	Tissue type	Pathology type	SMDCS code	OSIICS 13 code	OSIICS diagnosis
Ankle	Tendon	Ankle extensor tendinopathy	AN.11.28	ATE	Extensor tendon injuries at the ankle
		Ankle extensor tenosynovitis	AN.11.29	AT5	Tibialis anterior tenosynovitis
		Flexor hallucis longus tendinopathy	AN.12.28	AT7	Flexor hallucis longus tendinopathy
		Tibialis posterior tendon rupture	AN.13.09	ARP	Tibialis posterior tendon rupture
		Tibialis posterior tendinopathy	AN.13.28	FT7	Tibialis posterior tendinopathy
		Tibialis anterior tendinopathy	AN.14.28	AT5	Tibialis anterior tenosynovitis

OSIICS, Orchard Sports Injury and Illness Classification System; SMDCS, Sport Medicine Diagnostic Coding System.

time-loss, and the degree and urgency of medical attention.

Injury severity is captured with either a healthcare practitioner report or the weekly self-report of health complaints and exposure to circus arts training and performance (online supplemental appendices 2 and 3). Time-loss injury severity should be reported as full time-loss from all circus participation or partial time-loss from at least one discipline for at least 1 day after the injury. Circus-specific examples are provided in table 4. Following the IOC consensus statement,<sup>19</sup> time-loss duration should be counted as the day after injury onset (ie, the first full day of time-loss) through to the day before the artist resumes participation in all sessions of all circus disciplines or the day before they *would have* resumed full participation if they were not training due to other reasons, such as vacation. Injury severity should be categorised as mild (1–7 time-loss days), moderate (8–28 time-loss days) and severe (>28 time-loss days) as per the IOC consensus statement.<sup>19</sup> To further characterise the most severe injuries, we recommend reporting on injuries causing disability and death as fatal, non-fatal disability or severe, as per catastrophic injury guidelines.<sup>39</sup>

Injuries not resulting in time-loss include activity modification without time-loss or full participation but with symptoms. Questions 1–4 on the self-report form (online supplemental appendix 3) capture no time-loss injuries using a modification of the Oslo Sports Trauma Research Center Questionnaire on Health Problems (OSTRC-H2).<sup>33</sup> Questions 21, 22 and 23 differentiate complete time-loss, partial time-loss and no time-loss.

The IOC guideline recommends reporting injuries according to degree and urgency of medical attention.<sup>19</sup> In the self-report form (online supplemental appendix 3), question 20 captures the type and degree of medical attention. Further details could be provided to capture urgency with the type of care needed (eg, diagnostic test, emergency room visit or ambulance ride).

#### Capturing and reporting artist exposure

We recommend quantifying exposure in hours per IOC guidelines<sup>19</sup> to allow comparison with other performing arts and sports. Exposure hours should include all circus arts-related training and performance but exclude other sports or fitness activities. Exposure time should be separated into training and performance (online

**Table 4** Examples of circus-specific full and partial time-loss after injuries

Case	Full time-loss (days)	Partial time-loss (days)
A circus performer falls during the act and cannot complete the act due to pain in the back. The performer returns for the remaining acts in the show.	0	0
A circus student is learning a new aerial inversion skill and notices progressively worsening shoulder pain. The student cannot finish the class session due to pain but can return to class the next day with some modifications.	0	0
A circus performer injured their shoulder during a performance on Thursday. The next day, the performer could not perform at all, and for the rest of the weekend cannot perform aerial act but can perform character role. On Monday, the performer resumes aerial act.	1	3
A circus student injured their ankle practising a tumbling pass in class on Monday and has to sit out for the rest of the class. The student joins aerial class right after and can participate with modifications in class. The student misses tumbling classes for the rest of the week due to ankle injury but continues participating in other disciplines. The student returns to tumbling class the following Monday.	0	6

**Table 5** Artist exposure types in circus arts

Exposure type	Definition	Exposure data recorded
Class (student)*	This could include an individual or group class in which the artist is a student. May include warm-up, cool-down or discipline-specific conditioning activities, as well as skills, artistic creation and choreography.	Number of sessions by specific circus discipline.
Class (teacher)*	This could include individual or group classes in which the artist is in the role of a teacher and physically demonstrates warm-up, cool-down or discipline-specific conditioning activities, as well as skills, artistic creation and choreography.	Number of sessions by specific circus discipline.
Independent* training	This includes skill-specific training, artistic creation or choreography practice without a teacher guiding the session. May also include warm-up, cool-down or discipline-specific conditioning activities.	Number of sessions by specific circus discipline.
Rehearsal*	This includes practising a choreographed piece, act or entire show in preparation for a performance. This includes warm-up and cool-down.	Number of sessions by specific circus discipline.
Performance	This includes presenting a piece, act or entire show in front of an audience or recorded for an audience.	Number of performances by specific circus discipline. Please note time for a warm-up and cool-down would be recorded as training rather than performance exposure.*
Physical conditioning for muscle performance*	Physical conditioning to improve muscle activation, endurance, strength, power and/or coordination that is separate from training specific circus skills and not on a circus apparatus. This could include modes of exercises such as high-intensity interval training, where muscle performance exercises are used to achieve an elevated heart rate response.	Number of sessions. Could also specify the target body region or mode of training (eg, resisted training with weights, bodyweight exercise, etc).
Physical conditioning for flexibility/joint mobility*	Physical conditioning with the intent of increasing joint mobility or muscle flexibility. Please note this is different from contortion skill training.	Number of sessions. Could also specify the target body region or mode of training (eg, passive stretching, dynamic stretching/active flexibility, etc).
Other sports or fitness	Any sports or fitness activities that do not fit the above categories (eg, running, swimming, rock climbing, cycling, yoga).	Number of sessions. Could also specify the type of fitness training.

\*Included in measuring exposure in hours to circus training.

supplemental appendix 4A). Training includes participation in the following: (1) physical conditioning for muscle performance or flexibility/joint mobility; (2) skill practice, artistic creation or choreography across all circus disciplines that occurs during classes or independent training; and (3) rehearsal (table 5). Activities such as warm-up or cool-down would also be considered training, even if occurring before or after a performance. All the time an artist is present on stage, including performing their primary discipline as well as any ensemble, character or supportive roles, is included in performance exposure.

Due to the complexity of the circus arts, we recommend, in addition to hours, also recording exposure as the number of sessions for each exposure type (eg, class, independent training, physical conditioning, rehearsal or performance; table 5) by specific circus discipline.<sup>32 40</sup> We recommend recording disciplines by session since, in circus arts, it is common to train multiple disciplines within the same session. Therefore, calculating the time spent on each discipline within the class becomes cumbersome and prone to error.<sup>40</sup> Depending on the size and objectives of the study, exposure might be recorded by a single discipline or discipline subgroup (table 6). Artist exposures are counted as individual sessions that may (1)

be separated in time (eg, between classes or rehearsals on the same day); (2) include a separate warm-up; or (3) be a different discipline (eg, a single independent training practice that included silks and trapeze would be coded as two sessions, one of each discipline) and/or a different exposure type. Recording exposure should distinguish between the skill-based contortion discipline and general flexibility training. Exposure to performances should be recorded separately, similar to sports competition, and by specific circus discipline. An example of calculating 1 week of exposure for a single artist is provided in online supplemental appendix 4. To capture the intensity of the exposure, internal training load can be quantified using session rating of perceived exertion or other similar measures.<sup>41–43</sup>

For specific research questions (eg, risk factors associated with warm-up or influence of landings on knee injuries), it may be useful to collect additional information such as time, intensity or activity type used for warm-up, and for landings the number, impact load, height and surface.

### Expressing risk: prevalence and incidence

Prevalence refers to the proportion of injured circus artists at any given point in time (eg, the start of the



**Table 6** Circus arts discipline subgroup classification

Circus arts discipline subgroups	Definition	Examples
Aerial acrobatics	Circus discipline in which the artist is often suspended from an apparatus by various body parts and commonly uses pulling movements, for example, to invert on or climb the apparatus.	<ul style="list-style-type: none"> <li>▶ Silks (or tissue, fabric).</li> <li>▶ Rope (or corde lisse), Spanish web.</li> <li>▶ Trapeze (static, dance, flying).</li> <li>▶ Aerial hoop (or Lyra).</li> <li>▶ Cloud swing/sling/hammock.</li> <li>▶ Straps/loop straps.</li> <li>▶ Rings (Russian or gymnastic).</li> <li>▶ Chains.</li> <li>▶ Hair hanging.</li> <li>▶ Air cradle.</li> <li>▶ Aerial pole.</li> <li>▶ Russian cradle (flyer).</li> <li>▶ Iron jaw.</li> </ul>
Aerial acrobatics (with ground elements)	A subset of aerial acrobatics that often include impact and/or pushing movements in contact with the floor or apparatus.	<ul style="list-style-type: none"> <li>▶ Chinese pole/lollipop/pole dance.</li> <li>▶ Russian cradle (base).</li> <li>▶ High bar.</li> </ul>
Ground acrobatics (human propulsion)	Discipline that involves repetitive skills such as jumping, diving, rotational or other gymnastics-type movements where height from the ground is the result of human propulsion.	<ul style="list-style-type: none"> <li>▶ Tumbling/parkour.</li> <li>▶ Jump rope.</li> <li>▶ Icarian games.</li> <li>▶ Hoop diving.</li> <li>▶ Cyr/German wheel.</li> <li>▶ Dance.</li> <li>▶ Banquine.</li> </ul>
Ground acrobatics (apparatus propulsion)	Similar to the above, except that repetitive movements are performed on an apparatus or with a device that imparts an acceleration of the artists' movement, often resulting in landing from a significant height.	<ul style="list-style-type: none"> <li>▶ Teeterboard (Korean plank and Hungarian).</li> <li>▶ Russian swing.</li> <li>▶ Trampoline/tramp wall.</li> <li>▶ Wheel of death.</li> <li>▶ Trick riding (bicycle, motorcycle).</li> <li>▶ Bungee/harness.</li> </ul>
Ground acrobatics (balance/control)	Includes disciplines where the artist is typically weight-bearing on a stable or unstable surface (apparatus or human), focusing on creating postures or shapes with control and balance. It may involve some impact transitioning into and out of postures or on and off the base or apparatus.	<ul style="list-style-type: none"> <li>▶ Contortion.</li> <li>▶ Handbalancing.</li> <li>▶ Hand to hand/adagio/acrodance.</li> <li>▶ Human stacking/pyramid.</li> <li>▶ Acrobatic chair/chair stacking.</li> <li>▶ Ladder.</li> <li>▶ Rola bola/rolling globe.</li> <li>▶ Wire (tight, slack, high).</li> <li>▶ Stilts.</li> <li>▶ Trick riding (unicycle/horse).</li> <li>▶ Perch.</li> </ul>
Manipulation	This discipline involves the artist creating repetitive movements with an object, often requiring significant coordination and fine motor skills.	<ul style="list-style-type: none"> <li>▶ Juggling.</li> <li>▶ Diabolo/poi.</li> <li>▶ Foot juggling/antipodism.</li> <li>▶ Contact juggling.</li> <li>▶ Flowerstick.</li> <li>▶ Hooping.</li> <li>▶ Fire.</li> <li>▶ Knife throwing.</li> <li>▶ Plate spinning.</li> <li>▶ Bullwhip.</li> <li>▶ Baton twirling.</li> </ul>
Character	Discipline that often includes significant acting and theatrics. It may also include some acrobatic skills but typically with low physical demand.	<ul style="list-style-type: none"> <li>▶ Clown.</li> <li>▶ Ringmaster.</li> <li>▶ Mime.</li> </ul>
Music	Discipline that involves singing or playing a musical instrument.	<ul style="list-style-type: none"> <li>▶ Vocals.</li> <li>▶ Instrumentalists.</li> </ul>

 Adapted from Greenspan.<sup>35</sup>

academic year) or in a defined period (eg, show run, lifetime) for all circus artists in the study population.<sup>19 44</sup> Typically, prevalence is used to describe the overall extent of the circus injury problem and is a more appropriate measure for gradual-onset conditions.<sup>18</sup> Prevalence can

also be calculated for specific groups, such as per circus discipline.

Incidence describes the risk of developing a new injury among a population at risk during a specified time interval.<sup>44 45</sup> Injury incidence is typically used to estimate

the risk of circus injuries and is a more appropriate measure for sudden-onset conditions.<sup>19</sup> As described in the IOC consensus statement, several incidence-based measures can be applied.<sup>19</sup> We recommend expressing risk as to the number of injuries per 1000 hours of circus activities because it takes into account relative exposure among circus artists and allows for comparisons between, for example, different sports (eg, circus and gymnastics), types of activities (eg, performances and classes), circus discipline subgroups (eg, aerial acrobatics and ground acrobatics) or specific types of injury (eg, ankle sprains and shoulder subluxations). It can be of interest to present the clinical incidence, which reflects the average number of injuries per circus artist during a certain period (eg, school semester or the month following a holiday break) and can thus be used as an indicator for determining healthcare needs.<sup>44</sup>

### Study population characteristics

#### Classification of circus arts disciplines

To fully understand injuries among circus artists, differences among circus arts disciplines must be considered. Greenspan<sup>35</sup> introduced an acrobatic circus arts discipline classification informed by the previous categorisations<sup>5 6</sup> to define subgroups of circus disciplines where artists have similar physical demands. The classification was expanded to be more comprehensive for this consensus statement (table 6) and provides a framework for analysing injury patterns by subgroups of circus disciplines that could lead to interventions to decrease injury risk. Different subgroups of circus arts may have different injury risks, but within subgroups the individual disciplines may also have different injury risks. We recommend using this classification system for reporting circus arts injuries by discipline subgroup. To analyse injury patterns in smaller studies, combining all aerial and all ground acrobatics subgroups may be necessary.

#### Demographics

We recommend using the *demographic, health history, and circus experience intake questionnaire* (online supplemental appendix 5) to record the demographics and characteristics of the study population relevant to the circus context. In addition, we recommend including a standard health history questionnaire appropriate for the culture and language of the target population, such as sports participation history forms.<sup>46 47</sup>

#### Physical examination

By performing physical assessments, we may determine if particular physical characteristics are associated with injury risk. We recommend including baseline physical examination tests and measures if qualified assessors are available. Measures might include joint hypermobility,<sup>48</sup> joint range of motion, flexibility and strength. When possible, use tests similar to the functional requirements of circus activities, such as pull-ups for upper body strength or the double leg lowering test for abdominal

strength. Functional performance measures may also be included, such as the star excursion test or the lower extremity Y balance test<sup>49</sup> and the Landing Error Scoring System<sup>50</sup> for lower extremity, or the upper extremity Y balance,<sup>51 52</sup> closed kinetic chain upper extremity test and the seated shot put<sup>51</sup> for upper extremity assessment.

### Data collection methods

Guidelines for data collection methods proposed by the IOC consensus statement<sup>19</sup> are generally appropriate for circus arts. Different methods to capture injuries and exposure are available, such as the traditional pen and paper approach or web-based solutions (eg, the Performing Artist and Athlete Health Monitor<sup>18</sup>). We recommend the use of a web-based surveillance system. A recent prospective study investigating injuries and health problems among circus arts students shows that such a methodology may contribute to a higher response rate.<sup>18</sup> The medical report of injuries and illnesses form published with the IOC consensus statement<sup>19</sup> was modified for circus arts (online supplemental appendix 2). The report forms published with the IOC consensus statement are for healthcare practitioners only, and injuries that do not receive medical attention might be under-reported. Therefore, we developed, next to a healthcare practitioner report form for circus injuries (online supplemental appendix 2), self-report forms for (1) collection of baseline demographic, individual health history and circus experience information; and (2) weekly self-report of health complaints and exposure to circus arts training and performance (online supplemental appendices 3 and 5).

### CONCLUSION

This statement extends and adapts the recommendations of the IOC consensus statement<sup>19</sup> to circus arts. Relatively small sample sizes challenge injury research in circus arts, and consolidation or meta-analyses are limited due to heterogeneity in methodology and reporting. Published research is also limited to only certain regions of the world and in the future should include the global circus population. Implementation of this guideline would increase the consistency of reporting, thus enabling comparison and consolidation of research to allow for more valid, representative and applicable findings. It also provides a framework for a circus injury registry. Finally, this guideline should be used by researchers, clinicians and circus professionals to inform circus-specific injury prevention strategies, rehabilitation approaches and industry-level risk management with the ultimate aim of enhancing the performance and health of circus artists and the circus arts industry at large.

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**Acknowledgements** The authors would like to thank Adam Decker for helping to create the working group, as well as Dean Kriellaars and Fleur van Rens for their input and participation in some early meetings.

**Collaborators** Surveillance of Injuries in Research on Circus (SIRC) working group: SG (chair), DM, JN, JS, MIS, RMVR. External reviewers: Marco Bortoleto PhD, Agathe Dumont PhD, Chris Gatti PhD, Evert Verhagen PhD and Kathy Yu M.B.B.S., MPH, Grad Dip Sports Medicine, FRACGP.

**Contributors** All authors have significantly contributed to the writing and review of this manuscript. SG additionally served as the chair of the consensus working group.

**Funding** This work was supported by the Taskforce for Applied Research (Nationaal Regieorgaan praktijkgericht Onderzoek SIA) (grant number SPR.VG01.007).

**Competing interests** None declared.

**Patient consent for publication** Not required.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Supplemental material** This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

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