

Are inflatable play structures really safe for our children?

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Abstract

Purpose The frequency of injuries sustained while playing on inflatable toys such as bouncy castles have rapidly increased. These supposedly safe structures are likely unsafe. The objective of this review was to investigate the risk that these attractions represent and the necessary measures to minimize risk of accidents.

Methods We conducted a prospective study of 114 patients over a period of one year (2015 to 2016). Demographic data collected included: age, gender, anatomical location and side of involvement as well as supervision of the child whilst on the bouncy castle. The extracted data include mechanism of injury and risk factors, i.e. lack of supervision of the child, amounts of users jumping at the same time.

Results The injuries were slightly more frequent in male than female children; 2:1 up to six years of age. From the age of ten to 14 years the ration evened to 1:1, the higher incidence in female children was between the ages of six to eight years.

The most common injuries were to the humerus, followed by the distal radius. Only 28% of the parents said they were supervising while the child was jumping.

Conclusion Injuries associated with inflatable bouncers have increased over time. The main risk factors: were lack of effective adult supervision and the shared use by an excessive number of participants of different ages and weights.

These considerations lead to the conclusion that there is a necessity to enhance child health surveillance and to consider

limiting bouncer usage to children over the age of six years, to prevent and control injuries and to minimize their consequences.

Level of Evidence II - prospective study

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Introduction

Inflatable bouncers or moon bouncers have grown in popularity over the recent years as they are relatively cheap to acquire,¹ provide a source of entertainment for children and are generally regarded as a safe environment by parents. There are multiple descriptors for inflatable bouncers, including inflatable play structure, bounce house, bouncer and bouncy castle. They are encountered at fairs, festivals and amusement parks as well as at private parties. Restaurants, inns and even hotels, try to attract families with the installation of leisure games for minors, such as playgrounds with various attractions so that the little ones can have fun while adults enjoy a relaxed after-dinner or family celebration. In this respect, the bouncers are an ideal complement for parties and ensure hours of fun at low cost.

However, as their demand has soared, so have accident rates.^{2,3} In recent years, there has been a significant increase in the number of children treated in the emergency department (ED) for injuries resulting from the use of these devices (in the United States an injury rate of 5.3/100 000 children has been described).¹

The mechanisms of injuries were: first, a fall, both inside and outside of the bouncy castle; second, a collision between children due to the differences in sizes and ages.^{4,6} Also, less frequently yet more severe, were injuries resulting from faults in the anchoring system and wind gusts.⁷

The main risk factor was the lack of effective adult supervision, either by the parent or staff responsible for overseeing the attraction. Furthermore, overcrowding by children of different weights and sizes increased exponentially the chances of suffering an accident.⁸

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We carried out a prospective study of injuries secondary to inflatable play structure accidents that attended the Paediatric Emergency Department at our Hospital Universitario Son Espases. This is the first prospective European study of its kind, which has been conducted in a single referral centre for Paediatric Orthopaedics during a 12-month period (between February 2015 and February 2016). Our hospital is a paediatric referral site for the entire province; patients not only come from the city but from all the municipalities of the province. The population of the province is 1 169 591 inhabitants, with a population proportion corresponding to the age range of 0 to 14 years of 15% (Fig. 1).

The increase of inflatable play-related injuries may be explained by the growth of the inflatables industry,⁸ as well as by the lack of prevention measures and initiatives for reducing injury risks.

The aim of this study is to describe the epidemiology, type and chronology of the lesions and ultimately, we would like to outline some safety guidelines for inflatable attractions and alert civil society to the dangers of such facilities, still considered safe by the general public.

Material and methods

Only paediatric patients aged 0 to 14 years, who had experienced trauma in an inflatable play structure, were chosen for the study.

The patients' parents were informed at arrival to the ED about the study, and they consented to and signed the protocol for data collection.

Demographic data gathered included: age; gender; mechanism of injury (fall inside the inflatable play structure, fall outside the bounce house, collision with another participant, castle displacement); risk factors (lack of responsible supervision, users of different ages); type of injury; medical attention required; and complementary tests.

Adult supervision is defined as the need for vigilance at all times. There must be at least two people supervising the attraction.

The shifts should be respected, either by age, or by height, so that children of different constitution do not use attraction at the same time. The simultaneous use by a large number of people at the same time should be avoided, because it increases the danger of falls and

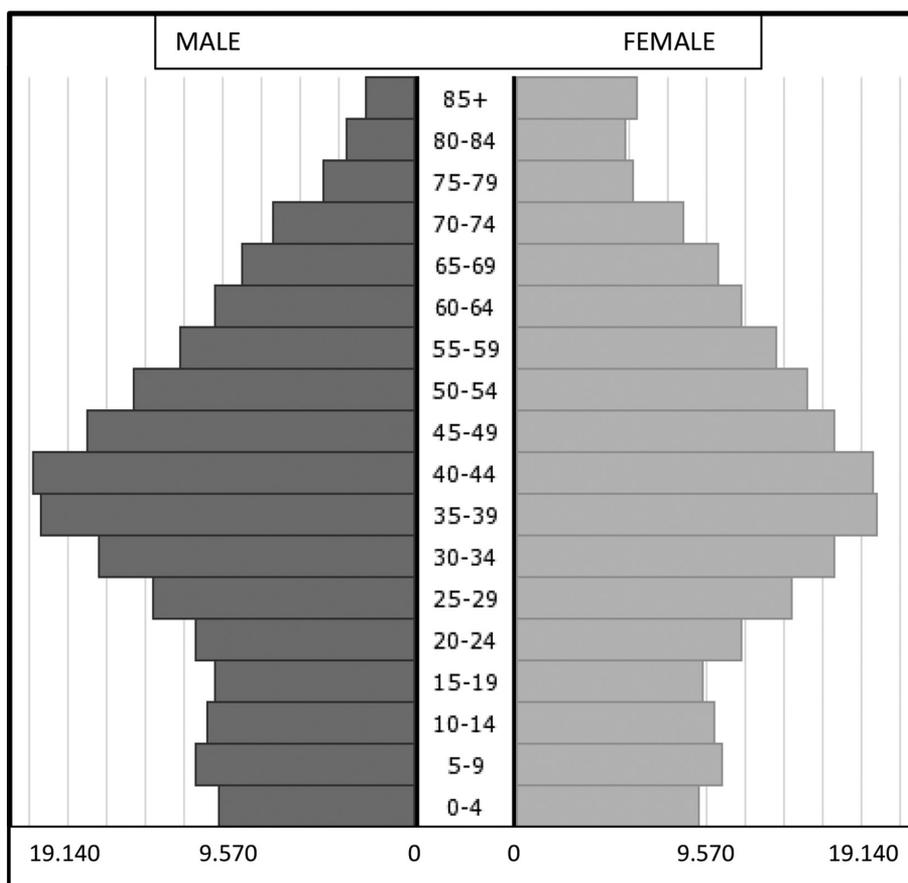


Fig. 1 Density of inhabitants between 2015 and 2016 in our province (male, left-hand side and female, right-hand side).

injuries, especially if children of different age ranges and weight are mixed.

Results

Between February 2015 and February 2016, 114 children were treated for inflatable play structure-related injuries.

The distribution of injuries showed a higher frequency in male compared with female children, with a ratio of 2:1 up to six years of age. From the age of ten to 14 years, the ratio evened to 1:1. The age range where the gender ratio is inconsistent is between the ages of six and eight where the incidence is higher in females 1:1.3.

The age peak, independent of gender, was between the ages of six and eight years (Fig. 2).

The most commonly injured anatomical region in the upper limb was the humerus, followed by the distal radius. The most common fracture was the supracondylar fracture. In the lower limb, the most common lesion was a sprain, followed by the tibial fracture. Moreover, two patients presented non-displaced lumbar vertebral fractures, in T12 and T10, respectively.

The trauma in the upper limb was more frequent in male compared with female children (ratio 1.3:1), and in the lower limb the ratio was 1.25:1. Both cases of spinal injuries happened to male children. Injuries sustained to the face and head were only observed in girls. There were two cases of traumatic head injuries due to direct collision with another child, and two cases of lesions to the eyebrow (Fig. 3).

Bounce houses injuries present seasonal variability according to literature. The most frequent seasons are the warmer periods of the year: spring and summer. We observed a rise in the number of lesions during the months of May to December, with a drop from December to March.

Out of our series, as many as 100 patients who attended ED had an unwitnessed fall, with the parents alerted by the child crying.

Of the 114 children in our study, only 28% of parents said they were supervising while the child was jumping, 25% said they were close to the bouncer but did not observe the fall and 47% said they were not supervising the child, nor in the vicinity of the bouncer, and were subsequently notified of the fall of the child. Of the 53% of the parents who claimed to have been in the vicinity of the castle (both those who observed the fall and those who did not see it), only 40% said that there was a person controlling access to the inflatable play structure.

At the moment of injury, the number of children jumping simultaneously ranged from two to ten. The mentioned mechanisms of injury were either: being hit by other children, or slipping off or falling out of the inflatable structure, or the trapping and twisting of a limb.

In all, 62 patients out of the total were treated non-operatively. These included: contusions, non-displaced fractures and sprains.

However, of the 114 patients, 52 children required admission to hospital for treatment and 50 of them required surgery; including those in the upper extremity. There were 20 supracondylar fractures, 12 of them were supracondylar fractures Garland II, eight supracondylar

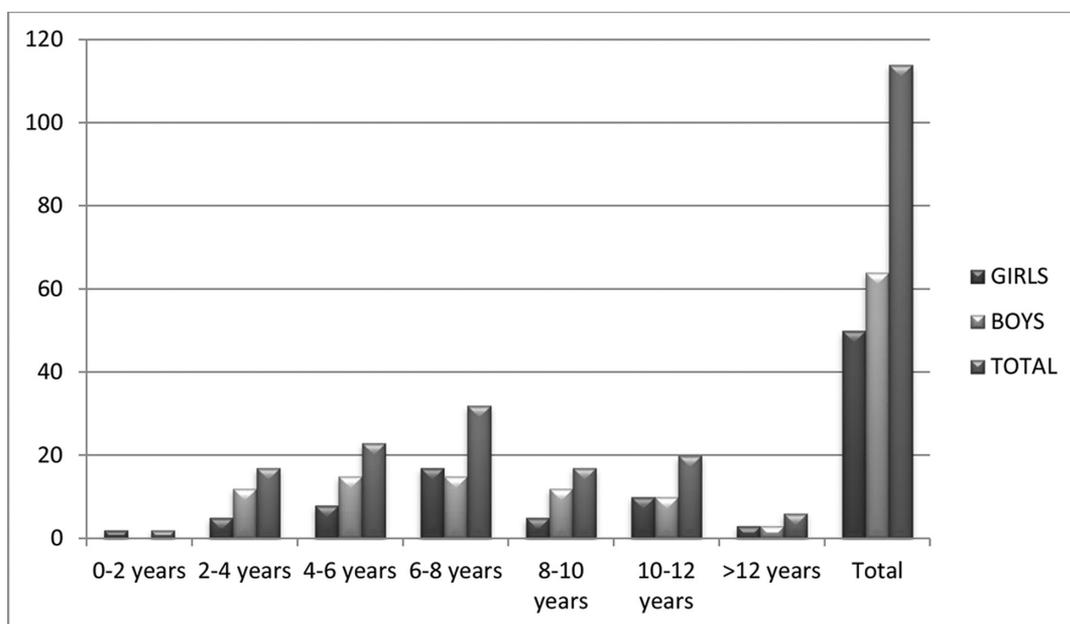


Fig. 2 Graph describing the incidence of lesions by age and gender, registered during a 12-month period at our hospital.

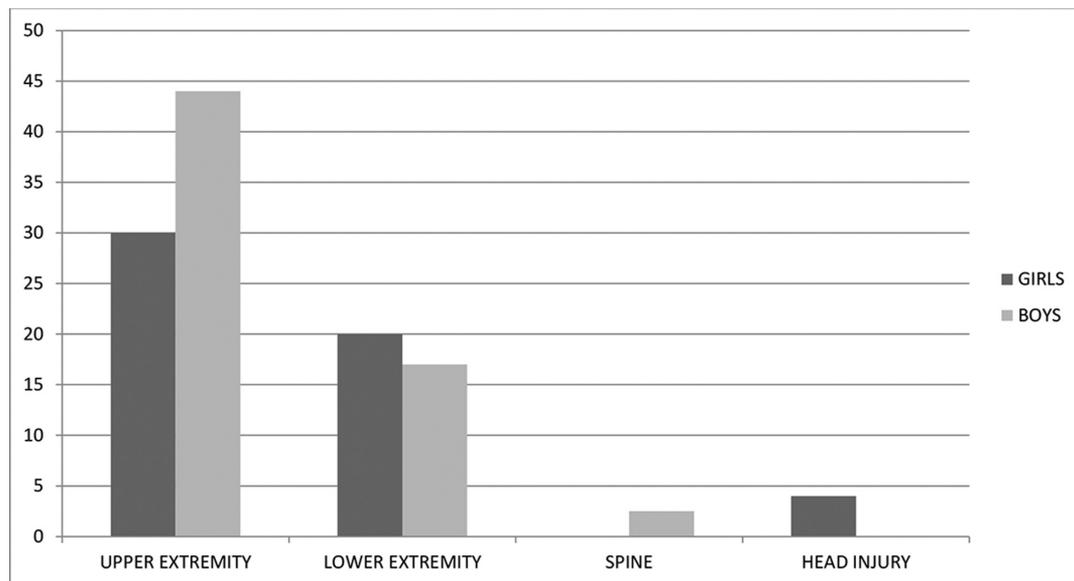


Fig. 3 Graph describing distribution by gender and anatomical location (upper E, upper extremity; lower E, lower extremity; head injury; spine).

fractures Garland III and two of them with vascular involvement that required an anterior approach and vascular repair. All of the ten distal radius fractures were reduced under sedation with Ketamine (Ketolar, Madrid, Spain) and Midazolam (Laboratorios Normon, Madrid, Spain) and control of fluoroscope in the operating room. Of ten forearm fractures (including fracture of both bones, or of only one of them), six of them required fixation with flexible intramedullary nailing or Kirschner wires and two radial head fractures needed reduction under anesthesia and control of fluoroscope without internal fixation. Children with humerus fractures required hospitalization more frequently, accounting for 47.7% of the total hospitalizations.

In the lower limb, the six displaced tibia fractures and two femur fractures required surgery, under general anesthesia and fixation with a flexible intramedullary fixation system.

The average hospital stay for fractures that required surgery with internal fixation was two to three days. Those who underwent closed reduction had a stay for 24 hours, to control distal trophism.

The two vertebral fractures were treated orthopaedically with a corset, but required hospital admission for pain control. The average stay was five days.

Discussion

The medical and public health community has made recommendations about the safe use of bouncy castles. Nevertheless, it is also important to involve the political class in order to toughen security controls and enact more comprehensive regularizations.⁹

Inflatable play structures appear very attractive to children but this study suggests that they are unsafe. The lack of adult supervision, the use of the facility by participants of different ages and sizes at the same time, as well as overcrowding, are the main risk factors for injuries. As observed in the graphs, there is variability in user age, from two years to ten years old, and as a result, there is often a variety of weights of children playing. It is imperative to insist upon the implementation of guidelines to regulate their use, especially with regards to age, where a minimum age should be set at six years.

With the goal of reducing the number of accidents related to inflatables structures, the European Safety standards UNE-EN 14.960:2014⁹ should be complied with at all times. The standard, which is compulsory in many European countries, describes the installation of the castles, safety standards to be taken during the process and the instructions of management and handling. However, in the current Spanish market, not all instalments hold this certificate. Furthermore, the fact that the facility has passed the quality and maintenance control does not guarantee it is safe.^{1,10}

In Spain, the UNE-EN 14960 standard specifies the safety requirements for inflatable play equipment in which the main activities are bouncing and sliding.

This law regulates both the type and dimensions of the structure, as well as the permitted materials and threads, as well as the inflatable volumes, among other details. On the other side, it also requires the specification of the capacity and the recommended age of use and requires an annual review to certify the safety of the facilities, but in many cases as we have been able to verify in this article, the basic safety measures are not applied.

This has made the law more and more punitive, attributing responsibility of negligence to the peddler, for the damages suffered by a minor in an inflatable play structure.

We recommend that the following measures^{2,11,12} should be met to ensure the inflatables are safe for use and that there is a lower amount of injuries associated with these attractions.

1. There should be responsible adult supervision, paying close attention to the children at play at all times during its use.
2. The equipment should be set up, operated and supervised by the hire company's own staff.²
3. A rotation system for different age or size groups should be used, together with the observance of an age limit for users. There are special inflatables available for adolescents and adults.
4. A safety distance of 1 m to 2 m should be kept around the facility, leaving the entrance and exit points free at all times. At the access to the bouncer, there must be a ramp that covers the entire width of the entrance arch. Likewise, there must be some type of material that cushions possible falls, such as mats or foam. A simple carpet is not enough; also, curbs, benches, trees or other accessories should not be present in that area.
5. The number of children using the bouncy castle must be limited to avoid overcrowding. This will allow each child to have safe space to play in.^{13,14}
6. It is forbidden to climb and/or hang from the walls of the inflatable.
7. Children should not be allowed to use the bouncy castle in adverse weather conditions such as high wind or in wet weather (inflatables can flip over and slippery surfaces may cause injury). It is recommended to deflate the installation when winds exceed 45 km/h.
8. All children must be made to remove footwear (always wear socks).
9. Removal of hard or sharp objects such as jewelry, buckles, pens and other similar pocket contents.
10. The castle must be adequately secured to the ground and sited away from obstacles such as fences or overhead power. They should be regularly inspected while in use.

Writing in *Pediatrics*, the researchers report that an estimated 64 657 children were treated in EDs around the United States for inflatable bouncer-related injuries between 1990 and 2010, with a mean rate per year of 5.28 injuries per 100 000 children.¹⁵

Over the 15-year period between 1995 and 2010 the rate went up 15-fold, although the increase was more rapid over recent years, with the annual injury

number and rate more than doubling between 2008 and 2010.^{2,15}

In European literature there is an Italian retrospective article⁸ for which data of 521 children were collected from 2002 to 2013. In our study, we observe a greater number of children affected in a one-year period compared with the mean annual affected population mentioned in the American and Italian studies.

With this study, we wanted to show the high volume of injuries than can occur with the temporary inflatable attractions/structures which are getting increasingly popular. Currently, bouncy houses and other inflatable structures are not only present at town fairs or local festivities, but are also often rented for private parties and family gatherings. For this reason, it is very important to understand the restrictions of their use and inappropriate and/or faulty facilities. Nevertheless, the good and responsible use of the attractions always requires supervision, as mentioned on several occasions in this study, especially in private events.

This study has certain limitations. Regarding the number of children jumping in unison in a bounce house, we do not know the number of children participating in games on bouncy castles in order to establish a statistic that informs us of the chances of suffering an accident. Nor do we know to what extent the standards of use described by the European Safety standards UNE-EN 14.960:2014 are not met, nor whether they are sufficient. What is certain is that the number of children and the severity of the injuries resulting from these activities that reach the paediatric emergency services are increasing.

Among the measures to be carried out, it seems sensible to restrict use only to children over six years of age, since we found that pre-school children are frequently injured and the ones most often suffering reported fractures of the upper extremity. According to our study, the number of injuries would be reduced by up to 34%.

Another limitation of this study is that the population of our province triples during the summer, exponentially increasing the number of patients who come to the paediatric emergency room

The problem has been exposed. Security technicians need to study improvements of the current procedures and the public administrations need to comply with the standards. Parents should know the risk and possible consequences of these activities.

Conclusions

Bouncy castles are a preventable cause of injury in children. Ensuring that parents are aware of the potential risks, improving surveillance of the injuries, developing national safety guidelines, especially with regards to age, where an age limit should be set to over six years old, and

separating children according to size and age, as well as improving bouncer designs, are the first steps to prevent accidents from happening.

Further investigation is needed to define additional preventive and safety guidelines and to characterize the full scope of injuries related to inflatable bounce use, including soft-tissue injuries.

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COMPLIANCE WITH ETHICAL STANDARDS

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ETHICAL STATEMENT

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

ICMJE CONFLICT OF INTEREST STATEMENT

None declared.

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