Notes on

PLAYGROUND SAFETY
Activity, Injury and Prevention

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Summary

This report reviews research literature and other publications related to the safety of children’s play areas.

During an average year in the USA, 15 children die in playground equipment-related accidents and more than 200,000 require emergency room treatment or hospitalization. Strangulation and falls are the most common, direct causes of death and injury respectively. Underlying infrastructural and behavioral risk factors include inadequate shock attenuation in surfacing beneath playground equipment, poorly designed and maintained playground equipment and inadequate adult supervision.

While the CPSC and other organizations actively promote guidelines for the safe design, maintenance and use of playground facilities, laws requiring compliance with common safety standards are scarce. The Americans with Disabilities Act imposes some requirements, but only six states require playground installations to meet CPSC or ASTM guidelines.

There is increasing public awareness of playground safety issues and federal legislation promoting state playground safety laws has been introduced in Congress. In response to public concern, play structures are evolving towards safer, less challenging designs and programs that encourage certification and inspection of playground facilities are developing.
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Introduction

Playgrounds and playground equipment evoke some of the most natural and uninhibited of childhood activities. The challenges offered by active, exploratory play are important contributors to a child’s physical, mental and social development.

Adventurous play also carries risks. Playground deaths are not uncommon, occurring more than once per month, on average. Each day, hundreds of children require emergency room treatment or hospitalization for playground-related activities.

Increasing public concern about playground safety has brought changes in the physical and social environment of public play facilities. Equipment, activity patterns and safety expectations are evolving rapidly in response to public pressure and legislative action.

The purpose of this report is to summarize available data about patterns of activity and injury among children at play, and to describe trends in playground safety. The report also offers some suggestions for possible responses to the information presented, including ideas for product development and brand enhancement.

Playground Activity Patterns

The playground has frequently been the venue of research by psychologists, sociologists and behaviorists seeking to study the physical and social development of children. The playground is often seen as a microcosm of society; where not only bodies but also personalities, belief systems and behavior patterns grow and become established.

There appears to have been no published research addressing activity choices, the frequency of different activities or the ways in which activity patterns change with age. Most research on activity patterns during play have been aimed at assessing energy expenditure and psychosocial correlates of activity levels. Consequently, there is only minimal information on activity patterns: play equipment choices, activity frequency and the ways that play activity selection evolves with age. A variety of methods, each with their own advantages and disadvantages, have been used to assess children’s activity levels. Some of these could be adapted to document specific motor activities.

• Direct observation provides a valid, if qualitative, measure of activity that is generally considered the most accurate of available methods\(^6\).

• Heart rate monitors and motion sensors\(^7\)\(^,\)\(^8\)\(^,\)\(^9\) allow remote, continuous monitoring of gross motor activity at much less cost than direct observation. The information is not specific to particular activities, however.

• Self-Reports\(^10\) or reports by teachers and parents are inexpensive but more dependent upon participants’ recall.

Age Differences

Some clues to age-related changes in activity patterns can be gleaned from the various recommendations made for age-appropriate play equipment. Preschool children are generally expected to enjoy activity panels, small swings & slides and playhouses. Older children are expected to explore more adventurous activities including larger swings and slides, climbers and horizontal ladders. Whether children’s preferences and choices the adult-imposed structure is, as yet, unknown.

Reasons for separating playground equipment and play activities by age include:

- Younger children are less physically capable then older ones.
- Play styles naturally change as children pass through the “independent”, “parallel” and “social” play stages of development.
- Younger children have smaller grips and need rails rungs and handles with smaller radii.
- Older children have higher centers of mass and hence higher guard rail requirements.

Further research is required to document the nature, variety and frequency of physical activity patterns in children using playgrounds. Such information would provide a baseline for assessments of injury risk and also offer knowledge that could be applied to the development of play equipment, footwear and other products.

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Playground Equipment Related Deaths

The primary causes of playground equipment-related death are hanging, falls and equipment failure

The US Consumer Product Safety Commission (CPSC) has files on 147 playground equipment-related deaths reported between January 1990 and August 2000\textsuperscript{11}.

- 79\% of the victims were less than 10 years old. The age of victims generally reflects the popularity of playground equipment among children between the ages of 2 and 9.
- Of the 147 reported deaths, 90 are known to have occurred on playground equipment installed in homes rather than in public playgrounds.
- Younger children were more frequently victims in home settings; older children were more likely to be killed in accidents at public facilities.

**Causes of Death**

1. Hanging
   Eighty-two of the 147 reported deaths were due to hanging, caused by entanglement with materials tied to the equipment or around the child’s neck. Examples include ropes, jump-ropes, shoe laces, leashes and drawstrings on clothing.

2. Falls
   Thirty-one of the reported deaths were attributed to falls, most (3/4) of which involved catastrophic head injury. The CPSC’s data included fall-related deaths from only a few states for most years of the survey. Therefore, the number of fatal falls and the total number of fatalities reported should be considered minimum values.

3. Equipment Failure
   Equipment tipping over or collapsing was involved in another 24 deaths.

4. Other causes of death
   - Entrapment (head or neck becoming stuck in equipment)
   - Impact with equipment.

\textsuperscript{11} Tinsworth, D.K., McDonald, J.E. Special Study: Injuries and deaths associated with children’s playground equipment. US Consumer Product Safety Commission, April 2001
Playground Equipment Related Injuries

Interpretation of Injury Statistics

Injury statistics must be interpreted carefully, giving consideration to the kind of data collected and the manner in which it was collected and presented. Care is especially important when comparing the results of different studies, since different definitions of “injury” and different statistical reporting techniques may make comparison misleading.

Some definitions:

- **Exposure**: A baseline for measuring risk, including an accounting of the population exposed to injury. For example, we might define an exposure as one child visiting one playground.

- **Injury Rate**: The number of injuries occurring over a period of time, without reference to exposures.

- **Injury Risk**: Injury rates relative to an exposure baseline. For example, “One injury per 1000 exposures”

- **Relative Risk**: A ratio comparing two injury risks. For example, if the injury risk is 0.6 per thousand exposures on the average playground and 1.2 per thousand exposures on playground A then playground A has a relative risk of 2; meaning that injuries are twice as likely to occur on playground B.

Measurements of Injury Risk and Relative Risk provide the most useful information. However, most playground injury statistics do not have exposure baselines, because of the difficulty and expense of collecting exposure information. Such statistics are valuable nonetheless, since they show the relative frequencies of different injuries and can also identify sources of risk, if not their relative importance.

**Injury Criteria**

Injury statistics must also be interpreted based on the criteria used to define an injury. For example, the CPSC’s nationwide surveys of playground equipment-related injuries use emergency room visits as the criterion for recording an injury. Minor injuries treated in Doctor’s offices and those not requiring medical attention are therefore not included in these statistics.
Injury Rates: CPSC statistics

During daylight hours in the USA, a playground equipment–related injury requiring emergency room treatment occurs every 1.3 minutes on average.

The CPSC tracks consumer product–related injuries in the National Electronic Injury Surveillance System (NEISS) database. Their most recent survey playground equipment–related injuries is based on a sample of 100 hospital emergency rooms located around the USA, and documents injuries during 1999. During that year:

- An estimated 205,850 playground equipment related injuries were treated at hospital emergency rooms.
  - One emergency room visit every 1.3 minutes during daylight hours
  - 7.5 injuries per 10,000 children in the US.
- Children aged 5-14 were at greatest risk
  - 4 years old and younger: 29.1 injuries per 10,000 children
  - 5-14 years: 34.8 injuries per 10,000 children
  - 15 years and older: 0.6 injuries per 10,000 children
- Most injuries occurred on playground equipment in public schools
  - 34% of injuries occurred on equipment in public schools
  - 23% in public parks
  - 18% in other public facilities
  - 23% of injuries occurred on equipment intended for home use
  - 1% occurred on homemade equipment
- 26% of injurious incidents in public facilities involved other children

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14 The CPSC statistics document injury rates but not injury risk or relative risk.
Injury Rates: Other Statistics

Playground injuries account for 61-74% of all injuries occurring in school

There have been numerous studies of playground injuries published during the last 12 years. Because of differences in data collection methods, it is not possible to combine the different reports. Highlights include:

- Playground equipment is the leading cause of injuries to children in school and childcare environments\textsuperscript{15}.

- Among children under the age of 14, 23\% are injured accidentally every year incurring nominal costs of $10 billion annually. Of these, 19\% are injured at school and 10\% are injured in sport or recreation\textsuperscript{16}. Playground injuries account for only about 4\% of the total but these injuries are 1.6 times more likely to be rated “severe” than those caused by other activities\textsuperscript{17}.

- Playgrounds rank fourth among sources of sports and recreation injuries, accounting for 13\% of the total injuries in children aged 5-9 \textsuperscript{18}.

- Studies of K-6 students from Utah, Boulder, Colorado and San Francisco found that playground injuries accounted for 61\% - 74\% of all school injuries\textsuperscript{19,20,21}.

- Estimates of Injury Risk:
  1.5 injuries per 100,000 student hours in daycare centers\textsuperscript{22}
  8.9 playground equipment-related injuries per 1000 student years\textsuperscript{7}.

\textsuperscript{15} American Academy of Orthopedic Surgeons, Playground Safety Fact Sheet: http://orthoinfo.aaos.org/
\textsuperscript{22} Briss et al (1994)
**Types of Injury**

The table below summarizes recent surveys of the types of injury sustained in playground accidents.

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Sample Size</th>
<th>Concussion or Head Injury</th>
<th>Arm or Leg Fracture</th>
<th>Cuts, bruise or scrape</th>
<th>Sprain or Strain</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macarthur</td>
<td>1999</td>
<td>126</td>
<td>4.8%</td>
<td>47.6%</td>
<td>43.6%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Mayr</td>
<td>1995</td>
<td>5.5%</td>
<td>5.5%</td>
<td>40.8%</td>
<td>37%</td>
<td>13%</td>
<td>3.7%</td>
</tr>
<tr>
<td>Lillis</td>
<td>1997</td>
<td>289</td>
<td>3%</td>
<td>28%</td>
<td>43%</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Waltzman</td>
<td>1999</td>
<td>204</td>
<td>5%</td>
<td>61%</td>
<td>18%</td>
<td>8%</td>
<td>6%</td>
</tr>
<tr>
<td>Pickett</td>
<td>1996</td>
<td>120</td>
<td>2.7%</td>
<td>20%</td>
<td>65%</td>
<td>3.3%</td>
<td>11.7%</td>
</tr>
<tr>
<td>Chalmers</td>
<td>1996</td>
<td>246</td>
<td>3.7%</td>
<td>26.4%</td>
<td>44.3%</td>
<td>7.7%</td>
<td>18%</td>
</tr>
<tr>
<td>Mack</td>
<td>1997</td>
<td>1868</td>
<td>12.4%</td>
<td>20.5%</td>
<td>53.2%</td>
<td>11%</td>
<td>13.9%</td>
</tr>
<tr>
<td>Laforest</td>
<td>2000</td>
<td>930</td>
<td>12%</td>
<td>55%</td>
<td>19%</td>
<td>11%</td>
<td>4%</td>
</tr>
</tbody>
</table>
Injury Hazards

80% of injuries are the result of falls

The table below summarizes some published reports describing the types of accident involved in playground injuries. These studies all show a strong trend for most playground-equipment injuries to be caused by falls.

<table>
<thead>
<tr>
<th>First Author</th>
<th>Year</th>
<th>Sample Size</th>
<th>Fall</th>
<th>Collision</th>
<th>Jump</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mayr</td>
<td>1995</td>
<td>103</td>
<td>72.4%</td>
<td>13.9%</td>
<td>5%</td>
<td>8.7%</td>
</tr>
<tr>
<td>Mott</td>
<td>1997</td>
<td>330</td>
<td>65%</td>
<td>21%</td>
<td></td>
<td>14%</td>
</tr>
<tr>
<td>Mowat</td>
<td>1998</td>
<td>45</td>
<td>80%</td>
<td>13.3%</td>
<td></td>
<td>7.7%</td>
</tr>
<tr>
<td>Pickett</td>
<td>1996</td>
<td>120</td>
<td>76.7%</td>
<td>11.7%</td>
<td></td>
<td>11.6%</td>
</tr>
</tbody>
</table>

- The CPSC\(^1\) study reported that 79% of injuries on public playground equipment and 81% of the injuries on home equipment were related to falls. Most injuries (68%) occurred during falls to the surface beneath the equipment, but some (10%) were the result of falling on to other parts of the play structure.

- Equipment height correlates significantly with severity of injury from falls. Younger children (<5 years) are more often injured on slides (40% v. 26%) while older children are more often hurt on climbing apparatus (47% v. 29%)\(^2\).

- Impacts with stationary or moving equipment accounted for between 8 and 17% of injuries described in various report.

Other Hazards
- Contaminants (broken glass, etc)
- Loose-fill material used as a projectile
- Sharp edges and pinch points
- Traffic on adjacent streets
- Metal fencing

Apparatus Involved
- Climbing apparatus, slides and swings are associated with more frequent and more severe injuries than other play equipment, accounting for 0% or more of the injuries reported in several studies.

- Equipment height correlates significantly with severity of injury from falls.

- Younger children (<5 years) are more often injured on slides (40% v. 26%) while older children are more often hurt on climbing apparatus (47% v. 29%)\(^2\).


Related Risk Factors

While falls and other impacts are the predominant mechanism of playground injury, there are underlying infrastructural and social factors than contribute to the injury rate. These include:

1. Lack of Supervision
   Many of the deaths that have occurred in the past 10 years could have been prevented if children were adequately supervised. Many deaths occur on home playground equipment where the expectation of safety is high, perhaps leading to a reduced level of supervision. NPPS estimates that inadequate supervision is a factor in 40% of playground injuries.

2. Inadequate Surfacing
   CPSC guidelines and ASTM standards set specific criteria for the performance of the surfacing used under playground equipment. The CPSC and other advisory groups also provide guidance as to how these surfaces should be installed and maintained. Compliance with standards is inconsistent, however. The National Program for Playground Safety estimates that approximately 80% of playground installations have inadequate surfacing.

3. Play Equipment Design
   Most new, commercially available, play equipment is designed with safety in mind. High platforms are enclosed and entrapment hazards are minimised, for example. Older equipment is still in use and often fails to meet current safety standards and may be positioned in ways that create conflict between one activity and another.

4. Lack of Maintenance
   Ideally, wood chip surfaces should be maintained on a weekly basis and equipment should be inspected for developing hazards on a regular basis. Maintenance programs are expensive, however. With many school districts and parks departments suffering tight budget constraints, the need for maintenance and safety inspections is frequently forgotten.

5. Mixed Use Facilities
   Many play facilities do not distinguish between activities intended for pre-school children and those for older children. According to NPSS, only 41% of playgrounds have separate age-appropriate areas. Smaller children are less agile, less strong and have a smaller grip. They need equipment that is lower in height and climbing structures components with smaller radii for better grasping with small hands.
Playground Safety Guidelines

The CPSC\textsuperscript{25}, NPPS\textsuperscript{26} and other organizations publish playground safety guidelines that seek to address both the direct and indirect causes of playground injuries. While readers are invited to refer to the original publications for detailed information, the following summarizes the important features of a safer playground environment:

**Reducing risk of injury from falls and impacts**
- Shock attenuating surfacing beneath playground equipment should conform to ASTM Standard F1292 and extend at least six feet from the apparatus.
- Platforms should have guardrails or protective barriers.
- Equipment should have drainage holes to reduce wet slip.
- Equipment should be spaced in a way that minimizes the potential for impact with other children.

**Reducing entrapment hazards**
- Openings and gaps in play equipment are either smaller than 3½” or greater than 9” so that either a child’s head cannot get in the gap, or it can easily get out.

**Reducing Strangulation Risk**
- Protrusions and V-shaped openings where clothing or drawstrings could get caught should be eliminated.
- Mechanisms where fingers or clothes could get caught should be enclosed.

**Reducing Other Hazards**
- Equipment should meet certain safety guidelines for design, materials, stability, etc.
- Adequate fencing to prevent conflict with traffic
- Regular maintenance and inspection of both of equipment and surfacing
- Regular removal of trash and debris, which frequently contain contaminants and hazardous materials (broken glass, bottle caps, animal excrement)

**Reducing Other Contributing Factors**
- Playground should be designed with age-appropriate equipment and with separate areas for different age groups
- Children, especially young ones, should be supervised during playground activities.
- Appropriate signage should indicate age-appropriate play areas and warn of potential hazards


\textsuperscript{26} National Program for Playground Safety (1996) National action plan for the prevention of playground injuries. The University of Northern Iowa, Cedar Falls, Iowa
Shock Attenuating Surfacing

Since the majority of playground injuries result from falls to the surface, considerable effort has been devoted in recent years to the study, development and promotion of surfaces with appropriate shock attenuation properties.

The trend towards safer, shock attenuating surfaces began in 1975 when the CPSC published its first hazard analysis and safety guidelines for playgrounds. Subsequently, woodchips, gravel, rubber and other “soft” materials began to replace harder surfacing materials like hard packed earth, grass and sand. Compliance with the guidelines has not been enforced, however. For example, a 1994 study showed that only 15.4% of public playgrounds in Kingston, Ontario, Canada complied with national standards. Similar findings have been reported in Atlanta, and Montreal. In 1993, a random sample of 25% of Boston’s playgrounds didn’t contain a single impact-absorbing surface.

Standards

Shock Attenuation

The current CPSC guidelines and ASTM standards for shock attenuation of playground surfacing were developed in an effort to provide a safe and attainable degree of impact attenuation. The primary goal of the surface shock attenuation standard is to prevent life threatening head injuries. Fractures, lacerations and abrasions are more common, but potential consequences of head injury are more severe.

The surfacing shock attenuation standard is based on an impact test using an instrumented headform. The headform is dropped on to the surface from a known height. The peak shock of impact \( g_{\text{max}} \) and a Head Injury Criterion (HIC) measure that considers both the magnitude and the duration of the impact shock are calculated.

The performance of a surface is rated in terms of its “critical height”, defined as the fall height from which certain impact criteria are not exceeded. Specifically, the standard for critical height is defined as the maximum height from which an instrumented headform yields \( g_{\text{max}} < 200 \) and \( \text{HIC}<1000 \) upon impact and temperatures of 0, 70 and 120 °F.

Accessibility

Since 2000, The Americans with Disabilities Act has required playground surfaces to be wheelchair accessible, too. The ASTM standard test method for accessibility employs an instrumented wheelchair. From a stationary start, a 165 lb chair occupant uses four

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propulsion strokes to cover a distance of about 6-7 feet within a 7 second period. A surface passes the test if push-rim torque values do not fall below –3.69 ft 3 lbf (–5.0 Nm) (reverse torque); if one or more wheels do not slip creating torque values above 7.38 ft 3 lbf (10 Nm) with no forward movement of the chair; and there is no torque or decreasing torque on the push-rim at the end of the trial. Access is required to at least one of each type of play equipment. ASTM F1487\textsuperscript{31} defines in more detail the type of play structures and equipment that are acceptable.

**Types of Shock Attenuating Surface**

**Loose-fill surfaces**

Loose-fill surfaces consist of particulate materials such as wood chips, engineered wood fiber, sand, or pea gravel distributed underneath playground equipment at a depth that allows an impact to be absorbed through displacement of the particles or through compression of the air spaces between particles.

Although initially inexpensive to install, regular maintenance is essential for continued impact attenuation performance. Other drawbacks of loose fill surfaces include susceptibility to weather conditions, the potential for injury from splintering, ingestion, or throwing of material, contamination (dirt, glass, animal feces and trash), and decomposition over time. Frequently, loose-fill materials are not maintained at an adequate depth either because of inappropriate installation specifications, or because the surface is not well maintained. Finding a loose –fill material that is both shock attenuating and wheelchair accessible can also be a challenge.

The table below shows approximate critical fall heights for different kinds of loose-fill surfacing materials\textsuperscript{32,33}.

<table>
<thead>
<tr>
<th>Depth and compression</th>
<th>Gravel</th>
<th>Sand</th>
<th>Wood Chips</th>
<th>Wood Fiber</th>
<th>Rubber</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Uncompressed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3&quot;</td>
<td>3’</td>
<td>6’</td>
<td>4’</td>
<td>5’</td>
<td>4’</td>
</tr>
<tr>
<td>6&quot;</td>
<td>5’</td>
<td>10’</td>
<td>8’</td>
<td>8’</td>
<td>12’</td>
</tr>
<tr>
<td>9&quot;</td>
<td>5’</td>
<td>10’</td>
<td>10’</td>
<td>10’</td>
<td>12’</td>
</tr>
<tr>
<td>12”</td>
<td>6’</td>
<td>12’</td>
<td>12’</td>
<td>12’</td>
<td>12’</td>
</tr>
<tr>
<td><strong>Compressed</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3”</td>
<td>4’</td>
<td>6’</td>
<td>4’</td>
<td>4’</td>
<td>4’</td>
</tr>
<tr>
<td>6”</td>
<td>4’</td>
<td>8’</td>
<td>6’</td>
<td>7’</td>
<td>12’</td>
</tr>
<tr>
<td>9”</td>
<td>5’</td>
<td>10’</td>
<td>8’</td>
<td>9’</td>
<td>12’</td>
</tr>
<tr>
<td>12”</td>
<td>6’</td>
<td>11’</td>
<td>12’</td>
<td>12’</td>
<td>12’</td>
</tr>
</tbody>
</table>


The ASTM test method does not take into account the possible of freezing wet surfacing materials. Freezing decreases the impact attenuation of wood products, sand, gravel, and some kinds of rubber matting, making these surfaces unsafe for falls from higher than 5 feet under freezing conditions\textsuperscript{34}.

**Unitary surfaces**

Unitary surfaces are continuous, monolithic surfaces, usually made of rubber composite materials. A typical installation has a cushioning layer of shredded or granular recycled rubber loosely bound with a polyurethane binder. A top layer of polyurethane bound EPDM rubber provides a durable, accessible wear course. Although expensive to install, unitary surfaces require minimal maintenance and typical installations easily meet accessibility criteria. They must be relatively thick (i.e. expensive) to meet critical fall height specifications in excess of eight feet.

In contrast to loose-fill materials, the cost of a unitary surface installation is more heavily influenced by the cost of materials rather than labor costs. Cost cutting in specifications or during installation can result in inconsistent material depths, inconsistent performance and, in some case, exposed or thinly covered concrete footings.

The critical fall height of a unitary, troweled in place rubber composite surface is approximately 2 feet per inch of surface depth.

**Availability of Shock Attenuating Surfaces**

A 1998 of study 1353 U.S. playgrounds found that 75% (992) had an “impact absorbing” surface, however 72% of these (721) lacked enough depth of material to meet critical fall height criteria. 20% of the playgrounds studied had exposed concrete footings\textsuperscript{35}. A similar 1998 study by The U.S. Public Interest Research Group (US PIRG) and the Consumer Federation of America found that 87% of 70 playgrounds studied did not have adequate protective surfacing\textsuperscript{36}. Eighty percent of playgrounds with a loose-fill surface had a depth of less than 6 inches (i.e. had a critical fall height of six feet or less).

**Effect on Shock Attenuating Surfaces on Injury Risk**

Not surprisingly, studies of fall and injury patterns have found that the combination of fall height and surface shock attenuation influence the relative risk of injury.


A New Zealand study\textsuperscript{37} found

- Falls from heights greater than 5 feet were 4 times more likely to cause an injury than those from under 5 feet.
- Falls from 6’6” were 10.6 times more likely to result in an injury.
- Non impact-absorbing (NIA) surfaces presented a 2.3 times greater risk of injury than impact-absorbing (IA) surfaces.
- Inadequately maintained loose-fill surfaces created a 2.1 times greater injury risk.

In other reports:

- Playgrounds not conforming to CPSC guidelines had a 21 times greater risk of injury than conforming playgrounds \textsuperscript{38}.
- The relative risk of injury on rubberized surfaces was half that of bark dust and 5 lower than that of a concrete surface\textsuperscript{39}.
- The rate of severe injury was six times greater on asphalt surfacing than on sand\textsuperscript{40}.
- The risk of serious head injury was found to be 1.7 times greater on grass than on sand\textsuperscript{41}.
- Unsuitable surfaces increase the risk of severe head injury. Depending on the fall height, between 79\% and 100\% of severe head injuries involve unsuitable surfaces\textsuperscript{42}. A fall from less than one foot onto an inappropriately hard surface can cause a severe head injury.


\textsuperscript{40} Sosin et al (1993)


Trends in Playground Safety

Public Awareness

- Active promotion by CPSC, NPPS, IPEMA and others is increasing public awareness of playground safety issues. Consequently, the playground environment is evolving, as are the related political and business issues.

- There are emerging national and local programs aimed at reduce playground injuries. Strategies include promotion of safer playground installations and social interventions such as increased inspection and maintenance programs, signage promoting adult supervision and community clean-up efforts. Some of these interventions have been shown to reduce the occurrence of playground injuries\textsuperscript{43,44,45}.

Legislative Activity

- Regulations implementing the Americans with Disabilities Act require certain public playground facilities to meet surface shock attenuation standards as well as accessibility criteria.

- Effective January 1, 2000, California became the first state to pass playground safety regulations into law. All California public playgrounds must be initially inspected by a certified playground safety inspector (CPSI) and comply with CPSC and ASTM guidelines for play areas. Five other states have since implemented similar laws.

- A bill introduced in Congress in 2001 by Congressman Frank Pallone, Jr. of New Jersey would provide federal grants to states with playground safety laws that require conformance to CPSC guidelines.

- The trend toward legally mandated inspection and compliance with safety guidelines is expected to reduce injury rates.

Playground Equipment

- In response to increased safety demands, play structure manufacturers have moved away from traditional equipment designs and towards play structures that minimise fall and entrapment hazards. New structures are more commonly made of more durable plastic rather than wood or metal to reduce maintenance costs.


\textsuperscript{44} Sibert,J.R., Mott,A., Rolfe,K., James,R., Evans,R., Kemp,A., and Dunstan,F.D.: Preventing injuries in public playgrounds through partnership between health services and local authority: community intervention study [see comments]. BMJ, 318:1595, 6-12-1999.

Because of the high cost of wheelchair-accessible, shock-attenuating playground surfaces with high critical heights, newer play structures tend to be lower in height and have enclosed platforms to reduce the occurrence of falls.

The use of playground equipment indoors, especially in childcare facilities, is increasing rapidly. About 10% of reported injuries occur in commercial childcare centers. Research shows that the surface matting used in these facilities is typically inadequate.

Increasingly, manufactured play structures are being installed found homes, sometimes with shock attenuating surfaces.

**Playground Surfacing**

The International Playground Equipment Manufacturers Association (IPEMA) has implemented a program of certification of playground surfacing. To acquire and maintain certification, surfaces must pass independent laboratory tests and ongoing quality control requirements.

The most recent revision of the ASTM F1292 shock attenuation standard includes a “Field Test” procedure that allows surfaces to be tested after installation, not just in the laboratory. The availability of portable test equipment is expected to increase conformance with safety standards.
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Playground Activity and Behaviour


**Playground Injuries, Risk Factors and Interventions**


Ref Type: Report


Ref Type: Report


**Playground Safety**


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| **U.S. Consumer Product Safety Commission**  
Washington, D.C. 20207-0001  
| **ASTM International**  
[F08.63](#) on Playground Surfacing Systems  
James Olshefsky, Staff Manager  
Robert Heath, Subcommittee Chairman  
Fibar Inc  
Phone: (914) 273-8770 x313  
Fax: (914) 273-8659  
[F15.29](#) on Playground Equipment For Public Use  
Katharine Morgan, Staff Manager  
Fran Wallach, Subcommittee Chairman  
Total Recreation Management Services  
Phone: (212) 321-2546  
Fax: (212) 912-1345 |
| **National Safety Council**  
| **National Program for Playground Safety**  
[http://www.uni.edu/playground/home.html](http://www.uni.edu/playground/home.html) |
| **Centers for Disease Control**  
[http://www.cdc.gov/safeusa/playgro/playgrou.htm](http://www.cdc.gov/safeusa/playgro/playgrou.htm)  
[Injury Fact Book](#)  
| **Injury Prevention Web**  
[http://www.safetypolicy.org/pm/playgrnd.htm](http://www.safetypolicy.org/pm/playgrnd.htm) |
| **Consumer Federation of America**  
PLAYING IT SAFE: JUNE 2000  
A nationwide safety survey of public playgrounds in the United States  
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<tr>
<td>International Play Equipment Manufacturers Association</td>
<td>8300 Colesville Rd., Ste. 250 Silver Spring, MD 20910 (800) 395-5550 Tollfree (301) 495-0240 Voice (301) 495-3330 Fax <a href="http://www.ipema.org/home.asp">http://www.ipema.org/home.asp</a></td>
<td><a href="http://www.ipema.org/home.asp">http://www.ipema.org/home.asp</a></td>
<td>IPAUSA: &quot;The child shall have full opportunity for play and recreation which should be directed to the same purposes as education; society and the public authorities shall endeavor to promote the enjoyment of this right;&quot; <a href="http://www.ipausa.org/links.htm">http://www.ipausa.org/links.htm</a></td>
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[http://www.access-board.gov/play/faqs.htm](http://www.access-board.gov/play/faqs.htm)
| ORPA | [http://www.orpa.org/NRPA.htm](http://www.orpa.org/NRPA.htm) | ORPA: Local organization that provides National Playground Safety Inspector Certification Course (CPSI) |
About BioMechanica

BioMechanica, LLC is an independent sports research and development company based in Portland, Oregon. The company specializes in applying biomechanical research to the development of new and innovative products, particularly in the area of shock attenuating protective equipment. We also offer testing services to the sports equipment and sports surfacing industries.

We have been actively involved in playground safety issues since 1993. Since then we have done extensive research on shock attenuating surfaces and have developed a new kind of playground surface with superior shock attenuation properties. We have been actively involved in the development of ASTM standards and are currently leading an effort by the CPSC, ASTM and others to overhaul playground surface test methods and performance standards.

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