Drowning and Safety

Entrapment accidents caused by drainage systems in swimming pools.

A statistical study of accident victims and unsafe environments found in field research.

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Introduction to entrapment in swimming pools.
Types of accidents and their causes.
Statistical analysis of entrapment accidents.
Methods of field study.
Results of field study.
Conclusion and discussion.
Introduction to entrapment

- Water is removed from pools for quality control or to feed water slides and attractions.

- Two types of drainage systems: drainage intakes and overflow gutters.

- The use of drainage intakes may cause an increased hazard potential for swimmers.

- A swimmer close to a drainage intake can be exposed to high negative gauge pressure or get trapped on the covering grille of a drainage intake.

- Annually dozens of severe and fatal accidents have been reported in Europe, Asia, North America and South America.
Different types of accidents

Body entrapment by suction

- Vacuum builds up
Different types of accidents

Hair entrapment

flow disturbances vortices
Different types of accidents

Mechanical entrapment

clothing / jewellery stuck on broken grille
Main causes of injuries and drowning

• Suction entrapment occurs when a swimmer blocking the drain is exposed to a high negative gauge pressure.

• Hair entrapment is related to high water velocities through the intake grille and occurs when:
  ▪ hair is sucked into the grille and gets entangled.
  ▪ the required force to pull the hair from the grille is too high.

• Mechanical entrapment occurs when clothing, jewelry or small limbs get stuck on the grille of the drainage intake.
Method of statistical analysis

• Statistical information about accident victims was collected from news articles and accident reports on the internet. For some accidents detailed information was obtained from relatives of victims.

• The search was conducted using keywords related to swimming pool entrapment in 22 different languages.

• Swimming pool entrapment accidents were found in 36 different countries.

• The results were categorized by the type of injury, age group and setting over the last two time periods of 5 years.
Statistics on the type of accident

2004 - 2009: 96 accidents

- Hair: 11
- Suction & limb: 65
- Mechanical: 1
- Unknown: 19

2010 - 2015: 110 accidents

- Hair: 18
- Suction & limb: 85
- Mechanical: 5
- Unknown: 2
Statistics on the type of injury

2004 - 2009: 96 accidents
- Fatality: 37
- Injured: 57
- No injury: 0
- Unknown: 2

2010 - 2015: 110 accidents
- Fatality: 40
- Injured: 65
- No injury: 2
- Unknown: 3
Statistics on the age group of victims

<table>
<thead>
<tr>
<th>Age Group</th>
<th>2004 - 2015: 206 accidents</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-6 years</td>
<td>42</td>
</tr>
<tr>
<td>7-11 years</td>
<td>65</td>
</tr>
<tr>
<td>12-16 years</td>
<td>39</td>
</tr>
<tr>
<td>17-80 years</td>
<td>22</td>
</tr>
<tr>
<td>Unknown</td>
<td>38</td>
</tr>
</tbody>
</table>

North America: 41 | 29
Europe: 32 | 47
Asia: 7 | 11
Africa: 1 | 3
South America: 13 | 20
Discussion of the statistical analysis

• Suction entrapment is the most common type of entrapment in pools.

• Victims are most often children, especially in the age group of 7-11 years old.
  ▪ Children learn by exploring and playing in the swimming pool.

• In the last 5 years more accidents have been reported in countries in Europe and South America.

• Accidents in North America start to decline after the VGB Pool and Spa Safety Act was introduced in the United States in December of 2008.

• Incidents and near-accidents in which the victim sustained no or only minor injuries are rarely reported.

• The number of entrapment incidents are very likely to be higher than the number of accidents that are represented in the statistical analysis.
Method of field study

Swimming pools at popular holiday destinations were selected at random for an undercover investigation.
Location: Hotels and Aqua parks in Spain (Canary and Balearic Islands) , Turkey and Egypt.

Direct observation of:
• The pools environment.
• The way into the pool (incl. stairways and disabled lifts).
• Inlet nozzles and the tiles or foil in the pool’s wall and floor.
• Cleaning and drainage intakes.
• Pool lighting.
• Separation between swimming and non-swimming area’s.

Measurement of:
• Water velocity at intakes with an anemometer.
• Hair test (conform European Standard EN 13451 - part 3)
Results of direct observation

In 84 out of 100 cases:
Technical defects were found in the pool’s environment.

In 32 out of 100 cases:
Pools had unsecured stepladders into the water.

In 96 out of 100 cases:
Pools had broken or removable inlet nozzles.
In **89** out of 100 cases:

Pools had cleaning intakes that were not secured with the required covering cap.

In **36** out of 100 cases:

Pools have flaws in the way lighting is mounted and how lighting is designed.

In **22** out of 100 cases:

Pools have an unsafe transitions from non-swimmer to swimmer areas.
In **39** out of 100 cases:

Water velocities at drainage intakes exceeded the permitted 0.5 m/s considerably.

In **22** out of 100 cases:

Pools have constructions that are not allowed and can endanger the swimmers.
Results of measurements

In 39 out of 100 cases:

Water velocities at drainage intakes exceeded the permitted 0.5 m/s considerably.

In 22 out of 100 cases:

Pools have constructions that are not allowed and can endanger the swimmers.
Conclusion and discussion

• In every swimming pool at least one hazardous circumstance was found that could cause an injury or an increased potential for drowning.

• None of the 100 investigated swimming pools would pass a sufficient safety inspection in accordance with European Standard 13451.

• 69 pools were rated as being in a poor condition and 31 were condemned to be dangerous and life-threatening.

• A detailed assessment of drainage intakes, including hair tests and the measurement of water velocities and negative gauge pressures, is urgently required.