FIXED-SITE AMUSEMENT RIDE INJURY SURVEY FOR NORTH AMERICA, 2016 UPDATE

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Preface

This report presents the results of work done by the National Safety Council (NSC), Research and Statistical Services Group, under contract to the International Association of Amusement Parks and Attractions. It includes estimates by the Council for calendar years 2003 through 2016. The Council's work is an extension of, but independent of, the estimates made for 2001-2002 by Heiden Associates, published in the June/July 2003 issue of *Injury Insights* (Heiden & McGonegal, 2003).

FIXED-SITE AMUSEMENT RIDE INJURY SURVEY FOR NORTH AMERICA, 2016 UPDATE

Since 2001 the International Association of Amusement Parks and Attractions (IAAPA) has sponsored an annual survey to collect and analyze ride, attendance, and patron injury data from facilities that operate fixed-site amusement rides. The IAAPA survey was originally undertaken to gain perspective on fixed-site amusement ride injuries in the United States. For the 2016 data year, IAAPA members in Canada were also asked to complete the ride injury survey. Because of the relatively small number of amusement facilities with fixed-site rides in Canada and their high percentage of IAAPA membership, this change effectively expands the coverage of the data collection from the U.S. to all of North America. The surveys include amusement and theme parks, tourist attractions, and family entertainment centers. The results of these surveys are presented below.

A total of 411 U.S and Canadian fixed-site amusement facilities were invited to participate in the 2016 survey of patron injuries. This total was essentially unchanged from the previous year and was the result of a detailed review of the IAAPA membership roster and market research activities conducted by IAAPA that revealed a number of parks had closed or no longer operated fixed-site rides which was offset by the addition of the Canadian facilities. All facilities received an initial survey packet and a follow-up postcard via mail, while non-respondents received an additional follow-up postcard and contact via email. In addition, IAAPA member facilities also received follow-up calls from IAAPA staff or board members urging participation. Facilities were asked to report attendance and ridership as well as the number of patron injuries. This survey process resulted in a total of 184 parks providing attendance-based data and 175 parks providing ridership-based data. Of these, 141 parks provided both attendance and ridership data. Compared to 2015, participation increased 15% among parks providing attendance data and 14% among parks providing ridership data (see "Survey Response" and "2003-2015 Methodology" below for more details). Parks participating in the 2016 study represent approximately 69% of total North American estimated attendance and 78% of the total estimated rides taken.

Separate attendance-based and ridership-based analyses were performed. Not all facilities were able to report both attendance and ridership and therefore there were differences in the selection of facilities used in each analysis. Table 1 on the next page presents the attendance-based estimates of ride related injuries for all U.S. parks compared to ridership-based estimates of ride related injuries for the period 2003-2016. The difference between the two injury estimates has varied from as little as four in 2014 to as much as 355 in 2007. In 2016, the attendance-based injury estimate of 1,197 was 56 injuries less than the ridership-based estimate of 1,253 injuries.

Table 1. Attendance-Based vs. Ridership-Based Injury Estimates, 2003-2016

Year	Attendance-Based		Ridership-Based		Difference between attendance-based and ridership-based injury count
	Estimated Annual Number of Ride-Related Injuries	Injuries per Million Attendance	Estimated Annual Number of Ride-Related Injuries	Injuries per Million Patron-Rides	
2003	2,044	7.0	1,954	1.0	+90
2004	1,637	5.2	1,648	0.9	-11
2005	1,783	5.2	1,713	0.9	+70
2006	1,797	6.6	1,546	0.9	+251
2007	1,664	4.6	1,309	0.7	+355
2008	1,523	4.7	1,343	0.8	+180
2009	1,181	4.4	1,086	0.6	+95
2010	1,299	4.4	1,207	0.7	+92
2011	1,204	4.3	1,415	0.8	-211
2012	1,424	4.6	1,347	0.9	+77
2013	1,356	4.7	1,221	0.9	+135
2014	1,150	3.8	1,146	0.7	+4
2015	1,502	4.8	1,508	0.8	-6
2016*	1,197	3.9	1,253	0.8	-56

Source: National Safety Council estimates based on annual fixed-site amusement ride injury surveys.
*Beginning in 2016, the ride injury survey was expanded to include both U.S. and Canadian facilities.

Confidence intervals were developed for the estimated 2016 fixed-site amusement ride injury rates for parks in the United States and are presented in Table 2 on the next page. Confidence intervals were first developed separately for each park type. Composite confidence intervals for the attendance and ridership rates were then estimated through weighted averages. The confidence intervals along with exposure estimates were then used to estimate the likely range of injuries experienced in 2016. The confidence intervals provided below assume a Poisson distribution of the data instead of the normal bell-shaped curve often used in statistics. The Poisson distribution is used in the medical and epidemiological fields to model events, particularly uncommon events like injuries and illnesses. This distribution is not symmetric about its mean and so the associated confidence intervals are not symmetric (the upper limit is slightly farther from the estimate than is the lower limit). Comparing previous injury and rate estimates to the 2016 confidence intervals shows that the 2016 attendance-based injury count estimate is consistent with 2014, 2013, 2011, 2010, and 2009 estimates. The 2016 attendance-based rate estimate is consistent with prior years estimates for 2014, 2011, 2010, and 2009. The 2016 ridership-based injury count estimate is consistent with previous estimates for 2014, 2013, 2012, 2010, 2008, and 2007. Finally, the 2016 ridership-based rate estimate is consistent with all previous estimates except for 2009 and 2003.

Table 2. 95% Confidence Intervals of Injury Rates and Counts Assuming a Poisson Distribution

	Attendance Based Estimates		Ridership Based Estimates	
	Injuries per Million Attendance	Injury Count	Injuries per Million Attendance	Injury Count
Upper Confidence Limit	4.4	1,385	0.9	1,447
Estimated Value	3.9	1,197	0.8	1,253
Lower Confidence Limit	3.5	1,037	0.7	1,088

Compared to 2015, the number of patron-injuries in 2016 decreased. Attendance-based estimates show a 20% decrease while ridership-based estimates show a 17% decrease. As a result of the increased attendance levels observed in 2016, the attendance-based injury rate decreased 19% to 3.9 injuries per million attendees. However, with ridership showing a slight decline in 2016, the ridership-based rate was unchanged at 0.8 injuries per million riders. Figures 1 and 2 below illustrate the longer term injury and injury rate trends for both the attendance- and ridership-based estimates. As can be seen, both estimate procedures show marked decreases in the number of patron-injuries since 2003. However, ridership-based injury rates have demonstrated less improvement than have attendance-based rates. Attendance-based and ridership-based injury estimates also show the following differences:

Attendance-based:

- The estimated injury total and injury rate were down in 2016 compared to 2015 (1,197 vs. 1,502 injuries and 3.9 vs. 4.8 injuries per million attendees, respectively).
- Compared to 2003, the estimated number of injuries in 2016 was down 41%, while the injury rate per million attendees was down 44%.

Ridership-based:

- The estimated injury total was down 17% in 2016 compared to 2015 (1,253 vs. 1,508 injuries), while the injury rate per million patron-rides was unchanged at 0.8 injuries per million patron-rides.
- Compared to 2003, both the estimated number of injuries and the injury rate per million patron-rides in 2016 were down—by 36% and 20%, respectively.

Figure 1.

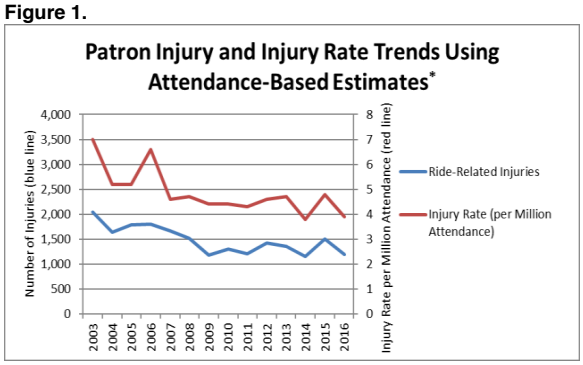
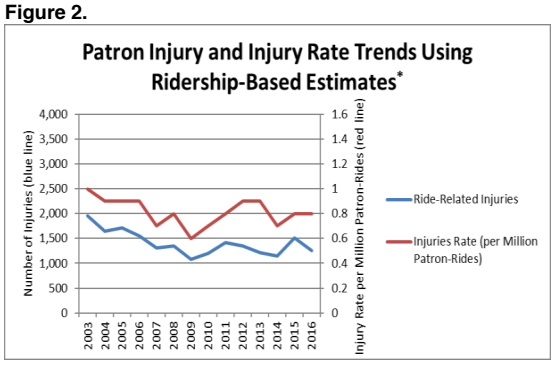


Figure 2.



*In 2016, the survey was expanded to include both U.S. and Canadian facilities.

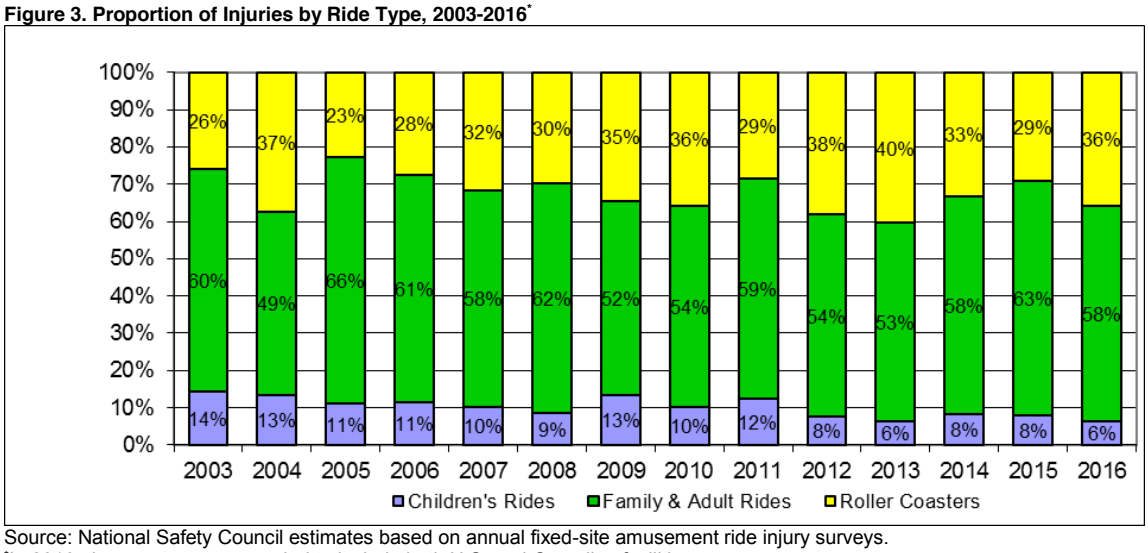
The distributions of injuries by ride type and injury severity for 2016 obtained from the ridership-based estimates were similar to the distributions obtained from the attendance-based for total injuries, serious injuries, and other injuries. The largest portion of injuries for both sets

of estimates took place on family and adult rides, followed by roller coasters and children's rides. However, the portion of injuries by injury severity on children's rides and family and adult rides across all injury categories – Serious, Other, and Total – were higher in the attendance-based analysis compared to the ridership-based analysis. For roller coasters, the proportion of injuries was higher across all injury categories in the ridership-based analysis compared to the attendance-based analysis.

Ridership-based rates are perhaps a more appropriate measure of exposure to risk than attendance-based rates because injuries on rides are the outcome of interest. Parks with similar attendance may have much different ridership numbers because of differences in the number and kinds of amusement rides provided. **The results discussed in the remainder of the report are based on the ridership analysis, which is shown in Table 3 on pages 6-7.**

As shown in Figure 3, about 58% of the injuries in 2016 occurred on family and adult rides compared to 63% in 2015, 58% in 2014, and 53% in 2013. The overall number of injuries on family and adult rides in 2015 was down 24% compared to 2015, decreasing from 952 to 723 or from 63.1 % to 57.7% of injuries. The number of injuries on children's rides decreased from 119 in 2015 to 81 in 2016, with the overall proportion of injuries on children's rides decreasing 1.4% -- from 7.9% to 6.5%. The overall number of injuries on roller coasters increased from 437 in 2015 to 450 in 2016, an increase of 3%. The proportion of injuries on roller coasters also increased from 29.0% of the injuries in 2015 to 35.9% of the injuries in 2016.

Figure 3. Proportion of Injuries by Ride Type, 2003-2016*



Source: National Safety Council estimates based on annual fixed-site amusement ride injury surveys.
*In 2016, the survey was expanded to include both U.S. and Canadian facilities.

The overall injury rate decreased from 0.84 injuries per million patron-rides in 2015 to 0.75 in 2016. The injury rate per million patron-rides in 2016 was 0.9 for roller coasters, 0.7 for family and adult rides, and 0.4 for children's rides.

Total ride injuries are comprised of events involving getting in/out of the ride and those events resulting from ride motion. A secondary analysis was conducted to gain a better understanding of the prevalence of injuries resulting from ride motion events. The 0.9 per million injury rate on roller coasters decreases to 0.8 per million rides when counting only those incidents due to ride motion. The overall 0.7 per million injury rate for family and adult rides decreases to 0.4 per

million rides due to ride motion, and the 0.4 per million injury rate for children's rides decreases to 0.2 per million rides due to ride motion.

About 8.5% of the injuries were reported to be "serious," meaning an injury resulting in immediate admission and hospitalization in excess of 24 hours for purposes other than medical observation. The remaining 91.5% were reportable injuries that were other than serious. The proportion of injuries that were serious in 2016 was up about 54% from the proportion in 2015. The rate of serious injuries per million patron-rides was 0.06 in 2016—an increase of 20% from 2015.

Table 3. Summary of Estimated Fixed-Site Amusement Ride-Related Injuries, 2003-2016 (based on ridership)

		Injuries by Ride Type				Injuries by Severity		
Year	Characteristic	Total	Children's Rides	Family and Adult Rides	Roller Coasters	Total	Serious Injuries	Other Reportable Injuries
2003	Estimated Number of Injuries	1,954	277	1,173	504	1,954	106	1,848
	Percent	100.0%	14.2	60.1	25.8	100.0%	5.4	94.6
	Injuries per Million Patron-rides	1.0	1.2	1.0	1.0	1.0	0.1	1.0
2004	Estimated Number of Injuries	1,648	219	806	613	1,648	132	1,516
	Percent	100.0%	13.3	49.5	37.2	100.0%	8.0	92.0
	Injuries per Million Patron-rides	0.9	1.0	0.8	1.2	0.9	0.1	0.8
2005	Estimated Number of Injuries	1,713	192	1,131	390	1,713	132	1,582
	Percent	100.0%	11.2	66.0	22.8	100.0%	7.7	92.3
	Injuries per Million Patron-rides	0.9	0.8	1.0	0.9	0.9	0.1	0.9
2006	Estimated Number of Injuries	1,546	177	943	426	1,546	135	1,411
	Percent	100.0%	11.4	61.0	27.6	100.0%	8.7	91.3
	Injuries per Million Patron-rides	0.9	0.7	0.9	1.0	0.9	0.1	0.8
2007	Estimated Number of Injuries	1,309	134	759	416	1,309	35	1,274
	Percent	100.0%	10.2	58.0	31.8	100.0%	2.7	97.3
	Injuries per Million Patron-rides	0.7	0.5	0.7	0.9	0.7	0.02	0.7
2008	Estimated Number of Injuries	1,343	117	827	399	1,343	80	1,264
	Percent	100.0%	8.7	61.5	29.7	100.0%	5.9	94.1
	Injuries per Million Patron-rides	0.8	0.6	0.8	1.0	0.8	0.05	0.7
2009	Estimated Number of Injuries	1,086	145	565	375	1,086	65	1,021
	Percent	100.0%	13.4	52.1	34.5	100.0%	6.0	94.0
	Injuries per Million Patron-rides	0.6	0.6	0.5	0.9	0.6	0.04	0.6
2010	Estimated Number of Injuries	1,207	122	652	433	1,207	59	1,148
	Percent	100.0%	10.1	54.0	35.9	100.0%	4.9	95.1
	Injuries per Million Patron-rides	0.7	0.5	0.6	1.0	0.7	0.03	0.7
2011	Estimated Number of Injuries	1,415	175	836	405	1,415	61	1,355
	Percent	100.0%	12.3	59.0	28.6	100.0%	4.3	95.7
	Injuries per Million Patron-rides	0.8	1.0	0.8	1.0	0.8	0.04	0.8

		Injuries by Ride Type				Injuries by Severity		
Year	Characteristic	Total	Children's Rides	Family and Adult Rides	Roller Coasters	Total	Serious Injuries	Other Reportable Injuries
2012	Estimated Number of Injuries	1,347	104	728	515	1,347	91	1,256
	Percent	100.0%	7.7	54.1	38.2	100.0%	6.8	93.2
	Injuries per Million Patron-rides	0.9	0.5	0.8	1.5	0.9	0.06	0.8
2013	Estimated Number of Injuries	1,221	78	649	494	1,221	84	1,137
	Percent	100.0%	6.4	53.1	40.5	100.0%	6.9	93.1
	Injuries per Million Patron-rides	0.9	0.5	0.8	1.5	0.9	0.06	0.8
2014	Estimated Number of Injuries	1,146	94	670	383	1,146	111	1,036
	Percent	100.0%	8.2	58.4	33.4	100.0%	9.6	90.4
	Injuries per Million Patron-rides	0.7	0.4	0.7	1.0	0.7	0.07	0.7
	Getting In/Out	0.3	0.3	0.3	0.2	0.3	0.01	0.2
	Ride Motion	0.5	0.1	0.4	0.8	0.5	0.06	0.4
2015	Estimated Number of Injuries	1,508	119	952	437	1,508	82	1,425
	Percent	100.0%	7.9	63.1	29.0	100.0%	5.5	94.5
	Injuries per Million Patron-rides	0.8	0.4	0.9	1.0	0.8	0.05	0.8
	Getting In/Out	0.2	0.2	0.3	0.2	0.2	<0.005	0.3
	Ride Motion	0.6	0.2	0.6	0.8	0.6	0.05	0.5
2016*	Estimated Number of Injuries	1,253	81	723	450	1,253	107	1,146
	Percent	100.0%	6.5	57.7	35.9	100.0%	8.5	91.5
	Injuries per Million Patron-rides	0.8	0.4	0.7	0.9	0.8	0.06	0.7
	Getting In/Out	0.3	0.2	0.3	0.1	0.3	0.01	0.2
	Ride Motion	0.5	0.2	0.4	0.8	0.5	0.04	0.5

Source: National Safety Council estimates based on annual fixed-site amusement ride injury surveys.
Note: Totals may not equal sum of parts due to rounding.
*Survey expanded to include both U.S. and Canadian facilities.

Survey Response

Of the 411 eligible facilities with rides in 2016, a total of 218 provided some or all of the data requested (43 provided attendance data only, 34 provided ridership data only, and 141 provided both attendance and ridership data). An additional 10 facilities provided their injury data, but were unable to provide an exposure data and were therefore not included in the analysis. The overall total of participating facilities for 2016 represents a 5% increase from the previous year. The respondents used in the analyses represented about 69.0% of the estimated total annual attendance and 78% of the estimated total rides taken at all facilities.

Table 4 on the following page summarizes the number of facilities whose data were used for the attendance-based and ridership-based estimates from 2004-2016. The 184 facilities used for the attendance-based estimate exceeded the historical high of 160 by 15%, while the 175 facilities used for the ridership-based estimate exceeded the previous high of 154 by 14%. It was impractical to find a single set of facilities that reported all data (attendance, ridership, and injuries) for all years as that would have reduced the reliability of the estimates.

Table 4. Number of facilities included in estimates

Year	Number of facilities used for injury estimates	
	Attendance-based	Ridership-based
2004	124	99
2005	117	90
2006	124	97
2007	125	104
2008	153	134
2009	113	105
2010	104	96
2011	117	100
2012	143	126
2013	160	147
2014	147	137
2015	160	154
2016*	184	175

*Survey expanded to include both U.S. and Canadian facilities.

Attendance and Ridership Estimates

Based on IAAPA membership data as well as on going NSC surveillance, it is estimated that 411 facilities were in operation at the end of 2016 (see Table 5). Total attendance and ridership is estimated by inflating the reported attendance figures by the ratio of the total number of facilities to the number reporting and calculating average rides per guest figures. Using this method, it is estimated that 383.9 million people visited North American facilities with fixed site amusement rides and approximately 1.68 billion rides were taken in 2016. As noted earlier, starting in 2016 the survey was expanded to include both U.S. and Canadian facilities.

Table 5. Estimated Number of Fixed-Site Amusement Parks with Rides, Attendance and Ridership

Year	Estimated Number of Facilities w/Rides in the U.S.	Estimated Annual Attendance (millions)	Estimated Annual Ridership (billions)
2001-2002	459	302.9	---
2003*	403	300.4	1.95
2004	403	300.0	1.81
2005	398	300.4	1.82
2006	395	291.7	1.76
2007	395	292.1	1.78
2008	422	291.2	1.70
2009	398	278.4	1.69
2010	386	290.1	1.70
2011	383	297.4	1.69
2012	373	324.1	1.51
2013	357	315.2	1.38
2014	405	366.9	1.57
2015	413	367.1	1.79

Year	Estimated Number of Facilities w/Rides in the U.S.	Estimated Annual Attendance (millions)	Estimated Annual Ridership (billions)
2016*	411	383.9	1.68

Source: 2001-2002, Heiden & McGonegal (2003). 2003-2016, National Safety Council estimates based on fixed-site amusement ride injury surveys.
*Changes in the estimating method beginning with 2003 affect comparability with the 2001-2002 survey. In 2016, the survey was expanded to include both U.S. and Canadian facilities.

2003-2016 Methodology

The National Safety Council conducted the survey using a master list of amusement/theme parks, family entertainment centers, and tourist attractions thought to have fixed-site rides. The original master list was prepared in consultation with IAAPA and Amusement Industry Consulting, Inc. A revised list of member and nonmember parks was provided this year by IAAPA. Additional parks thought to have rides that were on the previous park list were added to the IAAPA-provided list in order to have the most complete universe of parks. The survey consisted of a notification letter, a package of reporting information mailed one week later, a follow-up postcard mailed one week after the reporting package, and a final follow-up postcard mailed at the end of the response period. Up to three additional follow-up contacts to all non-respondents were conducted via e-mail. After the mailings and electronic follow-up, IAAPA volunteers made follow-up telephone calls and sent e-mails to non-responding IAAPA member facilities. Injury rates based on the reporting facilities were used to estimate national totals. (See also "Survey Response" above.)

2001-2002 Methodology

In 2001 and 2002 IAAPA mailed survey questionnaires to members previously identified as having fixed-site amusement rides. IAAPA retained Heiden Associates, Washington, DC, to analyze the survey results. Using the IAAPA survey results and other data, Heiden Associates estimated the number of U.S. facilities with one or more fixed-site amusement rides and the injury totals and rates.

References

Heiden, E.J., & McGonegal, S. (2003). 2001-2002 fixed-site amusement ride injury survey analysis. *Injury Insights*, June/July 2003.