



# Nonhygienic Behavior, Knowledge, and Attitudes Among Interactive Splash Park Visitors

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**Abstract** Nonhygienic behavior likely contributed to three recreational waterborne illness (RWI) outbreaks at Idaho splash parks. The study described in this article examined the influence of signage and hygiene attendant presence on rates of nonhygienic behavior among children at splash parks and knowledge and attitudes of their adult supervisors. Investigators observed children for nonhygienic behaviors at four Idaho splash parks, two with signage and attendants. Supervisors were surveyed (N = 551) using an eight-item survey. Individually observed children (N = 145) were often seen exposing their buttocks to splash feature water and placing an open mouth to water. The rate of nonhygienic behaviors was not lower at parks with signage or staff. Supervisors reported bathing children before splash park entry infrequently. Signage and hygiene attendants do not adequately limit nonhygienic behaviors at splash parks, and supervisors have insufficient understanding of RWI. These findings have implications for developing splash park regulations and RWI prevention efforts.

## Introduction

Interactive zero-depth splash parks are youth-oriented recreational water attractions with features that spray or pour water on visitors. Splash parks are popular recreational water venues because they are typically free, easily accessible, and often located within municipal parks. They have also been associated with recreational water illness (RWI) outbreaks (Centers for Disease Control and Prevention [CDC], 2000, 2009; Hoebe, Vennema, de Roda Husman, & van Duynhoven, 2004; Jones et al., 2006; Liang et al., 2006; Schaffzin et al., 2006).

Water, often initially supplied by a municipal source, might be treated and recirculated through the splash park, usually passed through a high-flow sand filtration system, chlorinated, and in certain parks, treated with ultraviolet disinfection systems. In the majority of states, splash parks are unregulated and not subject to construction review or routine inspection by public health (Kebabjian, 2003; Schaffzin et al., 2006). Therefore, no consistent requirements for water treatment, educational signage, or supervision at splash parks exist in the majority of states. In contrast with swimming pools,

splash parks operate with a smaller volume of water and consequently have substantially larger bather densities (gallons of water per bather), perhaps increasing the risk for RWI outbreaks (Kebabjian, 2003). Certain RWI outbreaks (e.g., Shiga toxin-producing *E. coli*) that have been associated with splash parks have the potential for causing severe, life-threatening illness, particularly among groups at high risk (i.e., young children) (Castor & Beach, 2004; Gilbert & Blake, 1998).

Nonhygienic behaviors (e.g., exposing buttocks to splash feature water or placing an open mouth to splash park water) likely contributed to three RWI outbreaks in Idaho in 2007 (Carter, unpublished data, 2007 and Jue, unpublished data, 2007) (CDC, 2009). In response, operators of two separate splash parks where RWI outbreaks occurred posted educational signage adjacent to the splash pads advising visitors that diapered children must wear swim diapers and that visitors should not drink the splash park water. Additionally, both of these splash park operators hired a hygiene attendant, either part-time or full-time, to limit nonhygienic behaviors. We identified no published studies reporting the effectiveness of any public health interventions at splash parks or reporting adult supervisor knowledge of splash park-associated RWI.

To assess the effectiveness of selected interventions and to provide baseline information on nonhygienic behavior, knowledge, and attitudes among splash park visitors, we

conducted a behavioral observation study at four Idaho splash parks, two of which had educational signage and hygiene attendants.

## Methods

The research protocol was reviewed by the Idaho Department of Health and Welfare Institutional Review Board Committee and granted an exempt status.

Our study had two primary components: structured observation of the behavior of children visiting splash parks and administration of questionnaires to their adult supervisors. A four-person research team was trained in both observation and interviewing. During each two-hour study session and on a rotating basis, three team members performed disguised observation while a fourth administered questionnaires. Seven two-hour observational sessions were completed at each of the four busiest Idaho splash parks that were located in municipal parks and free for the public. Two splash parks employed hygiene attendants and had signage with messages advising visitors not to drink the splash park water and stating that diapered children must wear swim diapers.

## Behavior Observation

### Participants

Participants were children playing in the splash park during observational sessions.

### Measures

Before each observational session, the splash park was photographed to allow for a cross-sectional count of total number of visitors (adults and children). The number of diapered visitors was determined by observer consensus. Wind speed in miles per hour and ambient temperature in degrees Fahrenheit were recorded before each observational session by using [www.weather.com](http://www.weather.com).

For each session, two 30-minute group observation periods were conducted during which observers independently monitored all children on the splash pad. In one-minute increments, each observer independently noted the presence (one or more occurrences of behavior) or absence of one or more of the following: diapered children on the splash pad, children making contact with buttocks to the water directly flowing from a splash feature or the feature itself,

children putting an open mouth to water, and diaper changing within a three meter radius of the splash pad, a distance thought to be close enough that the water runoff from the splash park or adjacent sprinklers might spread fecal contamination from a nearby surface onto the splash pad.

Individual observations were scheduled for 60 continuous minutes during each session. One child was chosen for observation by observer consensus, with preference given to the youngest-appearing child with the least supervision, which was the population observers believed had the highest likelihood for engaging in nonhygienic behavior. A selected child was observed for a maximum of 15 minutes. If a child left the splash park before completing 15 minutes of observation or when 15 minutes had elapsed, a new child was chosen. Child visitors who previously left the splash park before 15 minutes of observation time were eligible for continued observation upon their return to the splash park, for a maximum of 15 minutes. By observer consensus, we noted for each child the estimated age category (<1 year, 1–3 years, 4–6 years, 7–10 years, 11–17 years), sex, presence of a diaper, and the presence of a swim diaper, if diapered. For every observed child, each observer independently noted in one-minute increments the presence (one or more occurrences of behavior) or absence of the child making contact with buttocks to the water directly flowing from a splash feature or the feature itself, putting an open mouth to water, placing hands down his or her pants, and undergoing a diaper change within a three meter radius of the splash pad. Observers also recorded the frequency of high-risk behaviors performed by each child.

## Questionnaires

Interviewers were trained in survey administration. The interviewer approached splash park visitors who appeared to be at least 18 years old. Informed consent was obtained orally after explanation of the study's purpose and the voluntary, anonymous, and private nature of the survey. Potential participants were then asked if they were at least 18 years old and if they were the supervisor of a child attending the splash park. Respondents who answered yes to both questions received a laminated card that displayed the answer choices in English for the questionnaire items to facilitate administration.

### Participants

Participants, hereafter referred to as *supervisor* or *supervisors*, comprised a convenience sample of persons at least 18 years old who supervised children attending splash parks during the study sessions.

### Measures

To assess supervisor knowledge regarding RWI and prevention practices at splash parks, an eight-item survey was designed. Each question used a five-point Likert scale for possible answers. Four questions assessed supervisor practices (e.g., "How often do you tell your child not to drink the splash fountain water?" and "Do you bathe your child with soap before entering the splash park?") where 5 = every time, and 1 = never. Three items assessed supervisor knowledge of nonhygienic behaviors likely related to the spread of RWI at splash parks (e.g., "Playing in a splash park can cause children to have diarrhea.") where 5 = strongly agree, and 1 = strongly disagree. One question assessed the risk for RWI associated with splash parks.

### Statistical Analysis

To assess interobserver reliability for the observational sessions, we performed a calculation of the kappa statistic for multiple raters (King, 2004). Other data analysis was accomplished by using SAS® Enterprise Guide 3.0.2.414. For group and individual observations, Pearson's Chi-square test was used to evaluate the difference in minutes of behaviors observed between splash parks with educational signage and attendants and parks without signage and attendants. To adjust statistically for differences between nonrandomized groups, we performed a propensity analysis (Rubin, 1997). For each of the 145 children individually observed, we calculated a propensity score for exposure to a splash park with educational signage and hygiene attendants by using logistic regression with the following independent variables: ambient wind speed and air temperature, sex, presence of diaper on the child, age category, and minutes observed. On the basis of the propensity score, each child was assigned to quintiles. We assessed the distribution of the independent variables within each quintile. Using conditional logistic regression and controlling for each quintile (D'Agostino, 1998), we calculated

TABLE 1

Minutes Observed of Nonhygienic Behaviors in Children at Splash Parks\*

Behavior	Number of Minutes Behavior Observed <sup>a</sup> /60 Min. of Observation		p-Value <sup>b</sup>	Kappa
	Splash Parks With Signage and Attendants	Splash Parks Without Signage and Attendants		
Group <sup>c</sup>				
Diapered children on splash pad	52.9	25.9	<.001	0.93
Children exposing buttocks to splash feature water	47.0	11.9	<.001	0.78
Children placing open mouth to splash park water	8.2	11.6	.002	0.62
Diaper change occurring within 3-m of splash pad	0.4	0.1	.2	0.69
Individual <sup>d</sup>				
Child exposing buttocks to splash feature water	14.6	5.6	<.001	0.79
Child placing open mouth to splash park water	4.0	5.7	.09	0.84
Child placing hand down pants	0.0	0.1	.4	0.60
Child undergoing diaper change within 3 m of splash pad <sup>e,f</sup>	0.0	0.0		

\* By Presence of Educational Signage and Hygiene Attendants and Interobserver Agreement (Kappa) for Each Observed Behavior, Idaho, 2008.  
<sup>a</sup> One or more occurrences of behavior for each one-minute increment of observation.  
<sup>b</sup> Pearson's Chi-square test was used to evaluate the data.  
<sup>c</sup> 1,680 min. of observation (840 min. at splash parks with signage and attendants and 840 min. at splash parks without signage and attendants).  
<sup>d</sup> 1,088 min. of observation (638 min. at splash parks with signage and attendants and 450 min. at splash parks without signage and attendants).  
<sup>e</sup> No observations were made of individual children undergoing a diaper change.  
<sup>f</sup> No disagreement among observers.

adjusted odds ratios (aOR), comparing children exposed to signage and attendants with those not exposed to signage and attendants for the behaviors of placing an open mouth to splash park water and exposing their buttocks to splash features or the water flowing from splash features.

Results

Behavior Observation

During June 24–July 6, 2008, we completed 28 two-hour observational sessions (1,680 minutes of group observation and 1,088 minutes of individual observation). The kappa value for each observed behavior in both group and individual observation sessions ranged from 0.60 to 0.93 (Table 1), indicating good to excellent interobserver agreement (Bryington, Palmer, & Watkins, 2004).

Group Observation

The number of visitors at a splash park at the beginning of each session ranged from one to 82 (median = 8.5) persons, and the estimated bather density ranged from 29 to 2,000 (median = 218) gallons of water/visitor. (The bather density for one splash

park could not be estimated because the investigators could not determine the volume of the system.) Diapered children playing in splash parks was the most frequently observed behavior, with a mean of 39.4 min./60 min. of observation, followed by children exposing their buttocks to splash feature water (mean = 29.4 min./60 min. observation) and placing their open mouth to splash park water (mean = 9.9 min./60 min. observation). Diapered children were more likely to be observed at splash parks with signage and attendants (52.9 min./60 min. observation), compared with parks without signage and attendants (25.9 min./60 min. observation; *p*-value < .001) (Table 1). Children were more likely to be observed exposing their buttocks to splash features at splash parks with signage and attendants (47.0 min./60 min. observation), compared with parks without signage and attendants (11.9 min./60 min. observation; *p*-value < .001). Children were less likely to be observed placing their open mouth to splash park water (8.2 min./60 min. observation) at splash parks with signage and attendants, compared with splash parks without signage and attendants (11.6 min./60 min. observation; *p*-value = .002).

Individual Observation

Among the 145 children individually observed, the estimated ages and number of children were <1 year (2 [1%]), 1–3 years (88 [61%]), 4–6 years (40 [28%]), 7–11 years (13 [9%]), and 12–17 years (2 [1%]). Eighty-two (57%) were male and 55 (38%) were diapered, of whom 17 (31%) wore a swim diaper (Table 2). Twenty-one children (38%) wore traditional disposable diapers. Excluding children for whom swim diaper wear was uncertain (*n* = 17), diapered children at splash parks with signage or attendants (*n* = 23) were more likely to be observed wearing swim diapers, compared with splash parks without signage and attendants (*n* = 15; odds ratio [OR] = 6.2; 95% confidence interval [CI]: 1.2–41.9). Thirty-four (23%) children were observed placing an open mouth to splash park water, and 67 (46%) children were observed exposing their buttocks to splash feature water. Per 60 minutes of individual observation, children were most often observed exposing their buttocks to splash feature water (mean = 10.9 min.) or placing an open mouth (mean = 4.7 min.) to splash park water. Children observed at splash parks without signage and attendants exposed their buttocks to splash features more often, com-

TABLE 2

**Study Characteristics, Environmental Factors, Demographics, Participant Characteristics, and Behaviors During Individual Child Observation (N = 145)**

Study Characteristics	Splash Parks With Signage and Attendants (%)	Splash Parks Without Signage and Attendants (%)	OR (95% CI)	p-Value
Minutes of observation completed	638	450		
Mean minutes observation per child	8.5	6.4		.01 <sup>a</sup>
Environmental factors				
Mean ambient temperature (°F)	83.1	86.7		.3 <sup>a</sup>
Mean wind speed (mph)	6.9	7.4		.5 <sup>a</sup>
Children's demographics				
Number of children observed	75	70		
Sex				.7 <sup>b</sup>
Male	41 (55)	41 (59)		
Female	34 (45)	29 (41)		
Estimated age (years)				.053 <sup>b</sup>
<1	2 (3)	0 (0)		
1–3	51 (68)	37 (53)		
4–6	18 (24)	22 (31)		
7–11	4 (5)	9 (13)		
12–17	0 (0)	2 (3)		
Children's characteristics				
Diapered	34 (45)	21 (30)		.06 <sup>b</sup>
Swim-diapered (n = 55)				.046 <sup>b</sup>
Yes	14 (41)	3 (14)		
No	9 (27)	12 (57)		
Unsure	11 (32)	6 (29)		
Children's behaviors				
Putting open mouth to water			1.0 <sup>c</sup> (0.4–2.3)	
Yes	19 (25)	15 (21)		
No	56 (75)	55 (79)		
Placing buttocks to splash feature water			2.6 <sup>c</sup> (1.3–5.3)	
Yes	45 (60)	22 (31)		
No	30 (40)	48 (69)		

<sup>a</sup> Wilcoxon rank-sum test was used to evaluate data.

<sup>b</sup> Pearson Chi-square test was used to evaluate data.

<sup>c</sup> Odds ratios calculated using conditional logistic regression using propensity score quintiles as strata. The following independent variables were used in a logistic regression model to calculate a propensity score for each child: minutes of observation per child, ambient temperature, wind speed, sex, age category, and diapered status.

pared with children at splash parks with signage and attendants (Table 1).

No statistically significant difference was observed in the likelihood of placing an open mouth to splash park water for children exposed to splash parks with signage and attendants (OR = 1.6, 95% CI: 0.4–6.4), compared with splash parks without signage and

attendants. Children placed an open mouth to splash park water less frequently, however, at splash parks with signage and attendants (22.7 occurrences/60 min.), compared with splash parks without signage and attendants (59.2, 90% CI: 5.5–67.6). Nevertheless, the conditional logistic model failed to demonstrate a significant association between expo-

sure to parks with signage and attendants and placing an open mouth to splash park water (aOR = 1.0, 95% CI: 0.4–2.3), but did demonstrate that exposure to parks with signs and attendants was associated with children exposing their buttocks to splash features or the water flowing from splash features (aOR = 2.6, 95% CI, 1.3–5.3).

## Questionnaires

### Behavior

We completed 551 (98%) questionnaires among 564 adult supervisors approached in the splash park; 104 (19%) respondents were males. The survey items had high internal consistency (Cronbach's  $\alpha = 0.99$ ). Results are summarized in Table 3. The majority of supervisors reported bringing children to splash parks during the summer at least 2–3 times per month ( $n = 312$  [57%]), telling children not to drink the splash park water at least sometimes ( $n = 357$  [65%]), and washing the children's hands with soap and water after leaving the splash park at least sometimes ( $n = 441$  [80%]). A minority of supervisors reported telling children not to sit on the top of the splash fountains at least sometimes ( $n = 136$  [25%]) and bathing children they supervise with soap before entering the splash park at least sometimes ( $n = 151$  [27%]). Adult supervisors at splash parks with signage and attendants reported visiting splash parks less often (Pearson's Chi-square  $p$ -value = .03) and washing children's hands with soap and water after leaving the splash park more often ( $p$ -value = .02) than at splash parks without signage and attendants. No statistically significant difference occurred in other behaviors between supervisors at splash parks with signage and attendants, compared with splash parks without signage or attendants.

### Knowledge and Attitudes

Adult supervisors agreed or strongly agreed ( $n = 412$  [75%]) that allowing diapered children to play in splash parks is acceptable and agreed or strongly agreed that splash parks were safer than swimming pools ( $n = 312$  [57%]). Less than half of supervisors agreed or strongly agreed that playing in splash parks can cause children to have diarrhea ( $n = 270$  [49%]). No statistically significant difference existed between supervisor knowledge or attitudes at splash parks with signage and attendants compared with parks without signage or attendants.

## Discussion

Behaviors that increase the possibility for fecal contamination of splash park water and disease transmission likely amplify

the risk for splash park-associated RWI outbreaks and our study reveals that non-hygienic behavior occurs often at splash parks. Children were regularly observed exposing their buttocks to water flowing from splash features, which typically have high flow rates. The average swimmer might have  $\leq 10$  grams of residual fecal material adhering to his or her skin (Gerba, 2000); therefore, exposure of the buttocks to splash feature water, even if diapered or clothed, likely increases the risk for fecal contamination of splash park water.

Similar to swimming pools (CDC, 2001), fecal contamination of splash park water is most likely to occur during periods of high bather densities when multiple diapered children and toddlers are present. We observed high bather densities, including many diapered visitors wearing traditional diapers, which might be less effective at retaining formed stools when compared with traditional disposable diapers, and yet no diaper can contain all fecal material (Maas, Patch, Berkowitz, & Johnson, 2004). Diapered children who have diarrheal incidents pose an even greater possibility for fecal contamination of splash park water because fecal material can escape the diaper unseen (CDC, 2001). Furthermore, children who swallow fecally contaminated recreational water are at risk for RWI, particularly considering lesser exposures to recreational water (e.g., head immersion with or without splashing, face immersion, or exposure of the upper body) have been associated with RWI outbreaks (Pruss, 1998).

Despite prior RWI outbreaks associated with splash parks (CDC, 2000, 2009; Hoebe et al., 2004; Jones et al., 2006; Liang et al., 2006; Schaffzin et al., 2006), supervisor responses indicate a lack of understanding of adverse outcomes associated with splash park use, which might affect the adoption of appropriate preventive behavior (van der Plicht, 1998). A minority of adult supervisors reported that they disagreed or strongly disagreed that splash parks can cause diarrheal illness, and approximately one-third of supervisors reported being unsure if splash parks can cause diarrhea. Further, approximately 50% of respondents agreed or strongly agreed that splash parks were safer than swimming pools, revealing that drown-

ing risk was the primary concern of respondents, not RWI.

The results demonstrate that the usefulness of educational signage and hygiene attendants at splash parks in decreasing non-hygienic behaviors or influencing supervisor knowledge is limited. The propensity analysis did not demonstrate a substantial decrease in the frequency of placing an open mouth to splash park water or placing buttocks against splash features or the water flowing from splash features. Likewise, with the exception of the reported frequency of supervisors washing children's hands after play in the splash park, educational signage at splash parks did not seem to influence visitor behavior or attitudes with respect to questionnaire responses on nonhygienic behavior and splash park-associated RWI.

Our study has certain limitations. First, the cross-sectional methods for determining bather density did not account for wide fluctuations in the number of visitors during observation sessions. Second, during times of high bather densities, achieving high interobserver agreement during the group observation session for some non-hygienic behaviors was more difficult, specifically for visitors placing an open mouth to splash park water. This might have led to erroneously diminished frequencies during the group observation sessions for child visitors placing an open mouth to splash park water. Because the splash parks with educational signage and hygiene attendants had higher bather densities, the statistically significant difference observed during the group observation for children placing an open mouth to water at splash parks with signage and attendants, compared with parks without signage and attendants, might be questionable. Third, the variability in splash feature attractions among the splash parks might have resulted in skewed behavior patterns by visitors; certain features seemed to have been designed in a manner that made it easier or more fun for children to engage in nonhygienic behaviors.

## Conclusion

Findings from our study have implications for future design, operation, and regulation of splash parks. Splash park designers and public health officials should be mindful

TABLE 3

## Survey Responses From Adult Supervisors at Splash Parks by Presence of Educational Signs

Survey Questions	Number of respondents (%)		p-Value <sup>a</sup>
	Signs	No Signs	
On average, how often does the child you supervise visit a splash park?			.03
More than once a week	46 (13)	16 (9)	
Weekly	73 (20)	48 (26)	
2–3 times a month	76 (21)	53 (29)	
Once a month	82 (22)	34 (18)	
Once in the summer	90 (24)	33 (18)	
How often do you tell your child not to drink the splash park water?			.79
Never	97 (27)	43 (23)	
Once in a while	34 (9)	20 (11)	
Sometimes	18 (5)	12 (6)	
Most of the time	44 (12)	25 (14)	
Every time	174 (47)	84 (46)	
How often do you tell your child not to sit on top of the splash fountains?			.25
Never	236 (64)	121 (66)	
Once in a while	39 (11)	18 (10)	
Sometimes	36 (10)	9 (5)	
Most of the time	15 (4)	12 (6)	
Every time	41 (11)	23 (13)	
How often do you bathe your child with soap before entering the splash park?			.25
Never	228 (62)	117 (63)	
Once in a while	37 (10)	18 (10)	
Sometimes	21 (6)	16 (9)	
Most of the time	30 (8)	18 (10)	
Every time	51 (14)	15 (8)	
How often do you wash your child's hands with soap and water after leaving the splash park?			.02
Never	45 (12)	30 (16)	
Once in a while	20 (6)	15 (8)	
Sometimes	33 (9)	19 (11)	
Most of the time	55 (15)	41 (22)	
Every time	214 (58)	79 (43)	
It is OK if children wearing swim diapers play in the splash fountains.			.19
Strongly disagree	18 (5)	8 (5)	
Disagree	29 (8)	21 (11)	
Not sure	42 (12)	21 (11)	
Agree	207 (56)	112 (61)	
Strongly agree	71 (19)	22 (12)	
Children are safer playing at a splash park than a swimming pool.			.69
Strongly disagree	5 (2)	2 (1)	
Disagree	62 (17)	39 (21)	
Not sure	92 (25)	39 (21)	
Agree	138 (38)	72 (39)	
Strongly agree	70 (19)	32 (18)	
Playing in a splash park can cause children to have diarrhea.			.42
Strongly disagree	8 (2)	3 (2)	
Disagree	48 (13)	29 (16)	
Not sure	124 (34)	69 (37)	
Agree	152 (41)	73 (40)	
Strongly agree	35 (10)	10 (5)	

<sup>a</sup>Pearson's Chi-square test was used to evaluate the data.

that, despite the presence of posted educational signage, hygiene attendants, and adult supervisors, children engage in non-hygienic behavior that increases the risk for fecal contamination and disease transmission. Therefore, splash parks should be designed to provide protection against enteric pathogen transmission and in particular against chlorine-resistant organisms. Improved splash park design occurs through installation of supplemental disinfection technologies (e.g., ultraviolet light). We recommend that state and local governments consider mandating preconstruction public health review of splash park design, strin-

gent operating procedures, and installation of ultraviolet or similar supplemental disinfection technologies. 🐼

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