

Recreational Water Quality: Managing Your Risks

M&M's Probability Activity

To learn about probability, we will do an activity involving M&M's. This exercise will help you understand the probability of being exposed to a hazard, as well as risk assessment in general. Think of this activity as a way to build a story about what you may experience while visiting a beach. The amount of M&M's in your bag do not match your actual risk at the beach. Watch the steps of the activity and examples before you do it on your own using the link in the description.

M&M'S colors: Red, Orange, Green, Blue, Yellow and Brown. Each color represents a potential exposure to a hazard that you could experience while visiting the beach.

- Red – animal attack while swimming
- Orange – bad storm while sitting on the beach
- Blue – rip current that develops while swimming
- Green – toxins from the harmful algal bloom inhaled while sitting near the water's edge
- Yellow – sunburn from spending time in the sun
- Brown – pathogens accidentally ingested from swimming in waters with fecal pollution

Activity steps:

1. Count all M&M's from an individual bag. Count total amount of M&M's and by color.
 - a. Example:
 - Red – 4
 - Orange – 1
 - Yellow – 2
 - Blue – 5
 - Brown – 3
 - Total = 15
2. What is the probability of pulling 1 color out of your bag?
 - a. Number of 1 color of M&M's divided by total
 - b. Example: Red 4/15
In this story, you are likely to encounter an animal attack 4 out of 15 times you go swimming at the beach! Sounds like a dangerous beach.
3. What is the probability of pulling 1 color, then a second color (with replacing)?
 - a. Number of 1st color of M&M's divided by total, multiplied by Number of 2nd color of M&M's divided by total. Reduce all fractions where possible.
 - b. Example: Blue, then Orange
 $5/15 \times 1/15 = 5/225 = 1/45$
 - c. In this story, you are likely to encounter a rip current, then bad storm 1 out of 45 times you attend the beach. Since the rip current does not disappear when you get caught in it, it will go back into the probability pool, leaving 15 M&M's in the total.

4. What is the probability of pulling 1 color, then a second color (without replacing)?
 - a. Number of 1st color of M&M's divided by total, multiplied by Number of 2nd color of M&M's divided by (total – 1 M&M). Reduce all fractions where possible.
 - b. Example: Brown, then Yellow
 $3/15 \times 2/14 = 6/210 = 1/35$
 - c. In this story, you are likely to ingest pathogens, then get sun burnt 1 out of 35 times you attend the beach. Since you are ingesting the pathogens, they are removed from the pool of probability, making the total shrink down to 14 instead of 15 M&M's.

Worksheet:

M&M's Count Table

| Color | Number of M&M's |
|--------------|-----------------|
| Red | |
| Orange | |
| Blue | |
| Green | |
| Yellow | |
| Brown | |
| TOTAL | |

1. Choose 1 color. What is the probability of pulling that 1 color out of your bag?

2. Choose 2 colors. What is the probability of pulling 1 color, then a second color (with and without replacing)? Repeat this with 2 new colors.

Use this table to help you answer the discussion questions below.

Health Hazard Risk Table

| Injury - relative severity | Relative risk likelihood (Amount of people that will have this outcome in the same situation) | | | |
|--|--|-------------------------|-------------------------|--------------------|
| | High | Moderate | Low | Very low |
| Life threatening/permanent injury | Extremely high priority | Extremely high priority | Extremely high priority | Very high priority |
| Long-term injury | Extremely high priority | Very high priority | Very high priority | Moderate priority |
| Moderate injury or medical intervention required | Very high priority | Moderate priority | Moderate priority | Low priority |
| Short-term injury | Moderate priority | Low priority | Low priority | Very low priority |
| No injury | Low priority | Very low priority | Very low priority | Very low priority |

*Table adapted from Fig 1.2 WHO guidelines for safe recreational water environments
https://www.who.int/water_sanitation_health/publications/srwe1/en/

Discussion Questions:

- 1) What are the hazards involved in your story?

- 2) How severe are the consequences of being exposed to these hazards?

- 3) What is the probability you will be exposed to these hazards?

- 4) What can you do to manage your risk while at this mystery beach?