The Binomial Equation

Assume students have learned about:

- basic probability
- the concept of p-values
The Binomial Equation

\[ P(X=x) = \binom{N}{x} p^x (1-p)^{(N-x)} \]
Combinations

- Formula: “N choose x”

\[
\binom{N}{x} = \frac{N!}{x!(N-x)!}
\]

Example:

\[
\binom{4}{2} = \frac{4!}{2!(4-2)!} = \frac{4 \times 3 \times 2 \times 1}{(2 \times 1)(2 \times 1)} = \frac{12}{2} = 6
\]
Distribution of Binomial Data

\[ P(X=x) \]

- \( p=0.3 \)
- \( p=0.1 \)
- \( p=0.01 \)
- \( p=0.000125 \)
Example

- What is the probability that 2 people out of 100 will have syphilis if the rate in East Baltimore is the same as the rate in the U.S. (1.25 per 10,000)?
Using the Binomial Equation

• N = 100
• p = 0.000125
• X = 2

\[
\text{Prob}(X=2) = \binom{100}{2}0.000125^2(1-0.000125)^{100-2} = 0.000076
\]

\[
\text{Prob}(X \geq 2) = 1 - \text{Prob}(X<2) = 1-0.9876-0.0123 = 0.001
\]
Conclusion

- The one-sided p-value is 0.001, so we reject the null hypothesis and conclude that Baltimore’s syphilis rate is not the same as the U.S. syphilis rate.
Assumptions

- Constant proportion
- Independent data