Activity: Vaccine Efficacy

The **absolute risk** of something happening over a specific time is the probability of it happening.

Example 1: According to the National Cancer Institute, 125 out of 1000 women will develop breast cancer during their lives. The absolute risk, R_A of a women developing breast cancer is then:

$$R_A = \frac{\text{the number of women that developed breast cancer}}{\text{the total number of women}} = \frac{125}{1000} = 0.125 = 12.5\%$$

The **relative risk ratio** is the ratio that tells us how the probability that something will happen compares between two groups.

Example 2: There are two groups of people. Group A has 50 individuals that are 30 years and older. Group B has 20 individuals that are 29 years old and younger. A total of 15 people in group A snore. Only one person from group B snores. What is the relative risk ratio of snoring when comparing groups A and B?

Solution: Let us first calculate the probabilities that a person in a specific group snores. In group A 15 out of 50 people snore. The probability $P(A)$ that one person snores is:

$$P(A) = \frac{\text{the number of people in } A \text{ that snore}}{\text{the total number of people in group } A} = \frac{15}{50} = \frac{3}{10} = 0.3 = 30\%$$

Similarly, in the case of group B, the probability $P(B)$ will be:

$$P(B) = \frac{\text{the number of people in } B \text{ that snore}}{\text{the total number of people in group } B} = \frac{1}{20} = 0.05 = 5\%$$

The relative risk ratio, R_R, is the ratio that tells us how the probability that something will happen compares between two groups:

$$R_R = \frac{P(A)}{P(B)} = \frac{30\%}{5\%} = 6$$

The relative risk ratio of snoring based on groups A and B is 6. In other words, a person that is 30 and older is six times more likely to snore compared to a person younger than 30.

Note: the number of people in the two groups does not have to be the same.

Problem 1: The absolute risk of a non-smoker getting breast cancer over a lifetime is 12.5%. Smoking increases that risk by 20%. What is the relative risk ratio of contracting breast cancer over a lifetime between smokers and non-smokers?

The **absolute risk reduction** is the difference in outcomes between a control group and an experimental group (group that receives a treatment).

Example 3: Doctor Moreau tested a new medication (Serum A) on 1200 volunteers. He split the volunteers in two groups and recorded the results into the table below:

	total	negative outcome (death)
Control group	200	5
Exposed group	1000	10

The probability, $P(C)$, that a person from the control group died:

$$P(C) = \frac{5}{200} = 0.025 = 2.5\%$$

The probability, $P(E)$ that a person from the exposed group died:

$$P(E) = \frac{10}{1000} = 0.01 = 1\%$$

The absolute risk reduction, A_{RR} is:

$$A_{RR} = P(C) - P(E) = 2.5\% - 1\% = 1.5\%$$

Remember: The risk is a probability of a negative outcome. In this example, the outcome is "death".

The **relative risk reduction** or the **vaccine efficacy** is a ratio that tells us how much risk is reduced in an experimental group compared to a control group.

$$\text{the relative risk reduction} = \frac{\text{the absolute risk reduction}}{\text{the control group rate}}$$

Problem 2: Show that the relative risk reduction, R_{RR}, in Example 3 is 60% .

Problem 3: Doctor Moreau tested Serum B on 5000 volunteers. He split the volunteers in two groups and recorded the results into the table below:

	total	negative outcome (death)
Control group	1000	20
Exposed group	?	100

Find the relative risk reduction for Serum B. Discuss the results.

Problem 4: Vaccine A prevents 19 people from contracting an infection when administered to 20 people. Vaccine B decreases your chance of contracting the same infection by 95%. Which one would you take? Why?

Problem 5: The results from the Phase 3 trials for Pfizer's Covid-19 vaccine is given in the table below.

	total	Covid-19
Control group	21 728	162
Vaccinated	21 720	8

Find the relative risk reduction in percents (the vaccine efficacy). What does the vaccine efficacy tell you? ▦

Problem 6: The population of Canada in 2020 is about 38 million people. Using the data from Problem 5 find out:

a) How many Canadians could get infected with Covid-19 if no one is vaccinated?

b) How many Canadians could get infected with Covid-19 if they are all vaccinated?

c) According to official numbers, by Jan 12, 2021 Canada recorded over 668 000 Covid-19 infections. Discuss how this number compares with the numbers in parts a and b. Why?

Problem 7: The results from the Phase 3 trials for Moderna's Covid-19 vaccine is given in the table below.

	total	Covid-19
Control group	15 000	185
Vaccinated	15 000	11

Find the vaccine efficacy in percents. ▦

Problem 8: What would be the efficacy of the vaccine given in Problem 7 if the vaccinated group counted 25 infections instead of 11?