Quiz 1:

1. Trumpet University has three faculties: Arts, Engineering and Science. This year, the admission rate of every faculty is between 10% and 60%. Its chancellor, Daniel, claims that the university has an unprecedented low overall admission rate of 9% this year, a testament to the quality of the university. What do you make of this claim?

Faculty	Admissions Rate
Arts	10%
Engineering	60%
Science	40%

A) It can be correct: the overall admission rate could be below 10%.
B) It is wrong: the overall admission rate is larger than 10% but below 60%.
C) It is wrong: the overall admission rate is above 60%.

Explanation: The number of students admitted to the university is equal to the number of students admitted to Arts, to Engineering, or to Science. Less than 60% of the applicants to Arts are admitted; 60% of the applicants to Engineering are admitted; less than 60% of the applicants to Science are admitted. Hence the number of students admitted to the university is less than 60% of the total number of applicants, i.e. the overall admission rate is below 60%. A similar reasoning shows that the overall admission rate is above 10%.

A more precise explanation: Suppose the proportion of applicants to the Arts, Engineering and Science faculties are given by a, b and c respectively, so that a+b+c=1. The overall admissions rate is

$$r = 0.1a + 0.6b + 0.4c$$

By substituting different values of a, b, c, (with sum 1), you can see that r must be between 0.1 and 0.6. More formally, since $0.6 > 0.1$, $0.4 > 0.1$ and a, b, c are positive, we must have $r \geq 0.1a + 0.1b + 0.1c = 0.1$. Similarly, we have $r \leq 0.6$.

2. In a study done on the effect of consuming vitamin C on catching common cold, a part of primary results are as follows:

	Number of individuals catching cold	Number of individuals not catching cold	Total
Control group	25	75	100
Treatment group	13	87	100
Total	38	162	200

If you know that gender affects the rate of catching cold as in women are more prone to catch a cold and the following table shows the gender composition of treatment and control group, what is your conclusion?

	Male	Female	Total
Control group	30	70	100
Treatment group	70	30	100
Total	100	100	200

A) Vitamin C is likely to reduce cold by less than 12 cases per 100.
B) Vitamin C is likely to reduce cold by exactly 12 cases per 100.
C) Vitamin C is likely to reduce cold by more than 12 cases per 100.

Explanation: Based on the gender composition table, we observe that proportion of females is larger in control group. Since females are more prone to common cold, such a design is biased for the hypothesis of the study and the effect of vitamin C is being overstated. As the result, Vitamin C is likely to reduce cold but with less than 12 cases per 100 which is the result of the experiment. Please refer to unit 3 of chapter 1.

3. Consider two studies on the effect of drug X on blood pressure.
Study A is a double-blind randomized controlled experiment with treatment group of size 5 and control group of size 5. The average blood pressures in both groups are very similar.

Study B is a double-blind randomized controlled experiment with treatment group of size 500 and control group of size 250. The average blood pressure of the control group is much higher than that of the treatment group.

Choose the best option:
A) I will trust study A since the treatment and control groups have similar size, while they don't have similar size in study B.
B) I will trust study B since sizes of treatment and control groups are large and I can be more confident that the difference observed is due to the treatment.
C) I will trust neither study.

Explanation: In a controlled experiment where we want to test the effectiveness of a treatment or we want to see the effect of an exposure, it is important that control and treatment groups are as similar as possible so that the only difference between the two groups is the treatment. In unit 4 of chapter 1 we discussed that when dealing with **large** number of individuals, after we assign the individuals randomly to treatment and control, it is very likely that the two groups are similar in all aspects. Please note that it is totally fine if control and treatment groups are not the same size. When dealing with small group sizes, it is possible that the two groups are not similar. Can you imagine why?

4. Following an outbreak of Chikungunya on the island of Fanying, the local government decided to inoculate all its citizens with a new vaccine. The following year, only 1000 people were diagnosed with Chikungunya compared with 5000 the year before. Consider the following statements:

(I) The vaccine reduces Chikungunya infection.

(II) The vaccine has no effect.
(III) The vaccine increases Chikungunya infection.

(A) The data show that only (I) is true.
(B) The data show that only (II) is true
(C) The data show that only (III) is true.
(D) (I), (II), (III) are all consistent with the data.

Explanation: There were no controls in this experiment. It could be that the following year was not an epidemic year, or that those who were most vulnerable to infection had acquired immunity after infection in the previous year etc. There is no way to isolate the effect of inoculation in this situation.

5. In an experiment with historical controls which of the following is the main issue?

(A) Confounding
(B) Lack of a control group
(C) Difference in the size of the control and treatment groups

Explanation: It is explicitly mentioned in the lecture videos that the main problem with a historical control is the confounding factor. Individuals are not randomly assigned to control and treatment and it is highly possible that treatment and control groups have differences aside from treatment.