Past-paper walk-through

Sampling Distributions for Differences in Sample Means ▪ 5.8

eXercise

Questions in this set

- 2022 Q5

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 5

2022 ▪ Q5

Studies have shown that foods rich in compounds known as flavonoids help lower blood pressure. Researchers conducted a study to investigate whether there was a greater reduction in blood pressure for people who consumed dark chocolate, which contains flavonoids, than people who consumed white chocolate, which does not contain flavonoids. Twenty-five healthy adults agreed to participate in the study and add 3.5 ounces of chocolate to their daily diets. Of the 25 participants, 13 were randomly assigned to the dark chocolate group and the rest were assigned to the white chocolate group. All participants had their blood pressure recorded, in millimeters of mercury (mmHg), before adding chocolate to their daily diets and again 30 days after adding chocolate to their daily diets.

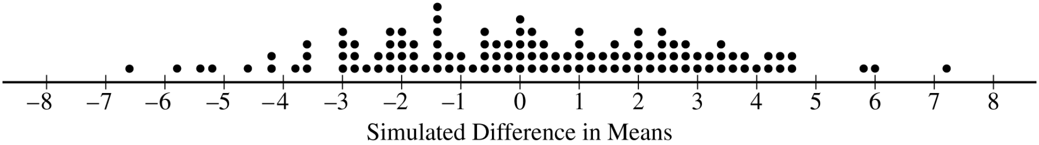
The reduction in blood pressure (before minus after) for each of the participants in the two groups is shown in the dotplots below.

Question 5

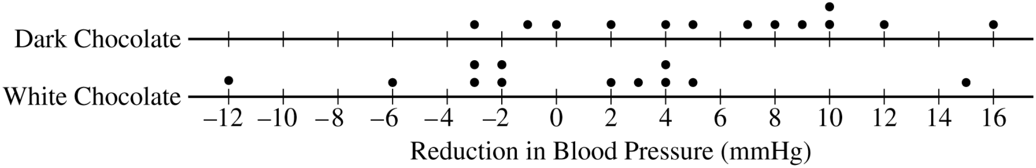
[Dotplots titled with x-axis "Reduction in Blood Pressure (mmHg)" from -12 to 16. "Dark Chocolate" row: approximate dot values at -2, 1, 2, 3, 4, 5, 6, 7, 8, 9, 9, 10 (highest stack), 16. "White Chocolate" row: approximate dot values at -12, -6, -2, -1, 3, 4, 4, 5, 16.]

(a) Determine and compare the medians of the reduction in blood pressure for the two groups.

Question 5



Question 5


Dark Chocolate
White Chocolate
−12 −10 −8 −6 −4 −2 0 2 4 6 8 10 12 14 16
Reduction in Blood Pressure (mmHg)

Question 5

2022 ▪ Q5

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(b) The researchers found the mean reduction in blood pressure for those who consumed dark chocolate is $\bar{x}_{dark} = 6.08$ mmHg and the mean reduction in blood pressure for those who consumed white chocolate is $\bar{x}_{white} = 0.42$ mmHg.

One researcher indicated that because the difference in sample means of 5.66 mmHg is greater than 0 there is convincing statistical evidence to conclude that the population mean blood pressure reduction for those who consume dark chocolate is greater than for those who consume white chocolate. Why might the researcher's conclusion, based only on the difference in sample means of 5.66 mmHg, not necessarily be true?

Question 5

2022 ▪ Q5

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(c) A simulation was conducted to investigate whether there is a greater reduction of blood pressure for those who consume dark chocolate than for those who consume white chocolate. The simulation was conducted under the assumption that no difference exists. The results of 120 trials of the simulation are shown in the following dotplot.

[Dotplot titled with x-axis "Simulated Difference in Means" from -8 to 8; roughly symmetric, mound-shaped distribution of 120 dots centered near 0, tallest stacks between -2 and 3, tapering to isolated dots near -8, -7, -6, -5, 6, 7.]

Use the results of the simulation to determine whether the results from the 25 participants in the study provide convincing statistical evidence, at a 5 percent level of

Question 5

significance, that adding dark chocolate to a daily diet will result in a greater reduction in blood pressure, on average, than adding white chocolate to a daily diet. Justify your answer.

Solution 5

(a)

Mark scheme

- The sample median reduction in blood pressure for those eating dark chocolate is 7 mmHg, which is greater than the sample median reduction for those eating white chocolate, about 0 mmHg. Full credit needs all three: (1) the medians are correctly determined (dark chocolate median $= 7$ mmHg; white chocolate median between -2 and 2 mmHg, inclusive), (2) the computed medians are correctly compared, (3) context is included (the response variable, reduction in blood pressure, and the two treatment groups, dark and white chocolate).

Solution 5

(b) Mark scheme

- The researcher's conclusion may not necessarily be true because looking at the difference in sample means alone does not account for the variability in the sampling distribution of the difference in sample means. A different random assignment of subjects to dark and white chocolate could result in a sample mean reduction for dark chocolate that is smaller than for white chocolate. The variability in the sampling distribution of potential differences in sample means must be considered when concluding convincing statistical evidence; an inference procedure can assess the likelihood that the observed difference in sample means (5.66 mmHg) occurred by random chance if the population means are actually equal. Full credit needs at least two of the following three: (1) indicates the

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researchers failed to consider the variability in the sampling distribution of differences in sample means (or that this should be considered), or states a different random assignment could produce different sample means, (2) explains that a difference of 5.66 mmHg could have occurred by random chance even if the population means are equal, (3) indicates that an inference procedure is needed. (A response may also earn full credit by instead correctly noting that no population conclusion can be drawn at all, because the sample was drawn only from the subpopulation of healthy adults.)

Solution 5

(c) Mark scheme

- The observed value of the sample statistic $\bar{x}_{dark} - \bar{x}_{white}$ is 5.66 mmHg. The simulation (under the assumption of no true difference) shows that a difference of 5.66 mmHg or larger occurred in only 3 of the 120 trials, so the (simulation-based) p-value is approximately $\frac{3}{120} = 0.025$. Because this p-value is less than 0.05, there is convincing statistical evidence that adding dark chocolate to the diet results in a greater mean reduction in blood pressure than adding white chocolate, for people similar to those in the study. (The hypotheses themselves are not required since they are given in the stem.) Full credit needs all four components: (1) calculates the correct p-value of 0.025, (2) provides

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supporting work from the simulation for the calculation (e.g. noting only 3 of the 120 trials met or exceeded 5.66 mmHg), (3) provides a correct conclusion in context about whether there is convincing evidence that dark chocolate gives a greater mean blood-pressure reduction than white chocolate, (4) justifies the conclusion by directly comparing the calculated p-value to 0.05.