

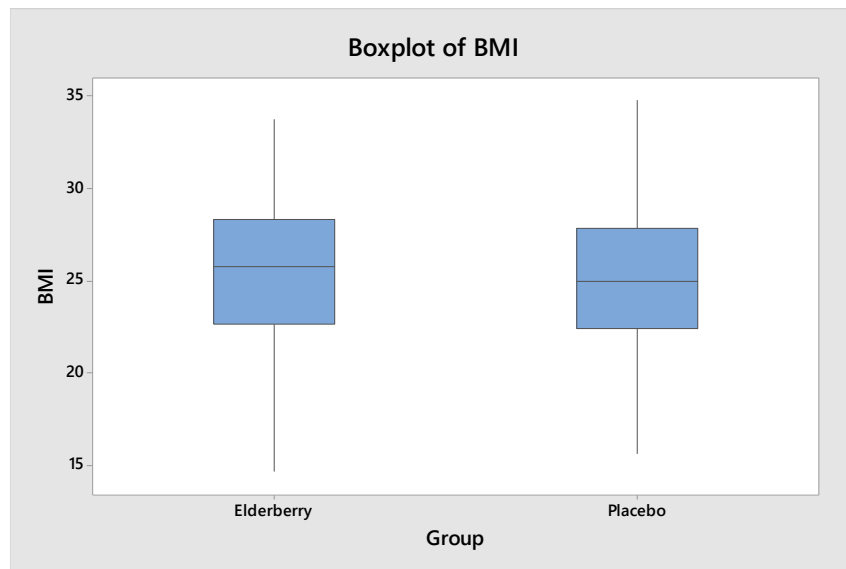
Answer 1:

a) The descriptive statistics for the BMI shows that the average BMI for elderberry extract (M=25.58, SD= 4.00) is marginally higher than the placebo group (M=24.95, SD= 3.98). It can also be noticed that lower and upper whiskers for the placebo group are marginally larger than elderberry group while lower and upper quartiles along with the median for the elderberry group are marginally larger than placebo group. Box plot clearly shows that the box for placebo group is marginally lower than the elderberry extract while the whiskers of the box plot are marginally higher than that of elderberry extract. Thus, there does not seem to be any major differences in BMI for the two treatment groups.

Table 1: Descriptive Statistics for the Elderberry and Place Groups

Group	N	Mean	StDev	Min	Q1	Median	Q3	Maximum
Elderberry	144	25.581	4.004	14.600	22.625	25.700	28.275	33.700
Placebo	139	24.946	3.980	15.600	22.400	24.900	27.800	34.800

Table 1: Box plot for the Elderberry and Place Groups



b) Paired t-test is used to compare whether black elderberry extract, a traditional herb, have beneficial effects for air travelers since we are comparing the physical health of same traveler two days before the travel and four days after the travel.

c) **State:** The null hypothesis for the paired t-test states that there is no difference in the physical health of the travelers two days before the travel and four days after the travel for elderberry group while the alternate hypothesis states that there is a difference in the physical health of the travelers two days before the travel and four days after the travel for elderberry group.

Formulate: Paired t-test is used to compare whether black elderberry extract, a traditional herb, have beneficial effects for air travelers and 5% significance level is used to analyze the results.

Solve: The results from the paired t-test conducted to test any difference in the physical health of the travelers two days before the travel and four days after the travel for elderberry group are presented below:

Table 2: Results for Paired T-test for physical health composite score of travelers two days before the travel and four days after the travel for Elderberry group

Paired T-Test and CI: PCS_Before, PCS_After
Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
PCS_Before	144	55.42	10.92	0.91
PCS_After	144	54.94	12.13	1.01

Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for $\mu_{\text{difference}}$
0.479	11.753	0.979	(-1.457, 2.415)

$\mu_{\text{difference}}$: mean of (PCS_Before – PCS_After)

Test

Null hypothesis $H_0: \mu_{\text{difference}} = 0$
 Alternative hypothesis $H_1: \mu_{\text{difference}} \neq 0$

T-Value	P-Value
0.49	0.625

Conclude: Physical health of the travelers two days before the travel (M=55.42, SD=10.92) was marginally better than four days after the travel for elderberry group (M=54.94, SD=12.13). However, there was no significant difference found in the physical health of the travelers before

and after the travel (Diff=0.479, SD=11.753, p=0.625) as the p-value is larger than the alpha level and we cannot reject the null hypothesis. Thus, it can be concluded that there is no significant difference in the physical health of travelers in the elderberry group before and after the travel.

95% confidence interval: The results showed that 95% confidence interval for the difference in physical health composite score before and after the travel lies between -1.457 and 2.415 for elderberry group. This means that there is 95% certainty that the difference in physical health composite score between before and after the travel will lie between -1.457 and 2.415 for elderberry group.

d) **State:** The null hypothesis for the paired t-test states that there is no difference in the physical health of the travelers two days before the travel and four days after the travel for placebo group while the alternate hypothesis states that there is a difference in the physical health of the travelers two days before the travel and four days after the travel for placebo group.

Formulate: Paired t-test is used to compare whether placebo extract have beneficial effects for air travelers and 5% significance level is used to analyze the results.

Solve: The results from the paired t-test conducted to test any difference in the physical health of the travelers two days before the travel and four days after the travel for placebo group are presented below:

Table 3: Results for Paired T-test for physical health composite score of travelers two days before the travel and four days after the travel for Placebo group

Paired T-Test and CI: PCS_Before, PCS_After
Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
PCS_Before	139	57.09	11.28	0.96
PCS_After	139	55.37	12.18	1.03

Estimation for Paired Difference

Mean	StDev	SE Mean	95% CI for μ difference
1.719	5.775	0.490	(0.751, 2.688)

$\mu_{\text{difference}}$: mean of (PCS_Before - PCS_After)

Test

Null hypothesis $H_0: \mu_{\text{difference}} = 0$

Alternative hypothesis $H_1: \mu_{\text{difference}} \neq 0$

T-Value	P-Value
3.51	0.001

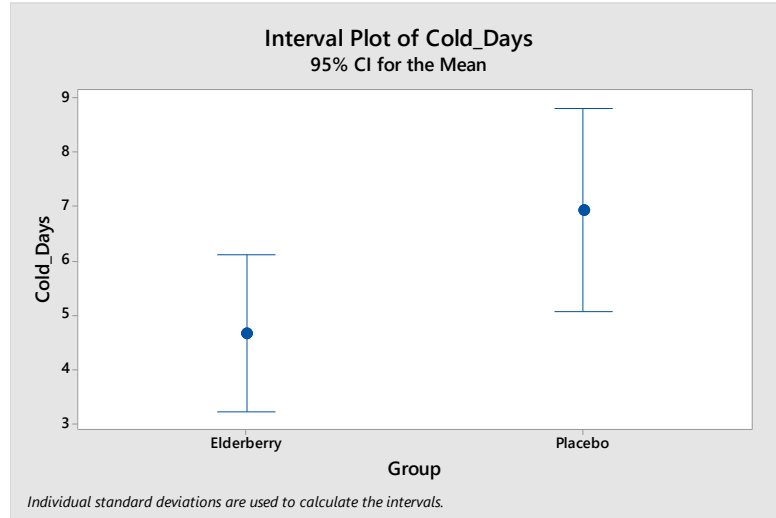
Conclusions: Physical health of the travelers two days before the travel (M=57.09, SD=11.28) was better than four days after the travel for placebo group (M=55.37, SD=12.18). Moreover, there was a significant difference found in the physical health of the travelers before and after the travel (Diff=1.719, SD=5.775, p=0.001), as the p-value is smaller than the alpha level and we reject the null hypothesis. This concludes that the physical health of travelers in the placebo group was significantly better two days before the travel than four days after the travel.

95% confidence interval: The results showed that 95% confidence interval for the difference in physical health composite score before and after the travel lies between 0.751 and 2.688 for the placebo group. This means that there is 95% certainty that the difference in physical health composite score for placebo group between before and after the travel will lie between 0.751 and 2.688.

Answer 2:

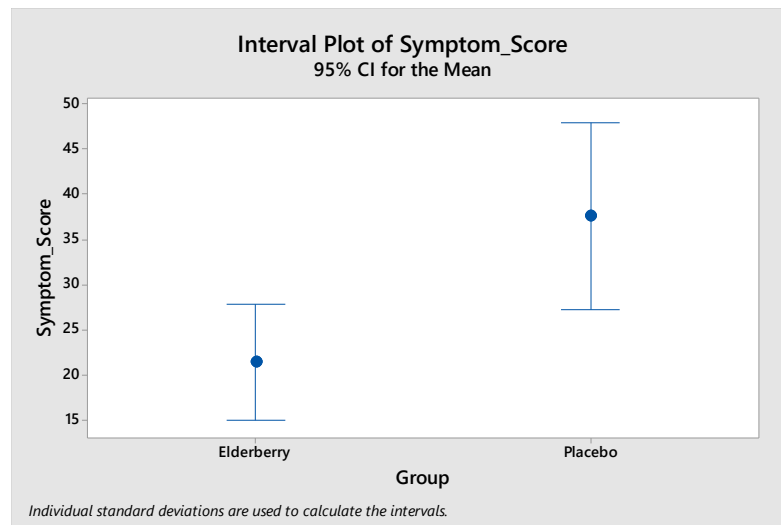
- a) The error bar plot for the number of cold days is somewhat overlapping for the elderberry and placebo groups suggesting that there might not be significant difference in the number of cold episode days in the two groups.

Figure 2: Error-bar plot for Cold days between Elderberry and placebo group



- b) The error bar plot for symptom score for elderberry group shows that the upper bar of the plot is marginally larger than lower bar of symptom score for placebo group. This suggests that there might be significant difference in the symptom score of the two groups.

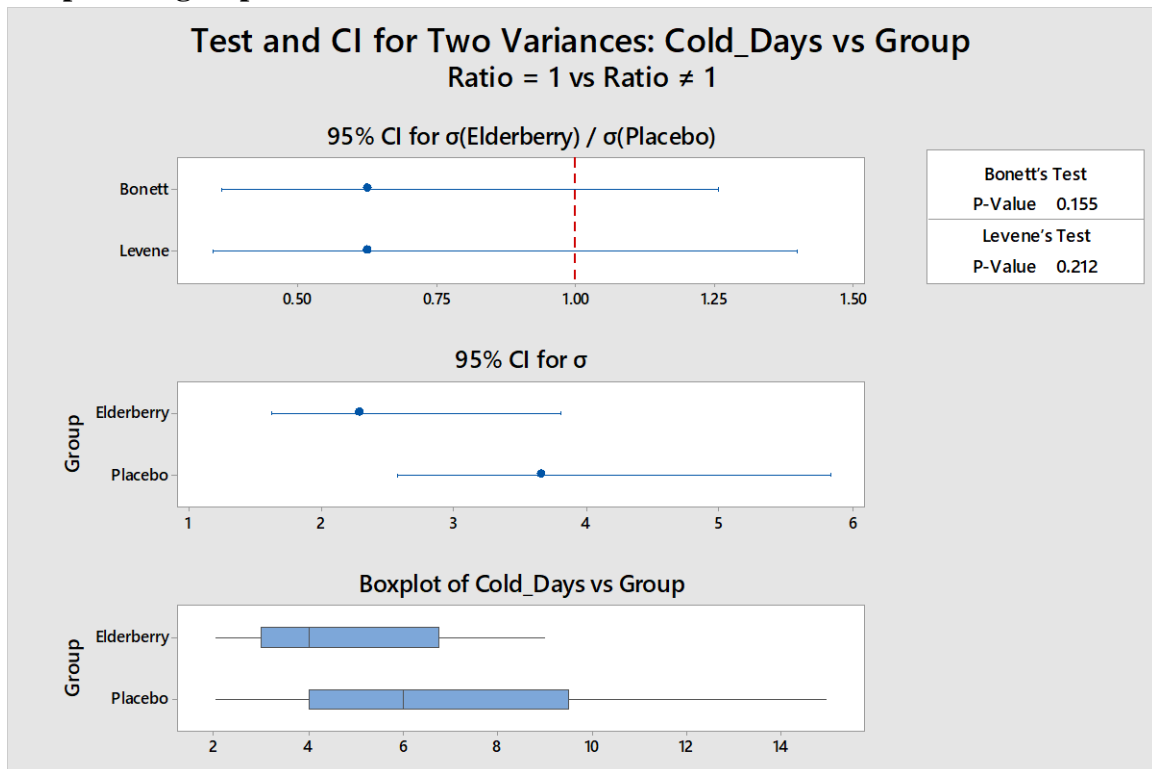
Figure 3: Error-bar plot for symptom score between Elderberry and placebo group



c) Two sample t-test is used to compare if there exists any significant difference in the number of cold episode days between the volunteers with elderberry extract since we are comparing them for different people in the two groups.

Furthermore, to test if the two sample t-test with equal variances should be used or unequal variances, the F-test to compare the variances of two groups is performed and as the results show that the p-value of the Levene's F-test is large at 0.212. Since, the p-value is larger than alpha level o 0.05, we conclude that the variances of the two groups are equal and thus, two sample t-test with equal variances should be used.

Table 4: Levene'test results for Cold days to compare variance between Elderberry and placebo group



State: The null hypothesis for two-sample t-test states that there is no difference in the number of cold episode days between elderberry and placebo group while the alternate hypothesis states that there is a difference in the number of cold episode days between elderberry and placebo group.

Formulate: Two sample t-test is used to compare if there exists any significant difference in the number of cold episode days between the volunteers with elderberry extract and 5% significance level is used to analyze the results.

Solve: The results from the two sample t-test conducted to test any difference in the cold episode days between the two groups are presented below:

Table 5: Two-sample t-test results to compare cold episode days between Elderberry and placebo group

Two-Sample T-Test and CI: Cold_Days, Group
Method

μ_1 : mean of Cold_Days when Group = Elderberry

μ_2 : mean of Cold_Days when Group = Placebo

Difference: $\mu_1 - \mu_2$

Equal variances are assumed for this analysis.

Descriptive Statistics: Cold_Days

Group	N	Mean	StDev	SE Mean
Elderberry	12	4.67	2.27	0.66
Placebo	17	6.94	3.65	0.88

Estimation for Difference

Difference	Pooled StDev	95% CI for Difference
-2.27	3.16	(-4.72, 0.17)

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-1.91	27	0.067

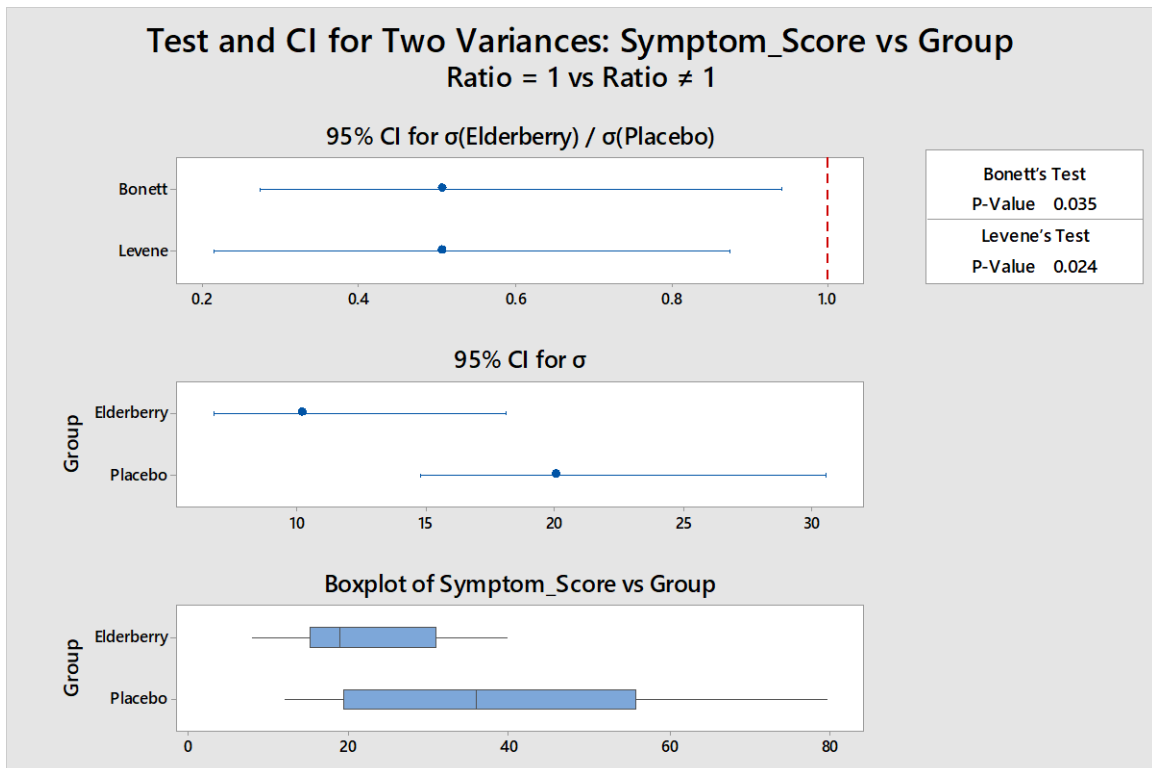
Conclusions: The placebo group (M=6.94, SD=3.65) has cold for larger number of cold episode days than elderberry group (M=4.67, SD=2.27). Thus, it can be concluded that there is no significant difference found in the number of cold days between the two groups (Diff=-2.27, 95% CI for diff =-4.47, 0.17 p=0.067) as the p-value is larger than the alpha level and we cannot reject the null hypothesis.

95% Confidence intervals: 95% confidence interval for the difference in average number of cold episode days between elderberry and placebo group lie between -4.47 and 0.17. This means that we are 95% certain that the difference in number of cold episode days between the two groups will lie between -4.47 and 0.17.

d) Two sample t-test is used to compare if there exists any significant difference in the symptom score between the volunteers with elderberry extract since we are comparing them for different people in the two groups.

Furthermore, to test if the two sample t-test with equal variances should be used or unequal variances, the F-test to compare the variances of two groups is performed and as the results show that the p-value of the Levene's F-test is 0.024. Since, the p-value is smaller than alpha level of 0.05, we conclude that the variances of the two groups are unequal and thus, two sample t-test with unequal variances should be used.

Table 6: Levene's test results for symptom score to compare variance between Elderberry and placebo group



State: The null hypothesis for two-sample t-test states that there is no difference in the symptom score between elderberry and placebo group while the alternate hypothesis states that there is a difference in the symptom score between elderberry and placebo group.

Formulate: Two sample t-test is used to compare if there exists any significant difference in the symptom score between the volunteers with elderberry extract and 5% significance level is used to analyze the results.

Solve: The results from the two sample t-test conducted to test any difference in the symptom score between the two groups are presented below:

Table 7: Two-sample t-test results to compare symptom score between Elderberry and placebo group

Two-Sample T-Test and CI: Symptom_Score, Group
Method

μ_1 : mean of Symptom_Score when Group = Elderberry

μ_2 : mean of Symptom_Score when Group = Placebo

Difference: $\mu_1 - \mu_2$

Equal variances are not assumed for this analysis.

Descriptive Statistics: Symptom_Score

Group	N	Mean	StDev	SE Mean
Elderberry	12	21.4	10.1	2.9
Placebo	17	37.5	20.0	4.9

Estimation for Difference

Difference	95% CI for Difference
-16.11	(-27.80, -4.42)

Test

Null hypothesis $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-2.84	24	0.009

Conclusions: The placebo group (M=37.5, SD=20) has higher symptom score than elderberry group (M=21.4, SD=10.1). Thus, it can be concluded that there is a significant difference found

in the symptom score between the two groups (Diff=-16.11, 95% CI for diff = -27.8, -4.42, $p=0.009$) as the p-value is smaller than the alpha level and we cannot reject the null hypothesis.

95% Confidence intervals: 95% confidence interval values for the difference in average symptom score for the travelers in elderberry and placebo groups is very large, suggesting that there is 95% probability that the difference in average symptom score will lie between 27.8 and 4.42 for the two groups.