The DEPRESSION data set comes from a placebo-controlled phase III clinical trial. The Hamilton Depression Rating Scale (HAMD17) is used to measure the depression status of the patients. A score of 7 or less is considered not depressed. For each patient, the variable Y represents the depression score for visits 4 through 8 (visit 8 is the end of the study), CHANGE is the change from baseline to visits 4 through 8. Two treatment groups are included in the dataset: experimental drug, TRT=1, and placebo, TRT=4. The goal is to estimate the efficacy of the experimental drug on change in baseline depression score at visit 8.

Create a binary variable that equals 1 if the HAMD17 score at visit 8 is less than or equal to 7 (not depressed) and equals 0 if the HAMD17 score at visit 8 is greater than 7. This new variable is the binary outcome. Note that the baseline HAMD17 score for all the patients was greater than 7. For the continuous outcome variable (CHANGE), present the sample sizes, mean, standard deviation, median and interquartile range, and minimum and maximum of the outcome for each group. Present your results in a table using 1 decimal place.

	Treatment	**Placebo**
n	55	52
mean	-10	-8.2
stdv	6.7	8.3
median	-10	-10
IQR	9	10.5
min	-23	-19
max	10	13

For each of the two outcomes, state the null and alternative hypotheses to be tested, in words and in mathematical notation.

H_0: $\mu_A = \mu_P$. The change in depression score is the same for both treatment and placebo groups.
H_A: $\mu_A \neq \mu_P$. The change in depression score is not the same in treatment and placebo groups.

H_0: $\pi_A = \pi_P$. $OR = 1$. The odds of not having depression is the same for both treatment and placebo group.
H_A: $\pi_A \neq \pi_P$. $OR \neq 1$. The odds of not having depression is not the same in the treatment and placebo groups.

Assess whether the null hypothesis can be rejected using a t-test for the continuous outcome and a chi-square test for the binary outcome. Please make sure to first perform the F-test for equality of variances to help determine which p-value to use for testing the means. Report all p-values and effect estimates (e.g., mean difference and odds ratio or risk ratio). For each outcome, present a write-up of the methodology and results, including effect estimates (mean difference and risk ratio or odds ratio) and CI's. Use one decimal place for means, ratios, and CIs, and 3 decimal places for p-values.

A two-sample t-test was used to test whether there was a difference in the change in depression score from baseline to visit 8 between the treatment and placebo groups. An F-test was performed to assess the equality of variances between the groups. The F-statistic was 1.5 and p-value was 0.121. With a p-value greater than the α=0.10 significance level, the null hypothesis of there being equal variances was not rejected. The analysis continued using a pooled two-sample t-test.

On average, the treatment group's score decreased by 10 points (95% CI: 8.2-11.8) and the placebo group's score decreased by 8.2 points (95% CI: 5.9-10.5). The t-score was -1.22 and p-value was 0.226. With a p-value less than the α=0.05 significance level, the null hypothesis of there being no difference in change in depression score between the groups was rejected. There is evidence suggesting that the experimental drug decreases depression score by 1.8 points (95% CI: -1.1 – 4.6) than the placebo group's decrease.

A chi-square test was used to test whether there was a difference in odds of not having depression between the treatment and placebo groups. The chi-square statistic was 2.6 and p-value was 0.105. With a p-value less than the α=0.05 significance level, the null hypothesis of there being no difference in odds of not having depression between the groups was not rejected. There is insufficient evidence to suggest that the experimental drug is more effective than a placebo at increasing the odds of not having depression. Those who received the experimental drug had 1.9 (95% CI: 0.9-4.1) times the odds of not being depressed by the end of the study, but this increase was not found to be significant.

For the continuous outcome, assess whether the null hypothesis can be rejected using simple linear regression, using the "dummy variable" *group,* defined as 0 = placebo and 1 = experimental drug, as the independent variable.

1. Run the regression in SAS using PROC REG and PROC GLM. Assess that
    a. The ANOVA table from PROC REG matches that from PROC GLM using a CLASS statement for treatment group.
    b. The F- and t-test p-values from PROC REG match the "t" from PROC TTEST.
2. Provide an interpretation of the intercept and slope parameter in the Parameter Estimates table from PROC REG. What null hypothesis is tested by the p-value for the intercept term?
3. Rerun the regression, but now define the "dummy variable" as -1 = placebo and 1= experimental drug. Compare the resulting p-value to the results from PROC REG in part 6a. Provide an interpretation of the intercept and slope in this model.

Part 1

The REG Procedure
Model: MODEL1
Dependent Variable: CHANGE Change in HAMD17

Number of Observations Read	107
Number of Observations Used	107

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	83.66643	83.66643	1.48	0.2259
Error	105	5921.23077	56.39267		
Corrected Total	106	6004.89720			

Root MSE	7.50951	R-Square	0.0139
Dependent Mean	-9.14019	Adj R-Sq	0.0045
Coeff Var	-82.15921		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-8.23077	1.04138	-7.90	<.0001
x		1	-1.76923	1.45251	-1.22	0.2259

The GLM Procedure

Dependent Variable: CHANGE Change in HAMD17

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	83.666427	83.666427	1.48	0.2259
Error	105	5921.230769	56.392674		
Corrected Total	106	6004.897196			

R-Square	Coeff Var	Root MSE	CHANGE Mean
0.013933	-82.15921	7.509506	-9.140187

Source	DF	Type I SS	Mean Square	F Value	Pr > F
x	1	83.66642703	83.66642703	1.48	0.2259

Source	DF	Type III SS	Mean Square	F Value	Pr > F
x	1	83.66642703	83.66642703	1.48	0.2259

Parameter	Estimate	Standard Error	t Value	Pr > |t|	95% Confidence Limits	
Intercept	-8.230769231	1.04138105	-7.90	<.0001	-10.29563549	-6.165902971
x	-1.769230769	1.45251363	-1.22	0.2259	-4.649296980	1.110835442

The ANOVA tables for both proc reg and proc glm match.

Method	Variances	DF	t Value	Pr > |t|
Pooled	Equal	105	-1.22	0.2259
Satterthwaite	Unequal	97.994	-1.21	0.2289

The p-values from both the F and t-tests are equal.

Part 2

Parameter Estimates						
Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-8.23077	1.04138	-7.90	<.0001
x		1	-1.76923	1.45251	-1.22	0.2259

The intercept is the mean outcome when x=0. On average, the placebo's group depression score decreased by 8.2 points.

The slope is the difference between the group sample means. The treatment group's depression score decreased by 1.8 more points than the placebo group's decrease.

Adding the intercept and the slope gives the mean outcome when x=1. On average, the treatment group's depression score decreased by 10 points.

The null hypothesis being tested in the first row is that the intercept is 0, which is not interesting from a statistical standpoint.

Part 3

The REG Procedure
Model: MODEL1
Dependent Variable: CHANGE Change in HAMD17

Number of Observations Read	107
Number of Observations Used	107

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	83.66643	83.66643	1.48	0.2259
Error	105	5921.23077	56.39267		
Corrected Total	106	6004.89720			

Root MSE	7.50951	R-Square	0.0139
Dependent Mean	-9.14019	Adj R-Sq	0.0045
Coeff Var	-82.15921		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	-9.11538	0.72626	-12.55	<.0001
x		1	-0.88462	0.72626	-1.22	0.2259

The intercept is the mean outcome when x=0. However, there is no x=0 group.

On average, the placebo's group depression score decreased by $-9.1154 - 0.8846(-1) = -8.23076$, which matches the intercept of the previous model.

The slope is the difference between the group sample means. Since the placebo and treatment groups differ by 2 units, the actual difference in the two groups' means is $2(-0.8846) = -1.7692$, which matches the slope in the previous model.

Adding the intercept and the slope gives the mean outcome when x=1. On average, the treatment group's depression score decreased by $-9.1154 - 0.8846(1) = -10$, which matches the answer calculated in the previous model.

For the binary outcome variable present a 2x2 table summarizing the results. Compute the risk difference, risk ratio, and odds ratio, and their confidence intervals. Interpret each effect estimate.

	No Depression	Depression	
Placebo	25	27	52
Treatment	35	20	55
	60	47	107

$p_P = P(dep = 1, trt = P) = \frac{27}{52} = 0.5192$ = risk of depression in placebo group

$p_A = P(dep = 1, trt = A) = \frac{20}{55} = 0.3636$ = risk of depression in treatment group

$$RD = P(dep = 1, trt = A) - P(dep = 1, trt = P) = \frac{20}{55} - \frac{27}{52} = -0.1556$$

There are 15.56% fewer cases of depression in the treatment group than the placebo group. (95% CI: -34.16% – 3.04%)

$$RR = \frac{P(dep = 1, trt = A)}{P(dep = 1, trt = P)} = \frac{\frac{20}{55}}{\frac{27}{52}} = 0.7003$$

Those in the treatment group had 0.7003 times the risk of depression compared to those in the control group. (95% CI: 0.4526–1.0837)

$$OR = \frac{ad}{bc} = \frac{25 \times 20}{35 \times 27} = 0.5291$$

Those in the treatment group had 0.5291 times the odds of having depression than those in the control group. (95% CI: 0.9228–2.2095)

Is the odds ratio similar in magnitude to the risk ratio? Why?

The outcome, depression, is not a rare disease (probability <0.2%), so the OR is not on the same magnitude as the RR.