

**Instructions:** Follow the homework instructions outlined in the syllabus.

**Please note:** When asked to perform a hypothesis test, always report the following: (1) State the null and alternative hypotheses of the test, (2) Specify the significance level, (2.5) Check any necessary assumptions, (3) Compute or report the appropriate test statistic, (4) Generate the decision rule (i.e., state the distribution of the test statistic under  $H_0$  (including degrees of freedom, if appropriate), the test critical value, and the p-value), (5) Draw a statistical conclusion, and state the conclusion in words in the context of the problem. Assume  $\alpha = 0.05$  unless told otherwise.

### Assignment

**Question 1:** Consider the following research questions/study scenarios. For each study, report the type of outcome variable being analyzed, the most appropriate method for numerically describing the response in each group (e.g., means, proportions), and which statistical test is most appropriate to address the research question. Report the null and alternative hypotheses of the test.

- a. [10] A large study ( $n=200$  per group) was performed to determine differences in pain experienced by children with sickle cell disease in inpatient vs. outpatient settings. Pain intensity was the primary outcome of interest. A visual analog scale provided a visual scale/ruler that subjects used to indicate their level of pain. The scale used ranged from 0-10 and is treated as a continuous variable. Assume the variability in the outcome is similar across groups.
- b. [10] Elderly subjects are participating in a trial to investigate the benefits of strength training, brisk walking, yoga, and swimming on expression levels of inflammatory biomarkers. Participants were randomly assigned to one of the four groups, and we can assume the variability is similar in the outcome across groups. The post-training expression levels (continuous, normally distributed outcome) are of interest. The investigators are interested in determining if there a difference in the post-training expression levels among those who participated in strength training, brisk walking, yoga, or swimming.
- c. [10] A pediatric dentistry clinic wants to evaluate whether the type of instruction on tooth brushing impacts compliance. A study was conducted where 50 parents receive tooth brushing instruction from the dentist and 50 parents receive tooth brushing instruction from a paper information packet to take home. Tooth brushing compliance is defined as parents brushing the child's teeth on 20 or more out of the 30 days following the visit. The goal is to compare tooth brushing compliance between the two instruction groups.

**Question 2:** Determine the number of paired comparisons that would need to be tested to compare the following number of groups. Report the adjusted error rate ( $\alpha^*$ ) in each case if  $\alpha = 0.05$ .

- a. [3] 3 groups
- b. [3] 5 groups
- c. [3] 7 groups
- d. [3] 10 groups

**Question 3:** [35] Could a patient's mean platelet volume be a predictive marker for acute myocardial infarction (heart attack)? An experiment was conducted in which four groups of patients seeking treatment for chest pain were compared with respect to mean platelet volume (MPV, measured in fL). The four groups considered were based on the clinical diagnosis and were (1) noncardiac chest pain, (2) stable angina pectoris, (3) unstable angina pectoris, and (4) myocardial infarction. The purpose of the study was to determine if the mean MPV differs for the four groups, and, in particular, if the mean MPV is different for the heart attack group (group 4). If this is the case, MPV could then be used as an indicator of heart attack risk and an antiplatelet treatment could be administered, potentially reducing the risk of heart attack. To carry out this study, patients seen for chest pain were divided into the 4 groups listed above according to their diagnosis. The researchers then selected a random sample of 35 from each of the  $k=4$  groups. The researchers believed that this sampling process resulted in random samples from the four populations. The table below presents summary statistics for each group.

Group number	Group Description	Sample Size	Sample Mean	Sample Standard Deviation
1	Noncardiac chest pain	35	10.89	0.69
2	Stable angina pectoris	35	11.25	0.74
3	Unstable angina pectoris	35	11.37	0.91
4	Myocardial infarction	35	11.75	1.07

Use the appropriate statistical test to determine if the mean MPV is different between two (or more) of the groups. **Follow all the steps required when performing the hypothesis test.** What can you conclude (assuming  $\alpha = 0.05$ )? If there is evidence to reject this overall null hypothesis, the researchers would like to determine if mean MPV is different for the myocardial infarction group compared to the other groups included in the study. That is, not all pairwise comparisons are of interest. The researchers specified *a priori* that they are only interested in comparing the myocardial infarction group (group 4) with groups 1, 2, and 3 individually. Conduct your tests to maintain an overall  $\alpha = 0.05$  for these secondary comparisons.

**Question 4:** [23] The authors of the paper "Age and Violent Content Labels Make Video Games Forbidden Fruits for Youth" (Pediatrics, 2009), carried out an experiment in 12-13-year-old boys to determine if restrictive labels on video games increased the attractiveness of the game for young game players. Participants read a description of a new video game and were asked how much they wanted to play the game. The description also included an age rating. Some participants read the description with an age restrictive label of 7+, indicating that the game was not appropriate for children under the age of 7. Others read the same description, but with an age restrictive label of 12+, 16+, or 18+.

The boys rated how much they wanted to play the game on a scale of 1 to 10, with a higher score indicating a greater desire to play the game. The average rating given by the boys in each group is reported in the table below.

Rating Scale		
Age Restrictive Label	N	Mean
7+	10	4.8

Rating Scale		
Age Restrictive Label	N	Mean
12+	10	6.8
16+	10	7.1
18+	10	8.1

Assume that the boys were assigned at random to one of the four age label groups (7+, 12+, 16+, and 18+). The study enrolled 10 boys in each age label group, enrolling a total of N=40 boys into the study.

The research question looks at the theory that the more restrictive age label on a video game, the more attractive the game is to 12- to 13-year old boys. Assume the ANOVA assumptions are satisfied. The partial ANOVA table is shown below. Your task is to complete the shaded cells in the ANOVA table and determine if the data provide convincing evidence that the mean rating is not the same for all four age label groups. **Follow all the steps required when performing the hypothesis test.** Perform the test using a significance level of 0.05.

Source	Sum of Squares	DF	Mean Square	F	P-value
Model			19.13		
Error	103.00				
Total	160.40				

finding critical values and p-values using software for upper-tailed F-test and 2-tailed t-test and Z-test

	Distribution	Critical Value ( $F^*$ , $t^*$ , $Z^*$ )	P-value
R	N(0,1)	<code>qnorm(1-alpha/2)</code>	<code>2*(1-pnorm(abs(teststat)))</code>
	t(df)	<code>qt(1-alpha/2, df)</code>	<code>2*(1-pt(abs(teststat), df))</code>
	F(df1, df2)	<code>qf(1-alpha, df1, df2)</code>	<code>1-pf(teststat, df1, df2)</code>
SAS	N(0,1)	<code>zstar=probit(1-alpha/2);</code>	<code>pvalz=2*(1-probnorm(abs(teststat)));</code>
	t(df)	<code>tstar=tinv(1-alpha/2, df);</code>	<code>pvalt=2*(1-probt(abs(teststat), df));</code>
	F(df1, df2)	<code>fstar=finv(1-alpha, df1, df2);</code>	<code>pvalf=1-probf(teststat, df1, df2);</code>
Excel	N(0,1)	<code>=NORM.S.INV(1-alpha/2)</code>	<code>=2*(1-NORM.S.DIST(ABS(teststat), TRUE))</code>
	t(df)	<code>=T.INV(1-alpha/2, df)</code>	<code>=2*(1-T.DIST(ABS(teststat), df, TRUE))</code>
	F(df1, df2)	<code>=F.INV(1-alpha, df1, df2)</code>	<code>=1-F.DIST(teststat, df1, df2, TRUE)</code>