HH/HLST 2300: Statistical Methods in Health Studies
Winter Term Assignment 2
Assigned: Friday January 29, 2021; Due 5PM Friday February 12, 2021
Submit 1 file for Assignment 2: PDF
PDF document name: LASTNAME_FIRSTNAME_WTAssignment2
Submit via eClass

Note1: WT Assignment 2 is worth a total of 45 marks. Therefore, assignments submitted late were deducted 2.25 marks per day (45 * 0.05 = 2.25)
Note2: If you did not use the proper assignment naming convention, 4 marks were deducted.

As noted in my eClass announcement on Nov 5, 2020, you will be deducted marks if you submit a file other than a pdf file and if that file is named incorrectly. **For WT Assignment 1, the deduction is 4 marks for incorrect file name. The submission file type has been set up in eClass such that the only accepted file type is PDF.**

Other reminders that you should take care to ensure while completing your assignment:
- Questions involving a data file must be answered using SPSS
- HLST 2300 rounding rules apply unless otherwise stated
- Screenshots of any hand-written work and SPSS must be of high resolution and be pasted upright (not sideways) so that they can be easily read and graded
- Answers to questions must directly follow the question asked – do not change the order of the questions
- If you fail to include the SPSS output instructed of you, you will receive zero for any subsequent questions that rely on that output

A researcher has collected data for 158 adult (age ≥ 18 yrs) patients arriving via the Emergency Department (ED) and admitted as an inpatient to Hospital ABC (Excel file: 2300WTassignment**1**.xls). The data includes the unique patient identifier, sex (female = 1; male = 2), age (years), arrival day of week (DOW) (Sunday = 1; Monday = 2; Tuesday = 3; Wednesday = 4; Thursday = 5; Friday = 6; Saturday = 7), arrival mode (walk-in = 1; ambulance = 2), ED triage level (Resuscitation = 1; Emergency = 2; Urgent = 3), comorbidity level (levels range from 0 – 4 where level 0 represents no significant comorbidity and level 4 represents the group with the largest number of comorbidities), discharge disposition (Discharge Home = 1; Discharged Home with Supports = 2; Transferred to Long-term Care = 3), scores measured at ED arrival, hospital admission and hospital discharge, hospital length of stay (LOS) in days and resource intensity weight (RIW) which is a proxy for hospital resource use.

Before proceeding with any analysis, be sure to:
- Ensure that variables are of correct measure (nominal, ordinal, scale).
- Add labels to all categorical variables. For the variable comorbidity level, add labels Level 0, Level 1,…, Level 4 to the values 0, 1, …, 4.
- Reduce the number of decimal places to 2 for hospital LOS in the variable view (it will likely show 15 decimal places but only requires 2 decimal places).

1. Among patients that arrive via ambulance, are scores measured at ED arrival, hospital admission and hospital discharge significantly different?
   a) State the specific test you used and why that test was chosen (may require copying and pasting SPSS output table for sample size of appropriate variable). **[4 MARKS]**

   - we are comparing three groups (ED arrival, hospital admission, and hospital discharge);
   - the three groups are repeated (same group of patients are being tested in all three conditions – arrival, admission and discharge);
   - the variable of interest, score, is a scalar variable. Among ambulance arrivals, since the sample size is large (n ≥ 30): $n_{score\ at\ arrival}$ = $n_{score\ at\ admission}$ = $n_{score\ at\ discharge}$ = 84, the CLT states that parametric test is robust even if the assumption of normality is not met.

Case Processing Summary

| | | Cases | | | | | |
| | | Valid | | Missing | | Total | |
	Arrival mode	N	Percent	N	Percent	N	Percent
score_arrival	walk-in	74	100.0%	0	0.0%	74	100.0%
	ambulance	84	100.0%	0	0.0%	84	100.0%
score_admission	walk-in	74	100.0%	0	0.0%	74	100.0%
	ambulance	84	100.0%	0	0.0%	84	100.0%
score_discharge	walk-in	74	100.0%	0	0.0%	74	100.0%
	ambulance	84	100.0%	0	0.0%	84	100.0%

Some of the typical errors found in Question 1a:
- Did not explain that arrival, admission and discharge are the three groups we are comparing. [-1 MARK]
- Did not explain that arrival, admission and discharge are repeated groups. [-1 MARK]
- Did not explain that score is a scale variable. [-1 MARK]
- Did not include a table that indicates the number of observations for arrival, admission and discharge scores specific to patients arriving via ambulance. [-1 MARK]

   b) Copy and paste the relevant SPSS output table(s) used in reporting results, including pairwise (Bonferroni corrected) comparisons if applicable. **[5 MARKS]**

Descriptive Statistics[a]

	Mean	Std. Deviation	N
score_arrival	54.2946	14.55001	84
score_admission	50.6215	14.46686	84
score_discharge	77.6380	14.88853	84

a. Arrival mode = ambulance

Mauchly's Test of Sphericity[a,b]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[c]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
scores	.631	37.723	2	.000	.731	.740	.500

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

   a. Arrival mode = ambulance

   b. Design: Intercept
     Within Subjects Design: scores

   c. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects[a]

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
scores	Sphericity Assumed	36072.127	2	18036.064	111.685	.000
	Greenhouse-Geisser	36072.127	1.461	24686.724	111.685	.000
	Huynh-Feldt	36072.127	1.481	24360.345	111.685	.000
	Lower-bound	36072.127	1.000	36072.127	111.685	.000
Error(scores)	Sphericity Assumed	26807.377	166	161.490		
	Greenhouse-Geisser	26807.377	121.279	221.039		
	Huynh-Feldt	26807.377	122.904	218.116		
	Lower-bound	26807.377	83.000	322.980		

   a. Arrival mode = ambulance

Estimates[a]

Measure: MEASURE_1

scores	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	54.295	1.588	51.137	57.452
2	50.622	1.578	47.482	53.761
3	77.638	1.624	74.407	80.869

   a. Arrival mode = ambulance

Pairwise Comparisons[a]

Measure: MEASURE_1

(I) scores	(J) scores	Mean Difference (I-J)	Std. Error	Sig.[c]	95% Confidence Interval for Difference[c]	
					Lower Bound	Upper Bound
1	2	3.673[*]	1.235	.012	.656	6.690
	3	-23.343[*]	2.286	.000	-28.930	-17.757
2	1	-3.673[*]	1.235	.012	-6.690	-.656
	3	-27.016[*]	2.187	.000	-32.360	-21.673
3	1	23.343[*]	2.286	.000	17.757	28.930
	2	27.016[*]	2.187	.000	21.673	32.360

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

a. Arrival mode = ambulance

c. Adjustment for multiple comparisons: Bonferroni.

Some of the typical errors found in Question 1b:
- Did not copy and paste the Descriptive Statistics table for arrival, admission and discharge scores. [-1 MARK]
- Did not copy and paste the Mauchly's Test of Sphericity table for scores. [-1 MARK]
- Did not copy and paste the Tests of Within-Subjects Effects table for scores. [-1 MARK]
- Did not copy and paste the Estimates table (mean and SE) for scores. [-1 MARK]
- Did not copy and paste the Pairwise Comparisons table for scores. [-1 MARK]

c) Report the results, including showing your calculations for effect sizes if point estimates not included in SPSS output. **[6 MARKS]**

A repeated measures ANOVA with a Greenhouse-Geisser correction determined that among ambulance arrivals, the mean scores at arrival (M = 54.30 or 54.29 (if reporting from descriptive statistics table), SE = 1.59), admission (M = 50.62, SE = 1.58) and discharge (M = 77.64, SE = 1.62) were statistically significantly different, $F(1.46, 121.28) = 111.69$, $p < .001$.

Post hoc tests using the Bonferroni correction revealed that pairwise differences between all scores were significantly different: at arrival and admission, d = .25, p = .012; at arrival and discharge, d = -1.59, p < .001; and at admission and discharge, d = -1.84, p < .001.

Arrival vs admission:

$$d = \frac{54.2946 - 50.6215}{\frac{(14.55001 + 14.46686)}{2}} = 0.25$$

4

Arrival vs discharge:

$$d = \frac{54.2946 - 77.6380}{\frac{(14.55001 + 14.88853)}{2}} = -1.59$$

Admission vs discharge:

$$d = \frac{50.6215 - 77.6380}{\frac{(14.46686 + 14.88853)}{2}} = -1.84$$

Some of the typical errors found in Question 1c:
- Note, if reported results without producing the corresponding tables (part b) where these results came from, no marks are earned for part c.
- Did not report the mean _and_ standard error for arrival, admission and discharge scores correctly. [-1 MARK]
- Did not report F-value _and_ degrees of freedom correctly. [-1 MARK]
- Did not report p-value correctly _and_ state that result was statistically significant. [-1 MARK]
- Did not show calculations for, or calculated incorrectly, or reported incorrectly any of the three Cohen's d values. Note that if you switched the order of subtraction, this is fine; the d values will have the same magnitude but the opposite sign. [-1 MARK]
- Did not report the Bonferroni-corrected p-values, for any of the three pairwise comparisons correctly. [-1 MARK]
- Did not state that all pairwise comparisons are statistically significant. [-1 MARK]
- Rounding errors. [-0.5 MARKS in total]

2. Are there significant differences in age by discharge disposition?
   a) State the specific test you used and why that test was chosen (may require copying and pasting SPSS output table for sample size of appropriate variable). **[4 MARKS]**

   The specific test used was the one-way ANOVA because:
   - we are comparing three groups (discharged home, discharged home with supports and transferred to long-term care patients);
   - the three groups are independent (you can only be discharged to one location);
   - the variable of interest, age, is a scalar variable. Since the sample size is large ($n \geq 30$): n_{home} = 55, $n_{homewithsupports}$ = 65, $n_{transferredtoLTC}$ = 38, even if age among the three dispositions is skewed (ie non-normal), the CLT states that a parametric test is robust even if the assumption of normality is not met.

Case Processing Summary

		Cases					
		Valid		Missing		Total	
	Discharge Disposition	N	Percent	N	Percent	N	Percent
Age (years)	Discharged Home	55	100.0%	0	0.0%	55	100.0%
	Discharged Home with Supports	65	100.0%	0	0.0%	65	100.0%
	Transferred to Long-term Care	38	100.0%	0	0.0%	38	100.0%

Some of the typical errors found in Question 2a:
- Did not explain that discharged home, discharged home with supports and transferred to long-term care are the three groups we are comparing. [-1 MARK]
- Did not explain that discharged home, discharged home with supports and transferred to long-term care are independent groups. [-1 MARK]
- Did not explain that age is a scale variable. [-1 MARK]
- Did not include a table that indicates the number of age observations by discharge disposition. [-1 MARK]

b) Copy and paste the relevant SPSS output table(s) used in reporting results, including pairwise (Bonferroni corrected) comparisons if applicable. **[4 MARKS]**

Descriptives

Age (years)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
Discharged Home	55	82.75	5.232	.706	81.33	84.16	73	96
Discharged Home with Supports	65	84.66	5.951	.738	83.19	86.14	73	98
Transferred to Long-term Care	38	85.71	5.652	.917	83.85	87.57	76	101
Total	158	84.25	5.724	.455	83.35	85.15	73	101

Tests of Homogeneity of Variances

		Levene Statistic	df1	df2	Sig.
Age (years)	Based on Mean	.606	2	155	.547
	Based on Median	.450	2	155	.638
	Based on Median and with adjusted df	.450	2	150.082	.638
	Based on trimmed mean	.648	2	155	.524

6

ANOVA

Age (years)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	216.567	2	108.284	3.407	.036
Within Groups	4926.806	155	31.786		
Total	5143.373	157			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: Age (years)

Bonferroni

(I) Discharge Disposition	(J) Discharge Disposition	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Discharged Home	Discharged Home with Supports	-1.916	1.033	.196	-4.42	.58
	Transferred to Long-term Care	-2.965*	1.189	.041	-5.84	-.09
Discharged Home with Supports	Discharged Home	1.916	1.033	.196	-.58	4.42
	Transferred to Long-term Care	-1.049	1.151	1.000	-3.84	1.74
Transferred to Long-term Care	Discharged Home	2.965*	1.189	.041	.09	5.84
	Discharged Home with Supports	1.049	1.151	1.000	-1.74	3.84

*. The mean difference is significant at the 0.05 level.

Some of the typical errors found in Question 2b:
- Did not copy and paste the Descriptives table or values in the table are different than those shown. [-1 MARK]
- Did not copy and paste the Test of Homogeneity of Variances table or values in the table are different than those shown. [-1 MARK]
- Did not copy and paste the ANOVA table or values in the table are different than those shown. [-1 MARK]
- Did not copy and paste the Multiple Comparisons table or values in the table are different than those shown. [-1 MARK]

c) Report the results, including showing your calculations for effect sizes if point estimates not included in SPSS output. **[6 MARKS]**

A one-way ANOVA showed that there were significant differences in age between discharge home (M = 82.75, SE = .71), discharged home with supports (M = 84.66, SE = .74) and transferred to long-term care (LTC) (M = 85.71, SE = .92), F(2, 155) = 3.41, p = .036. A post-hoc test (Bonferroni

correction) showed that age differences between discharge home and transferred to LTC were significantly different, d = -.54, p = .041. The differences in age between discharge home and discharged home with supports was not statistically significant, d = -.34, p = .196. Similarly, the differences in age between discharged home with supports and transferred to LTC was also not statistically significant, d = -.18, p = 1.000.

Discharge home vs discharged home with supports:

$$d = \frac{82.75 - 84.66}{\frac{(5.232 + 5.951)}{2}} = -0.34$$

Discharge home vs transferred to long-term care:

$$d = \frac{82.75 - 85.71}{\frac{(5.232 + 5.652)}{2}} = -0.54$$

Discharged home with supports vs transferred to long-term care:

$$d = \frac{84.66 - 85.71}{\frac{(5.951 + 5.652)}{2}} = -0.18$$

Some of the typical errors found in Question 2c:
- Note, if reported results without producing the corresponding tables (part b) where these results came from, no marks are earned for part c.
- Did not report the mean _and_ standard error for age for all three discharge dispositions correctly. [-1 MARK]
- Did not report F-value _and_ degrees of freedom correctly. [-1 MARK]
- Did not report p-value correctly _and_ state that result was statistically significant. [-1 MARK]
- Did not show calculations for, or calculated incorrectly, or reported incorrectly any of the three Cohen's d values. Note that if you switched the order of subtraction, this is fine; the d values will have the same magnitude but the opposite sign. [-1 MARK]
- Did not report the Bonferroni-corrected p-values for all three pairwise comparisons correctly. [-1 MARK]
- Did not state that discharged home vs long-term care is the only statistically significant pairwise comparison. [-1 MARK]
- Rounding errors. [-0.5 MARKS in total]

3. Are there significant differences in the distribution of comorbidity levels among the three triage levels?
    a) State the specific test you used and why that test was chosen (may require copying and pasting SPSS output table for sample size of appropriate variable). **[3 MARKS]**

    The specific test used was the Kruskal-Wallis ANOVA because:
    - we are comparing three groups (resuscitation, emergency and urgent);
    - the three groups are independent (you can only be assigned one triage level for your ED visit);

- the variable of interest, comorbidity level, is an ordinal variable.

Some of the typical errors found in Question 3a:
- Did not explain that resuscitation, emergency and urgent are the three groups we are comparing. [-1 MARK]
- Did not explain that resuscitation, emergency and urgent are independent groups. [-1 MARK]
- Did not explain that comorbidity level is an ordinal variable. [-1 MARK]

b) Copy and paste the relevant SPSS output table(s) used in reporting results, including pairwise (Bonferroni corrected) comparisons if applicable. **[5 MARKS]**

Percentiles

| | | | Percentiles |
		Triage Level	5	10	25	50	75	90	95
Weighted Average (Definition 1)	Comorbidity level	Resuscitation	.00	.00	.75	1.50	3.00	4.00	.
		Emergency	.00	.00	.00	1.00	2.00	3.00	3.00
		Urgent	.00	.00	.00	.00	1.50	3.00	3.70
Tukey's Hinges	Comorbidity level	Resuscitation			1.00	1.50	3.00		
		Emergency			.00	1.00	2.00		
		Urgent			.00	.00	1.00		

Kruskal-Wallis Test

Ranks

	Triage Level	N	Mean Rank
Comorbidity level	Resuscitation	14	103.96
	Emergency	99	80.57
	Urgent	45	69.53
	Total	158	

Test Statistics[a,b]

	Comorbidity level
Kruskal-Wallis H	6.908
df	2
Asymp. Sig.	.032

a. Kruskal Wallis Test

b. Grouping Variable: Triage Level

9

Mann-Whitney Test

Ranks

	Triage Level	N	Mean Rank	Sum of Ranks
Comorbidity level	Resuscitation	14	72.07	1009.00
	Emergency	99	54.87	5432.00
	Total	113		

Test Statistics[a]

	Comorbidity level
Mann-Whitney U	482.000
Wilcoxon W	5432.000
Z	-1.925
Asymp. Sig. (2-tailed)	.054
Exact Sig. (2-tailed)	.056
Exact Sig. (1-tailed)	.029
Point Probability	.002

a. Grouping Variable: Triage Level

$px = k*ps = 3(.056) = .168$

Mann-Whitney Test

Ranks

	Triage Level	N	Mean Rank	Sum of Ranks
Comorbidity level	Emergency	99	75.70	7494.50
	Urgent	45	65.46	2945.50
	Total	144		

Test Statistics[a]

	Comorbidity level
Mann-Whitney U	1910.500
Wilcoxon W	2945.500
Z	-1.453
Asymp. Sig. (2-tailed)	.146
Exact Sig. (2-tailed)	.146
Exact Sig. (1-tailed)	.073
Point Probability	.000

a. Grouping Variable: Triage Level

$px = k*ps = 3(.146) = .438$

Mann-Whitney Test

Ranks

	Triage Level	N	Mean Rank	Sum of Ranks
Comorbidity level	Resuscitation	14	39.39	551.50
	Urgent	45	27.08	1218.50
	Total	59		

Test Statistics[a]

	Comorbidity level
Mann-Whitney U	183.500
Wilcoxon W	1218.500
Z	-2.499
Asymp. Sig. (2-tailed)	.012
Exact Sig. (2-tailed)	.012
Exact Sig. (1-tailed)	.007
Point Probability	.000

a. Grouping Variable: Triage Level

$px = k*ps = 3(.012) = .036$

Some of the typical errors found in Question 3b:
- Did not copy and paste the percentiles table or values in the table are different than those shown. [-1 MARK]
- Did not copy and paste the Kruskal-Wallis ranks _and_ Test statistics tables or values in the tables are different than those shown. [-1 MARK]

- Did not copy and paste the Mann-Whitney Test Table or values in the table are different than those shown (eg did not select exact p-values), for each pairwise comparison. [-1 MARK per Mann-Whitney Table]

c) Report the results, including showing your calculations for effect sizes if point estimates not included in SPSS output. **[8 MARKS]**

A Kruskal Wallis ANOVA showed that there was a statistically significant difference in the distribution of comorbidity levels among triage level Resuscitation (Weighted Average Mdn = 1.50, IQR [.75, 3.00]), triage level Emergency (Weighted Average Mdn = 1.00, IQR [0.00, 2.00]) and triage level Urgent (Weighted Average Mdn = 0.00, IQR [0.00, 1.50]), H(2) = 6.91, p = .032. The Mann-Whitney test, with significance levels corrected for multiple testing (Bonferroni correction) showed that the distribution of comorbidity levels between resuscitation and urgent were significantly different, U = 183.50, z = -2.50, p = .036, $r = \frac{-2.499}{\sqrt{59}} = -.33$. We did not find statistically significant differences in comorbidity levels between resuscitation and emergency, U = 482.00, z = -1.93, p = .168, $r = \frac{-1.925}{\sqrt{113}} = -.18$, or between emergency and urgent, U = 1910.50, z = -1.45, p = .438, $r = \frac{-1.453}{\sqrt{144}} = -.12$.

Some of the typical errors found in Question 3c:
- Note, if reported results without producing the corresponding tables (part b) where these results came from, no marks are earned for part c.
- Did not report the median *and* IQR comorbidity level for resuscitation, emergency and urgent groups correctly. [-1 MARK]
- Did not report H-value *and* degrees of freedom correctly. [-1 MARK]
- Did not report p-value correctly *and* state that result was statistically significant. [-1 MARK]
- Did not report all U-values correctly. [-1 MARK]
- Did not report all z-values correctly. [-1 MARK]
- Did not show calculations for, or calculated incorrectly, or reported incorrectly the Bonferroni-corrected p-values, for any of the three pairwise comparisons. Note if showed calculations in part b, this is fine. [-1 MARK]
- Did not state that resuscitation vs urgent is the only statistically significant pairwise comparison. [-1 MARK]
- Did not show calculations for, or calculated incorrectly, or reported incorrectly any of the three r values. Note if showed calculations in part b, this is fine. [-1 MARK]
- Rounding errors. [-0.5 MARKS in total]