Backpack Weight in Respect to Gender, Program and Year of Study

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Introduction

The focus of this research project was to collect backpack weights of one-hundred and fifty university students and determine if the weight increases with a higher year of study in science versus non-science students. This study investigates the assumption that students in higher years of study would yield heavier backpacks. This increase of backpack weight would suggest many negative impacts on a student including physical effects due to the overbearing weight. A study conducted by Perrone et al. found that an increased backpack weight was having negative effects on students, including negative physical and physiological effects (2018). Shuman published a study that highlighted an increase in forward-leaning due to a heavy backpack (2003).

The study was set at Thompson Rivers University, with data collected from a random population of students in the International Building (IB), the Science Building, and the Old Main (OM) building on campus. The optimal sample size was at least fifty students' data from each building to ensure better test results for better-supported conclusions. For data collection, we asked for the preferred gender, program, and year of study of the students along with taking the weight of their backpacks.

It is important to note that prior to asking students about their schooling and to weighing their backpacks, this study was approved by the Research Ethics (human subjects) Committee, including an approved questionnaire for the students to complete after consent to participate was given. This approval also approved the claim of complete privacy, and safekeeping and destruction of data.

We used the flow chart to test two group comparisons which led us to use the K-S test for normality, a two-sample variance test, the two-sample t-test for all three data sets, and then a descriptive statistics test. The goal of this study was to determine how gender, year of study, and program affects the weight of the backpack and the significance of each comparison.

Methods

We used a travel scale by *Kikkerland* and over a span of 2 days, walked around campus within school hours and asked students if we could weigh their backpacks. The scale recorded the weight in pounds, which we then recorded to the first decimal place. We then proceeded to ask for program specification as well as year of study and preferred gender pronouns. Once the projected goal of collecting 150 samples was satisfied, we put the data into Microsoft Excel and organized it by stacking it into one whole sample in a column. We then proceeded to unstack the data into weight via year, gender, and program. We then uploaded the information into the Minitab software so we could perform the data analysis.

We first used Minitab to perform a Kolmogorov-Smirnov test for normality for each individual data set (see Table 1.) We organized the information of backpack weight in three sections: male vs. female, science students vs. non-science students, and Year 1 of study vs. all other years of study. Then when these were equal, we went on to perform a test for variances, also known as an F-test (see Table 2.) Once we had the variances for the samples, we did the two-sample t-test (see Table 3) for all three data sets. The last test we performed was a simple descriptive stats test which yielded the results for mean, standard deviation, variance, median, and coefficient of variance.

Results

Data collected from our two-day sample of 150 independent students were analyzed using Minitab to carry out three statistical tests. The Kolmogorov-Smirnov (KS) test conducted looking to see if our samples backpack weight, for Male (KS value 0.099) and Female (KS value 0.076) students in all years of study and programs (p-value = > 0.150) fits a normal curve. Similar to gender degree type for science majors (KS value 0.090) and non-science majors (KS values 0.088) with a probability of obtaining equal variances of (p-value = > 0.150) were looked at if their variances fit a normal curve. Year of study was found to be a bit more variable with first-year students (KS value = 0.118) obtaining a KS value much larger than all the other years of studies (KS value 0.087) while p-values were calculated to be 0.055 and 0.103, respectively.

To test to see whether the data had equal variances, we used an equal variance (F-test). If the test results all yielded a p-value over 0.05, we would fail to reject the null hypothesis that our data would be normal. All our data groups (year, program, and gender) all have p-values over 0.05, as seen in Table 2, so we failed to reject each test. Furthermore, after supporting each test, as the data all appeared to be normal, we then conducted a two-sample t-test for each section.

The first two-sample t-test conducted was to compare gender and bag weight which resulted in a negative T-value of -0.009 and a p-value determining the significance of the results of 0.931. Then a comparison of students in science degrees and non-science degrees using the same two-sample t-test produced a lower negative T-value of -1.09 and a p-value of 0.276. The last use of this test was looking at first-year students compared to all other students in higher years which resulted in a T-value of 0.002 which is closest to the standard curves mean and produced a p-value of 0.987.

The final test conducted was a basic stats test that calculated the mean, standard deviation, variance, coefficient of variance and median. Testing of each variable for every sample was conducted and Male only samples were found to have the lowest standard deviation (4.219) and variance (17.799), while it has the greatest coefficient of variance (34.77). While Female samples had the greatest standard deviation (5.081), variance (25.812) and coefficients of variance (41.64). Students in science degrees obtained the lowest mean value of (11.771) and median (11.00), while non-science students had the greatest mean of (12.598).

The sample of students in their first year of study had the second-highest variance (21.112) and overall greater basic statistic values compared to non-first year students except median which was only (12.00) for first year and (12.50) for higher years.

Table 1. Results from K-S normality tests.

Tests	**KS value**	**P-value**
Male	0.099	>0.150
Female	0.076	>0.150
Sciences	0.090	>0.150
Non-sciences	0.088	>0.150
Year 1 of study	0.118	0.055
All other years of study	0.087	0.103

Table 2. Results from two-sample variance test (F-test for equal variances).

Test	**F value**	**P-value**
Male vs Female	0.69	0.131
Sciences vs non-sciences	0.99	0.950
Year 1 vs All others (of study)	1.06	0.812

Table 3. Results from two-sample t-tests.

Test	**T value**	**P-value**
Male vs Female	-0.009	0.931
Sciences vs non-sciences	-1.09	0.276
Year 1 vs All others (of study)	0.002	0.987

Table 4. Results from the basic stats test.

Tests	Mean	Standard Deviation	Variance	Coefficient of Variance	Median
Male	12.133	4.219	17.799	34.77	12.000
Female	12.2020	5.081	25.812	41.64	12.500
Sciences	11.771	4.487	20.130	38.12	11.000
Non-sciences	12.598	4.518	20.409	35.86	12.500
Year 1 of study	12.164	4.595	21.112	37.77	12.000
All other years of study	12.151	4.473	20.006	36.81	12.500

Discussion

Statistical analysis of our three tests for Gender, Program, and year of the study was conducted after collection of data taken over a 2-day span. It is important to note that for a test to be supported, the p-value had to range over 0.05 or 5%. If any p-values fell below the 5% mark, the test would, therefore, be rejected. The KS test used to observe if our data fit a normal curve resulting in use deciding to fail to reject the null hypothesis by chance alone our p-value was found to be greater than a=0.05 by 0.150 for Degree and gender (Table 1). Year of study gave use a p-value of 0.055 and 0.103 for first-year students and upper-year students respectively (Table 1). Year of study for both variables resulted in our group failing to reject the null hypothesis that backpack weight was distributed normally by chance alone. Therefore, we failed to reject all KS tests for normality as all the data appeared to be normal, as seen in Table 1. Moreover, as seen in Table 2, we failed to reject the two-sample variance tests for gender, program and year, as all pairs of data appeared to have equal variances. Finally, in Table 3, we failed to reject the two-sample t-test for gender as the p-value was 0.931 (above 0.05) as the data plots appeared to be the same. We also failed to reject the two-sample t-tests for both program and years as both the p-values were 0.276 and 0.987 respectively, therefore, indicating that the plots appeared to be the same.

To fully support the results, basic statistics tests were completed, as seen in Table 4. Basic statistics are important because they allow us to potentially conclude why the tests yielded the results that they did. The basic statistics table also reduce our data into comprehensible values that can be easily used for comparisons and summaries.

In future tests, it would be beneficial to initially take a sample of random students, but then weight their backpacks every day of school for a week and take the average weight rather than one day of the week. This is due to the daily variation of a student’s backpack weight due to the constant change in daily classes over the days of the week. Another study may also ask students to report of any physical, both long-term and short-term pain due to the weight of their backpacks.

References

Perrone, M., Orr, R., Hing, W., Milne, N., & Pope, R. (2018). The Impact of Backpack Loads on School Children: A Critical Narrative Review. *International journal of environmental research and public health*, *15*(11), 2529. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6267109/#

Shuman, Barbara Dixon. 2003. “The effect of backpack weight on the height of middle school students”. Theses Digitization Project. 2172. https://scholarworks.lib.csusb.edu/etd-project/2172

Appendix

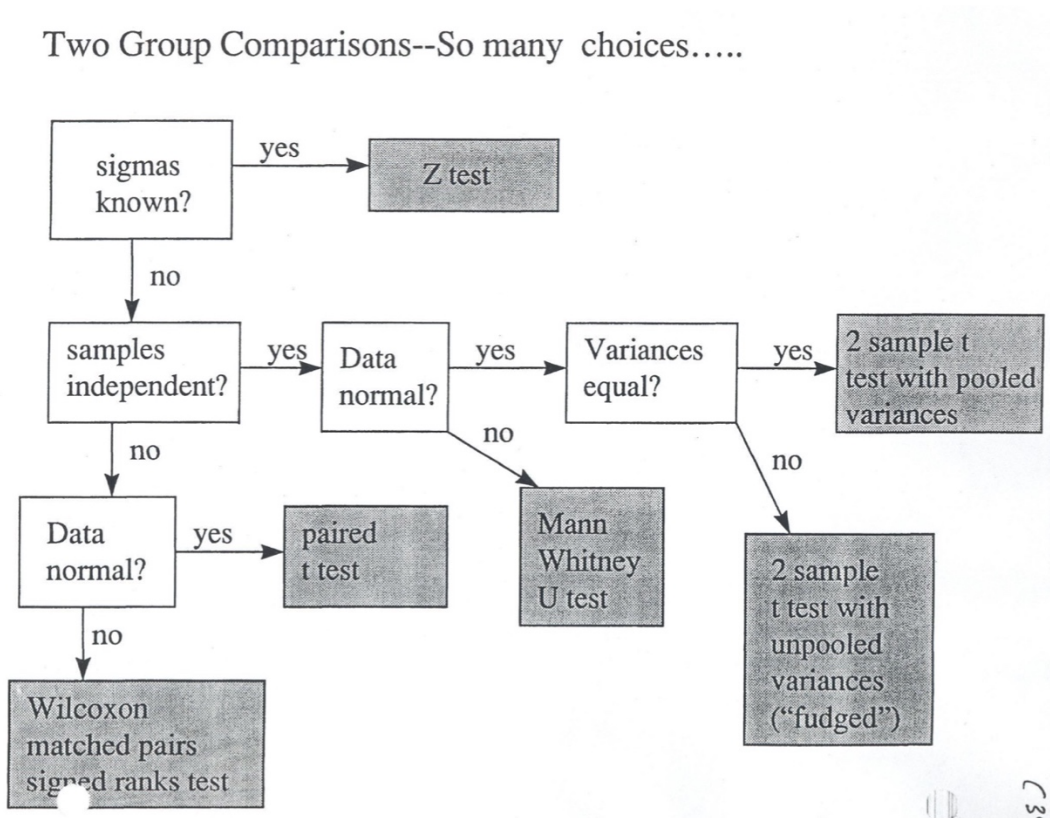

Figure 1. Flow chart used to determine 2-tailed t-test and K-S test used in the study.

Table 5. Two-tailed t-test values calculated for year.

Two-tailed T-test ----- for year

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
0.02	140	0.987

Table 6. Two-tailed t-test values calculated for program.

Two-tailed T-test ---- for program

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-1.09	140	0.276

Table 7. Two-tailed t-test values calculated for gender.

Two-tailed T-test---- for gender

Null hypothesis	$H_0: \mu_1 - \mu_2 = 0$
Alternative hypothesis	$H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
-0.09	140	0.931

Table 8. Basic Statistics values recorded for year.

Basic Statistics --- for year

Variable	Mean	StDev	Variance	CoefVar	Median
Year 1	12.164	4.595	21.112	37.77	12.000
All others	12.151	4.473	20.006	36.81	12.500

Table 9. Basic Statistics values recorded for program.

Basic Statistics --- for program

Variable	Mean	StDev	Variance	CoefVar	Median
Non-sci	11.771	4.487	20.130	38.12	11.000
Sciences	12.598	4.518	20.409	35.86	12.500

Table 10. Basic Statistics values recorded for gender.

Basic Statistics --- for gender

Variable	Mean	StDev	Variance	CoefVar	Median
Female	12.133	4.219	17.799	34.77	12.000
Male	12.202	5.081	25.812	41.64	12.500

Table 11. F-test for equal variances for year of study.

YEAR

Test and CI for Two Variances: Year 1, All others

Method

σ_1: standard deviation of Year 1
σ_2: standard deviation of All others
Ratio: σ_1/σ_2
F method was used. This method is accurate for normal data only.

Descriptive Statistics

Variable	N	StDev	Variance	95% CI for σ
Year 1	55	4.595	21.112	(3.868, 5.660)
All others	87	4.473	20.006	(3.893, 5.258)

Ratio of Standard Deviations

Estimated Ratio	95% CI for Ratio using F
1.02725	(0.811, 1.318)

Test

Null hypothesis H_0: $\sigma_1 / \sigma_2 = 1$
Alternative hypothesis H_1: $\sigma_1 / \sigma_2 \neq 1$
Significance level $\alpha = 0.05$

Method	Test Statistic	DF1	DF2	P-Value
F	1.06	54	86	0.812

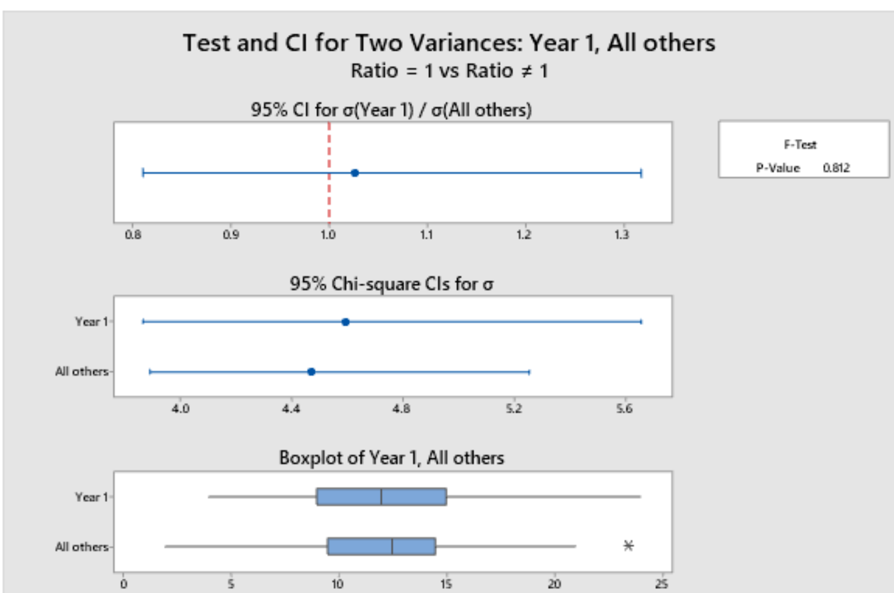

Table 12. F-test for equal variances for program.

PROGRAM

Test and CI for Two Variances: Non-sci, Sciences

Method

σ_1: standard deviation of Non-sci
σ_2: standard deviation of Sciences
Ratio: σ_1/σ_2
F method was used. This method is accurate for normal data only.

Descriptive Statistics

Variable	N	StDev	Variance	95% CI for σ
Non-sci	76	4.487	20.130	(3.869, 5.340)
Sciences	66	4.518	20.409	(3.857, 5.454)

Ratio of Standard Deviations

Estimated Ratio	95% CI for Ratio using F
0.993141	(0.782, 1.256)

Test

Null hypothesis	H_0: $\sigma_1 / \sigma_2 = 1$
Alternative hypothesis	H_1: $\sigma_1 / \sigma_2 \neq 1$
Significance level	$\alpha = 0.05$

Method	Test Statistic	DF1	DF2	P-Value
F	0.99	75	65	0.950

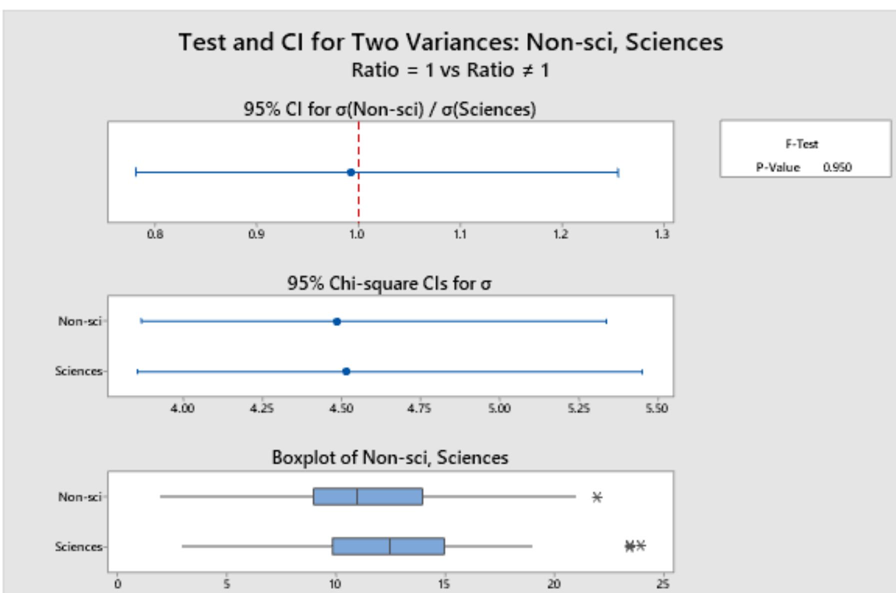

Table 13. F-test for equal variances for gender.

GENDER

Test and CI for Two Variances: Female, Male

Method

σ_1: standard deviation of Female
σ_2: standard deviation of Male
Ratio: σ_1/σ_2
F method was used. This method is accurate for normal data only.

Descriptive Statistics

Variable	N	StDev	Variance	95% CI for σ
Female	95	4.219	17.799	(3.692, 4.922)
Male	47	5.081	25.812	(4.222, 6.381)

Ratio of Standard Deviations

Estimated Ratio	95% CI for Ratio using F
0.830403	(0.638, 1.057)

Test

Null hypothesis H_0: $\sigma_1 / \sigma_2 = 1$
Alternative hypothesis H_1: $\sigma_1 / \sigma_2 \neq 1$
Significance level $\alpha = 0.05$

Method	Test Statistic	DF1	DF2	P-Value
F	0.69	94	46	0.131