

Loomis Ideal Body Proportions

An investigation of the artistic ideal versus actual body proportions

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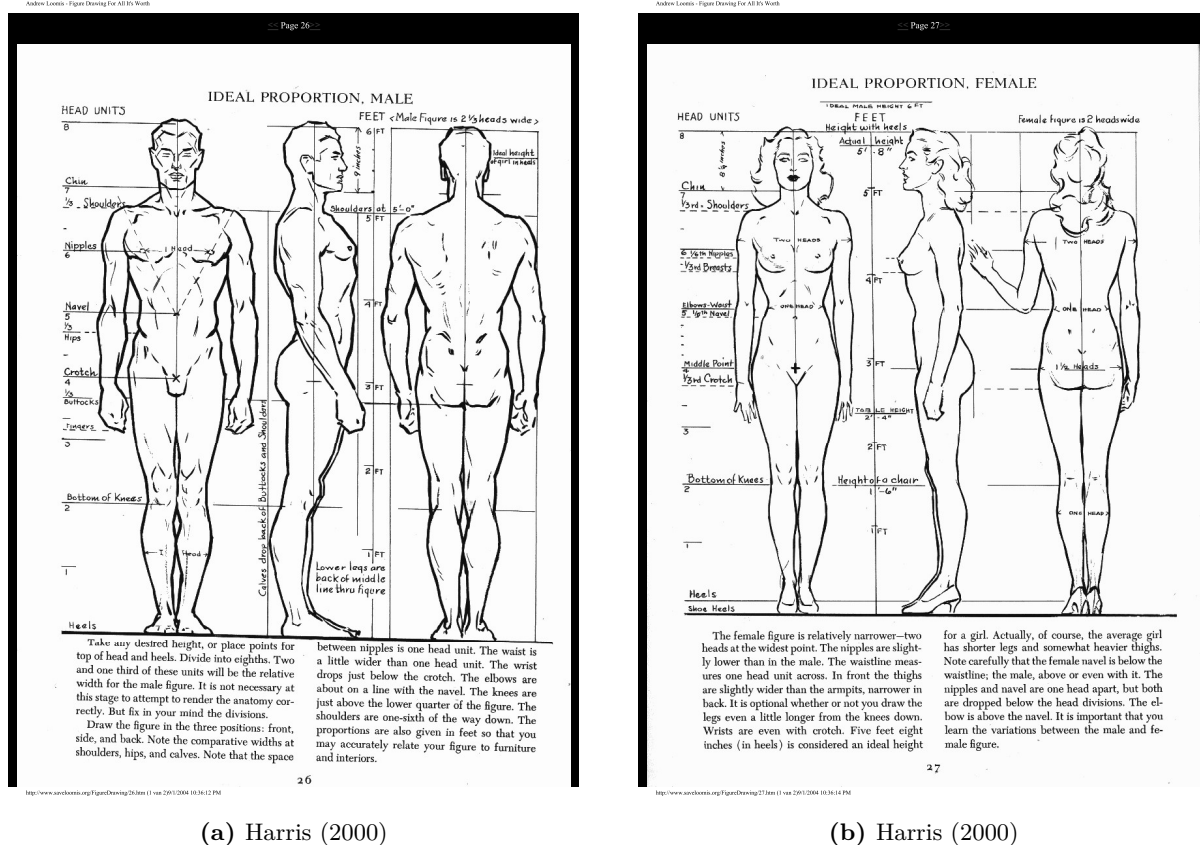
In this article we compare the ideal body proportions characterized by Andrew Loomis (Loomis 1943) to a sample of 223 adults collected by WSU students. Loomis proposed that the total height of the ideal human body should be 8 times the height of the head for both men and women. To test the validity of this claim, a data set was used that was collected by students as part of a course project. The students prepared a handout and requested information such as eyecolor, gender, dominant hand, and various numeric measurements of different body parts. Submissions were aggregated and screened to remove poor quality and potentially fabricated entries. The data was explored to determine if the observed head height to total body height ratios were in agreement with the idealized proportions proposed by Loomis. Variations based on gender were also explored, and other general proportional “rules” were also investigated. The results showed low positive correlation between head height and overall body height. Additionally, the standard deviation from the ideal proportion proposed by Loomis was found to be $\pm 10\%$ for 68% of respondents. A general “rule” was uncovered that the height from the floor to armpit is strongly correlated with the total height, however, this is not surprising. No other significant “rules” were found from exploring the data.

Keywords: Andrew Loomis, Correlation

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1 Introduction

Andrew Loomis was a well known and influential art instructor in the mid 20th century who authored a series of drawing manuals describing how to accurately depict the human body. These manuals are still being published over 80 years later and are widely considered to be the penultimate guide to figure drawing (Harris 2000). In his iconic work “Figure Drawing For All It’s Worth”, he describes the artistic ideal male and female proportions (Fig. 1). Loomis proposed that to draw a male or female subject accurately, the artist should divide the figure into 8 sections. The section height should be the length of the individuals head, and that length should correspond to roughly 1/8th of the entire length of the body.



(a) Harris (2000)

(b) Harris (2000)

Figure 1

2 Primary research question

Were the idealized body proportions proposed by Loomis accurate?

2.1 Secondary question

Do these proportions hold true for both male and female populations?

2.2 Tertiary question

Are there other proportion “rules” that can be inferred from the data?

3 Data Description

Data was collected from WSU students as part of a course in Multivariate Statistics. Each student was responsible for submitting body measurements and metadata from 10 unique people. Students created a hand out and requested measurements of different body parts from both the left and right hand sides, as well as categorical data regarding eye color, dominant writing hand, ethnicity, and other covariates. The student data submissions were aggregated and then anonymized and screened for duplicate or low-integrity entries. The initial dataset of 428 samples was reduced to 251 individuals ranging in age from 1 to 94 years old. Since body proportions change from juveniles through adulthood, the data set was further constrained to include only adults 18 years of age or older, leaving a pool of 223 individuals. Loomis maintained that the same ratio applied to both males and females, so subjects from both genders were considered.

Participants were expected to measure themselves and were asked to rate the quality their measurements. While both left and right sides body parts were requested, the difference in recorded length attributable to asymmetry was considered to be less than the measurement error. Therefore, the average of both sides was calculated and submitted.

3.1 Summary of Sample

Approximately 47% of respondents were female, 53% were male, and less than 1% identified as non binary. The average age of the study participants was 37, while the median age was 29. The ethnicity of the participants surveyed was 73.5% Caucasian, 17% Asian, 3.1% Hispanic, 1.3% African American, 3.1% mixed race, and 1.8% were members of other races.

3.2 Summary Statistics of Data

A Kaiser-Meyer-Olkin (KMO) Test was performed and confirmed the data was suitable for factor analysis. The data was then scaled and a correlation table was prepared for total height and head height (Table 1). A correlation table showing all the measurements was also prepared and has been included in the Appendix.

Table 1: Descriptive Statistics and Correlation Analysis

	M	SD	1	2	3
1 Total Height (in)	.0	1.00	1		
2 Head Height (in)	.0	1.00	.18**	1	
3 Total Height (in)	.0	1.00	1.00***	.18**	1
4 Head Height (in)	.0	1.00	.18**	1.00***	.18**

Notes: Pearson pairwise correlations are reported;
a two-side test was performed to report correlation significance.

† $p < .10$ * $p < .05$ ** $p < .01$ *** $p < .001$

4 Key Findings

Height was found to have a strong positive correlation with the armpit to floor measurement (Appendix: Table 1). Head height and overall height, however, were not shown to have a strong correlation (Table 1). To further investigate the accuracy of Loomis's ideal body proportions, each individual survey respondents height was divided by 8, and that number was compared to the actual head height measurement. The 1/8th total height approximation for head height was found to have one standard deviation equal to +/- 10% for the data for both genders. When each gender was examined separately, the standard deviation for males was 10.16092% and for females was found to be 10.84867%, showing females have a slightly wider variation from the mean than males.

5 Conclusion

While Loomis's ideal body proportions may form a useful baseline for drawing the human body, our study showed that the participants in the sample population did not to conform to the idealized standard. This finding was shown to hold true regardless of gender, as neither gender appears to closely conform to the standard proportions proposed by Loomis. From analysis of the correlation table, other proportional "rules"

that could be inferred follow intuitive logic. For example, total height was shown to be strongly correlated with the floor to armpit measurement. Foot length, floor to knee distance, floor to hip, and lower arm length showed a moderate positive correlation.

6 APPENDICES

6.1 *Data Provenance*

6.1.1 Data Collection Handout

Figure 2: Handout Page 1

Name: _____

What is your dominant hand? _____

What is your dominant eye? _____

What color are your eyes? _____

What side is your dominant swing of a bat? _____

How old are you? _____

By what gender do you currently identify? _____

What is your ethnicity? _____

Measurement Guide

height	Standing height of the individual, preferably with NO SHOES on
head.height	Height from the top of the head to below the chin
head.circumference	Distance around head, measured right above ears/eyes
hand.length	Length of hand from middle finger to wrist
hand.width	Width of hand from pinkie finger to thumb fully stretched
hand.elbow	Length from middle finger to elbow
elbow.armpit	Length from elbow to arm pit
arm.reach	Standing flatfooted, length from floor to the extended arm
arm.span	Length from each middle finger, fully extended
foot.length	Length of foot from largest toe to back of heel
floor.kneepit	Distance from floor to the knee pit
floor.hip	Distance from the floor to the hip
floor.navel	Distance from the floor to the navel
floor.armpit	Distance from the floor to the arm pit

Notes: (To be completed later)

Figure 3: Handout Page 2

	Circle One: Imperial Metric	
Body Part	Measurement	
height		
head.height		
head.circumference		
floor.navel		
arm.span		
	Right	Left
hand.length		
hand.width		
hand.elbow		
elbow.arpmit		
arm.reach		
foot.length		
floor.kneepit		
floor.hip		
floor.arpmit		

How long did this take? _____

What is the overall quality of the measurements? (1-10) _____

6.1.2 Full Correlation Table

Figure 4: Correlation Table

Table 1: Descriptive Statistics and Correlation Analysis

	M	SD	1	2	3	4	5	6	7	8	9	10
1 height	.0	1.00	1									
2 head height	.0	1.00	.18**	1								
3 head circumference	.0	1.00	.22**	.17*	1							
4 hand width	.0	1.00	.41***	.08	.30***	1						
5 hand elbow	.0	1.00	.61***	.12†	.05	.40***	1					
6 elbow armpit	.0	1.00	.34***	.03	-.22**	.03	.38***	1				
7 arm reach	.0	1.00	.23***	.05	.05	.36***	.02	-.06	1			
8 foot length	.0	1.00	.64***	.18**	.16*	.48***	.47***	.25***	.36***	1		
9 floor kneepit	.0	1.00	.62***	.20**	.14†	.16*	.42***	.26***	.11	.42***	1	
10 floor hip	.0	1.00	.58***	.08	.14†	.41***	.39***	.21**	.18*	.43***	.41***	1
11 floor armpit	.0	1.00	.81***	.13†	.24***	.43***	.59***	.32***	.28***	.56***	.52***	.68***

Notes:

Pearson pairwise correlations are reported.

a two-sided test was performed to report correlation significance.

†p < .10

*p < .05

**p < .01

***p < .001

6.2 Preparing the Report Workspace as a subsection

6.2.1 Preparing the Report Workspace as a subsubsection

Preparing the Report Workspace as a paragraph

Preparing the Report Workspace as a subparagraph Below is the necessary functions and libraries required to run the code referenced in this document.

```
library(devtools);          # required for source_url
```

```
## Warning: package 'devtools' was built under R version 4.0.3
```

```
path.humanVerseWSU = "https://raw.githubusercontent.com/MonteShaffer/humanVerseWSU/"
source_url( paste0(path.humanVerseWSU,"master/misc/functions-project-measure.R") );
```

```
## Warning: package 'survival' was built under R version 4.0.3
```

Below is the code to load the data and prepare it for analysis.

```
path.project = "C:\\Users\\jsmit\\Desktop\\WSU\\DataAnalytics\\STAT419\\
WSU_STATS419_FALL2020\\project-measure\\";

path.to.secret = "C:\\Users\\jsmit\\Desktop\\WSU\\DataAnalytics\\STAT419\\_SECRET\\";

measure = utils::read.csv( paste0(path.to.secret, "measure-students.txt"),
                           header=TRUE, quote="", sep="|");

path.github = "https://raw.githubusercontent.com/jsmith0434/WSU_STATS419_FALL2020";
source_url( paste0(path.github,"/master/functions/functions-project.R") );

measure_data = utils::read.csv( paste0(path.to.secret, "final.measure.txt"),
                                header=TRUE, quote="", sep="|");
measure_cleaned = cleanUpData(measure_data)

adults = measure_cleaned[measure_cleaned$age >= 18, ]
```

Below is the code to generate the summary statistics and save them as the table that you see in Section ??.

```
path.humanVerseWSU = "https://raw.githubusercontent.com/MonteShaffer/humanVerseWSU/"
source_url( paste0(path.humanVerseWSU,"master/misc/functions-project-measure.R") );

path.project = "C:\\Users\\jsmit\\Desktop\\WSU\\DataAnalytics\\STAT419\\
WSU_STATS419_FALL2020\\project-measure\\";
path.tables = paste0(path.project,"tables\\");

file.correlation = paste0(path.tables,"height-head-correlation-table.tex");

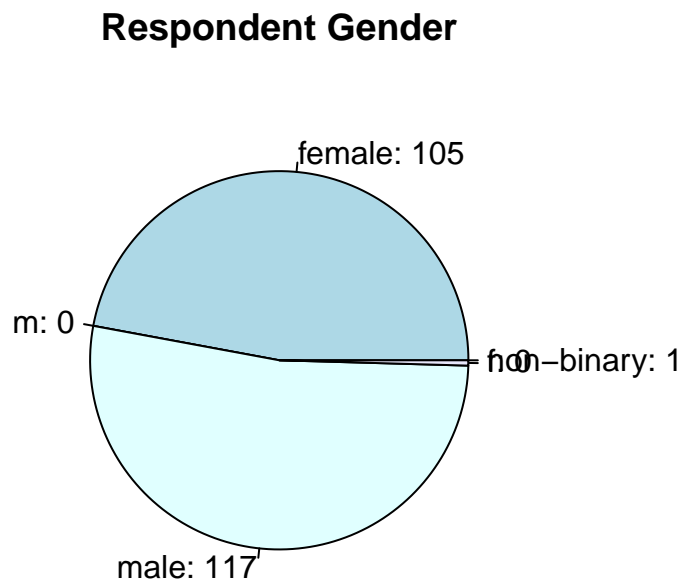
myData = as.matrix(adults[, 3:4]); # numeric values only, only what will appear in table
myData = scale(myData)
myData = cbind(myData,myData);
```

```
buildLatexCorrelationTable(myData,
  rotateTable = FALSE,
  width.table = 01.1,
  myFile = file.correlation,
  myNames = c("Total Height (in)", "Head Height (in)", "Total Height (in)", "Head Height (in)" );

Sys.sleep(2); # in case Knit-PDF doesn't like that I just created the file...
```

A pie chart showing the breakdown of participants by gender.

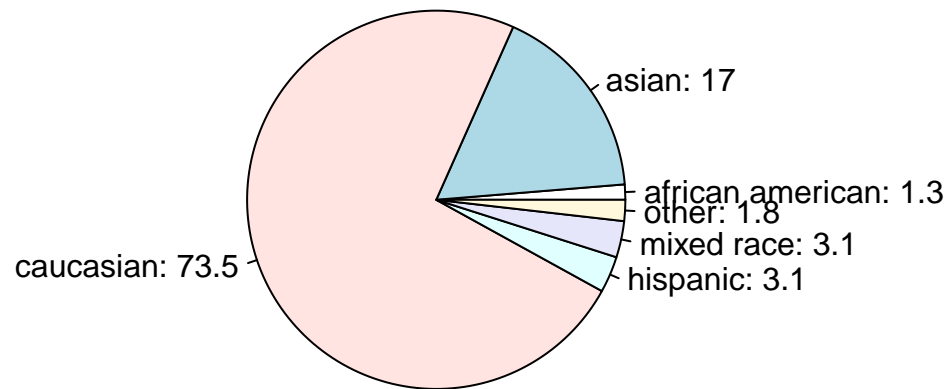
```
mytable2 <- table(adults$gender)
lbls <- paste(names(mytable2), ":", mytable2, sep="")
pie(mytable2, labels = lbls, main="Respondent Gender")
```



A pie chart showing ethnicity.

```
mytable <- round(prop.table(table(adults$ethnicity))*100,1)
lbls <- paste(names(mytable), ":", mytable, sep="")
pie(mytable, labels = lbls, main="Respondent Ethnicity")
```

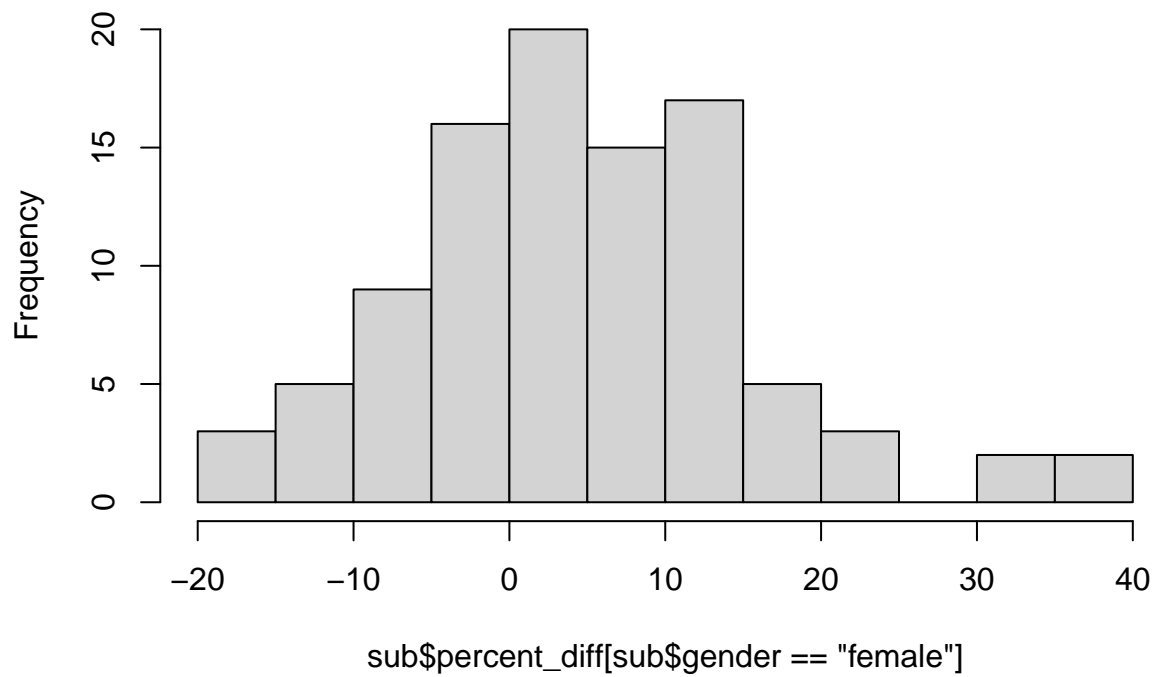
Respondent Ethnicity



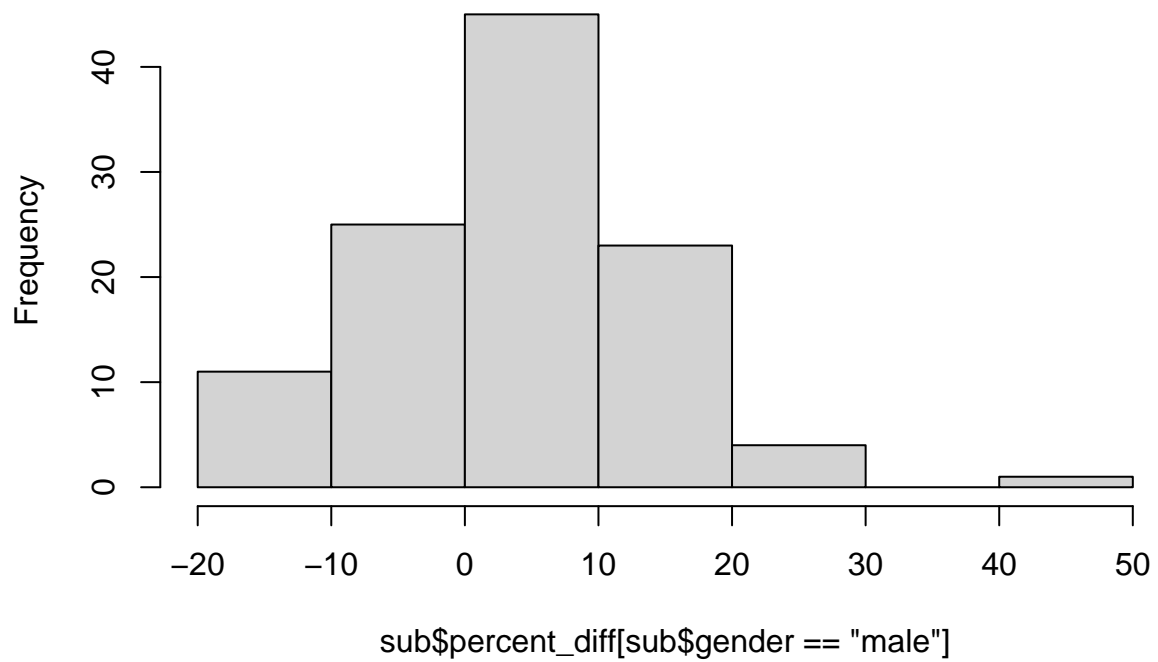
Histograms that show the distribution of the percent deviation from the ideal standard head height to body height ratio proposed by Loomis.

```
sub = adults[, c("height", "head.height", "gender")]
sub$eighth = sub$height/8
sub$percent_diff = ((sub$head.height - sub$eighth)/sub$head.height) * 100

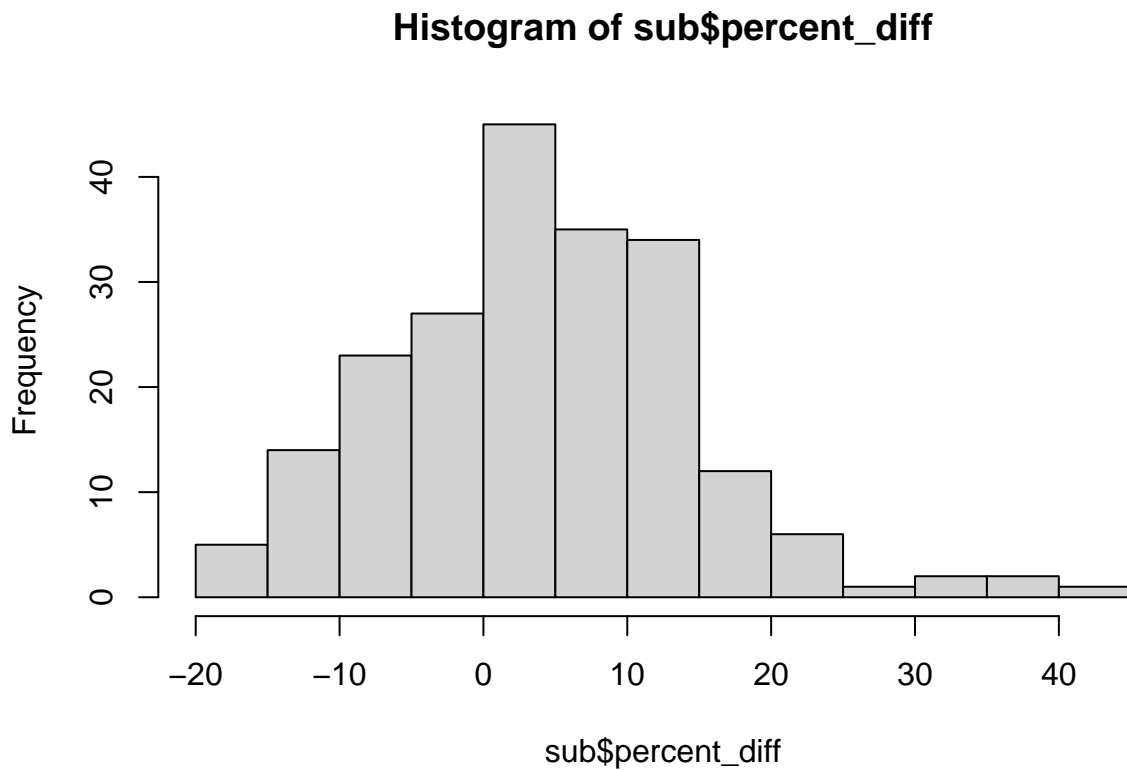
hist(sub$percent_diff[sub$gender=="female"])
```

Histogram of sub\$percent_diff[sub\$gender == "female"]

```
hist(sub$percent_diff[sub$gender=="male"])
```

Histogram of sub\$percent_diff[sub\$gender == "male"]

```
hist(sub$percent_diff)
```



The code used to generate the KMO score.

```
sub2 = adults[,c(3,4,5,20:27)]
sub2 = scale(sub2)
sub2 = as.data.frame(sub2)

# this is the standard correlation matrix
sub2.corr = cor(sub2, use = "complete.obs");

library(REdaS); # install.packages("REdaS", dependencies=TRUE);
sub2.KMO = KMOS(sub2, use = "complete.obs");

my.kmo = sub2.KMO$KMO;
my.kmo
```

The code used to generate the large correlation table included in the appendix.

```
myData2 = as.matrix(sub2)

file.correlation = paste0(path.tables,"scaled-correlation-table.tex");

buildLatexCorrelationTable(myData2,
  rotateTable = TRUE,
  width.table = 1.6,
  myFile = file.correlation,
  myNames = c(colnames(sub2), colnames(sub2))
)
```


REFERENCES

- Harris, J.F. 2000. *Andrew Loomis: A Legacy in Words and Pictures*. Syracuse University.
- Loomis, Andrew. 1943. *Figure Drawing for All It's Worth*. Viking Adult.

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