

The Influence of Biological Sex on Human Body Part Ratios

How these Ratios Compare Between the Sexes

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In this article we compare the *empirical characteristic function* (??) to a *moment-generating-functional form* to compute the proportion of hypotheses m that are rejected under the null hypothesis.

Here is a second paragraph of the abstract (if necessary), and with the pipe notation it doesn't break. Notice it still needs to be indented.

Generally, we write this abstract last. Often it is called the executive summary. It should succinctly summarize the entire document. You can include references such as this one to the Appendices section 6 if necessary.

Keywords: multiple comparisons to control; multivariate chi-square distribution; nonlinear growth curves; Richard's curve; simulated critical points

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1 Introduction

As a customary portion of the STAT 419 course at Washington State University, the students involved were required to take part in a data collection/manipulation project involving the measurements of various body parts. Following the data collection, professor Monte Shaffer compiled all contributions made by the students into a single, pipe-delimited text file whose explicit content is to remain confidential and only used for the sake of addressing a variety of research questions.

After receiving the data set ($n = 428$) and cleaning up particular observations using a range of methodologies based on what I had in mind for how this data will be used, I determined that I would focus on what kind of influence biological sex has on certain human body part ratios. To supplement my inquiry of this data, I centered my research questions around particular measurements of the human body, such as height, arm span, foot length, distance from elbow to armpit, head height, just to name a few. Research questions pertaining to this study and supportive R code can be found below.

2 How does being male or female influence the ratios between certain body parts?

2.1 How does 'height' compare to 'arm span' between males and females?

2.2 How does 'foot length' compare to the length of 'elbow to armpit' between males and females?

2.3 How many average 'head height' lengths are males and females relative to their respective, average 'height'?

3 Data Description

As mentioned in the introduction, the data set utilized throughout this research paper was supplied through the combined efforts of professor Monte Shaffer and the students of the STAT 419 class at Washington State University. Each student was tasked with recording distinct observations of 37 variables from 10 different people, ideally with an even mix of males and females. For each observation (person), there are measurements of body parts, data collector/surveyor identifiers ran through a MD5 hash function, and general information

about each surveyor. Body part measurements were recorded using body measuring tape in either inches or centimeters, but for the sake of consistency throughout the research paper, all centimeter values were converted to inches and will be referred to in inches.

These observations were recorded in early September 2020 and compiled by the instructor for our use in late October 2020. Given that these observations were recorded amid the COVID-19 pandemic, each student was required to make a simple, yet descriptive handout that would detail how one would go about recording their own body measurements and the necessary values to take note of. This would be an ideal situation of how observations were recorded and sent electronically by each surveyor, but observations could also be taken in person given that the recorder and surveyor were comfortable being in close proximity of each other. An example of a two-page handout created by Kevin Black, as well as further information regarding this data set, can be found in Appendix 6.1.2 and Appendix 6.2, respectively.

On the surface, the purpose for writing this research paper and collecting the necessary data can simply be attributed to project requirements for a university course. However, the deeper reasoning behind why this research paper was composed the first place was to give students a more thorough understanding of the data analytics process. More specifically, how to not just work with the data, but how to understand the data and derive effective questions, how to test for patterns and conclusions in a statistical, analytic environment, and how to exercise data provenance practices. This process will be very similar between all data focused projects in a data analyst's career, so this is a good starting point for garnering crucial experience.

4 Key Findings

5 Conclusion

Table 1: Descriptive Statistics and Correlation Analysis

	M	SD	1	2	3	4	5	6	7	8	9
1. ln(High-technology Exports)	22.03	2.22	1								
2. Human Development (HDI)	.78	.10	.36***	1							
3. Trade Openness (OPEN)	81.25	60.73	.22***	.21***	1						
4. WTO	.82	.39	.11**	.18***	.14***	1					
5. Team: Sole Inventor	.37	.16	-.05	.04	-.22***	-.30***	1				
6. Team: Multiregional	.38	.19	-.31***	-.32***	.11***	.25***	-.72***	1			
7. Firm = 0	.17	.14	-.46***	-.33***	-.23***	-.20***	.35***	-.04	1		
8. Firm = 2+	.04	.05	-.03	-.10**	-.02	.09**	-.19***	.20***	-.03	1	
9. Independent Claims (DEPTH)	2.43	.54	.00	.04	.06†	.32***	-.38***	.35***	-.14***	.03	1
10. Unique Technologies (BREADTH)	1.64	.19	.00	-.03	-.05†	-.20***	-.20***	.10**	-.05	.00	.14***

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

Notes: Pearson pairwise correlations are reported. Correlations and Summary Statistics fail to account for country-level and time-varying effects. We caution the reader to make inferences from these basic associations. They do not capture joint associations inherent to a regression model.

6 APPENDICES

6.1 *Data Provenance*

6.1.1 *Utilization of Data Provenance*

6.1.2 Data Collection Handout

Figure 1: Handout Page 1

PROJECT 1: "HANDOUT"

This handout is a prelude to a data collection project comprised of having 10 individuals record numerous measurements around their body (measured in centimeters), along with general information that does not require measuring. Your name will be encrypted using a hash function known as MD5, so your measurements and identifying data will remain confidential throughout the project. Below, you will find the various measurements you need to take, which could take 20+ minutes. Covariates labeled with (left, right) means you will need to measure both the left and right appendages for that field, separated by a comma. Diagrams are shown on the next page, which will show you how to take the measurements yourself for each field and are annotated by the abbreviations listed in the table below.

AREA FOR RESPONDENT

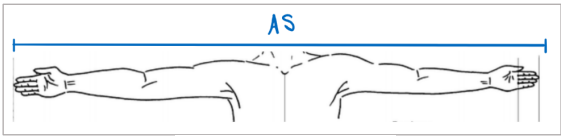
COVARIATE	MEASUREMENT
Name (first name, last initial)	
Dominant writing hand	
Dominant eye for seeing	
Eye color	
Dominant swinging hand	
Age	
Gender	
Ethnicity	
Height	
<i>Standing height of the individual with no shoes on. H on diagram.</i>	
Head height	
<i>Height from the top of the head to below the chin. HH on diagram.</i>	
Head circumference	
<i>Distance around the head, measured above the eyes/ears. HC on diagram.</i>	
Hand length (left, right)	
<i>Length of the hand from the middle finger to the wrist (just below the palm). HL on diagram.</i>	
Hand width (left, right)	
<i>Width of a fully stretched hand from the pinky finger to the thumb. HW on diagram.</i>	
Hand to elbow (left, right)	
<i>Length from the middle finger to the elbow. HE on diagram.</i>	
Elbow to armpit (left, right)	
<i>Length from the elbow to the arm pit. EA on diagram.</i>	
Arm reach (left, right)	
<i>Length from floor to the extended arm maximum point, standing flatfooted. AR on diagram.</i>	
Arm span	
<i>Length from each middle finger, with fully extended arms. AS on diagram.</i>	
Foot length (left, right)	
<i>Length of the foot from the largest toe to the back of the heel. FL on diagram.</i>	
Floor to knee pit (left, right)	
<i>Distance from the floor to the knee pit. FK on diagram.</i>	
Floor to hip (left, right)	
<i>Distance from the floor to the hip. FH on diagram.</i>	
Floor to navel	
<i>Distance from the floor to the navel (belly button). FN on diagram.</i>	
Floor to armpit (left, right)	
<i>Distance from the floor to the arm pit. FA on diagram.</i>	

Figure 2: Handout Page 2

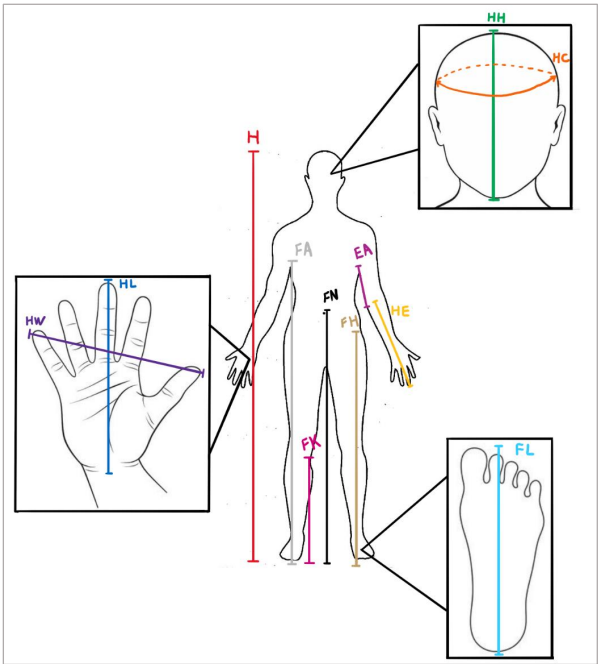
PROJECT 1: "HANDOUT"

DATA COLLECTOR USE ONLY

COVARIATE	EVALUATION
Quality (1-10)	
Minutes	
To be completed later?	
Notes	



How to measure arm span.



How to measure height, head height, head circumference, hand length, hand width, hand to elbow, elbow to armpit, foot length, floor to knee pit, floor to hip, floor to navel, and floor to armpit.



How to measure arm reach.

6.2 Data Set Explained

In addition to how the data set was described in Section 3, explanations regarding each variable can be found below. After the collaborative effort of all students having their data compiled, the data set ended up having 428 total observations. However, the data set was filled with an enormous amount of NA values, potentially due to the time constraints of some students or lack of attempt to fill out all fields. As a result, running the function `na.omit()` on the data set during the data cleaning process returned a data frame containing only 176 observations, about 41.12% of the original data set size.

Figure 3: Description of Each Field

[illegible]

- data_collector:
- person_id:
- side:
- height: Standing height of the individual with no shoes on.
- head.height: Height from the top of the head to below the chin.
- head.circumference: Distance around the head, measured above the eyes/ears.
- hand.length: Length of the hand from the middle finger to the wrist (just below the palm).
- hand.width: Width of a fully stretched hand from the pinky finger to the thumb.
- hand.elbow: Length from the middle finger to the elbow.
- elbow.armpit: Length from the elbow to the arm pit.
- arm.reach: Length from floor to the extended arm maximum point, standing flatfooted.
- arm.span: Length from one middle finger to the other, with fully extended arms.
- foot.length: Length of the foot from the largest toe to the back of the heel.
- floor.kneepit: Distance from the floor to the knee pit.
- floor.hip: Distance from the floor to the hip.
- floor.navel: Distance from the floor to the navel (belly button).

- floor.earmpit: Distance from the floor to the arm pit.
- units:
- writing:
- eye:
- eye_color:
- swinging:
- age:
- gender:
- quality:
- minutes:
- ethnicity:
- notes:

6.3 R Code Used for Research

Below is the necessary functions and libraries required to run the code referenced in this document.

```
# Import necessary libraries
library(stats) # For cor()
library(devtools) # For source_url()

# Source functions
path.hub = "https://raw.githubusercontent.com/KevnBlack/WSU_STATS419_FALL2020/"
source_url(paste0(path.hub, "master/functions/functions-project-measure.R"))

# Import data
path.to.secret = "D:/School/Fall 2020/STAT 419/datasets/"
measure = utils::read.csv(paste0(path.to.secret, "measure-students.txt"),
                           header=TRUE, quote="", sep="|")

# Clean data
measure.df = prepareMeasureData(measure)

# Isolate male and female data
measure.df.m = measure.df[measure.df$gender == "male",]
measure.df.f = measure.df[measure.df$gender == "female",]
cor.m = cor(measure.df.m$height.NA, measure.df.m$arm.span.NA)
cor.f = cor(measure.df.f$height.NA, measure.df.f$arm.span.NA)

# Correlation Graphs
par(mfrow=c(1,2))
plot(measure.df.m$height.NA, measure.df.m$arm.span.NA,
     main=paste("Correlation =", round(cor.m, 5)),
     xlab="Male Height (in)", ylab="Male Arm Span (in)", col="blue")

plot(measure.df.f$height.NA, measure.df.f$arm.span.NA,
     main=paste("Correlation =", round(cor.f, 5)),
     xlab="Female Height (in)", ylab="Female Arm Span (in)", col="red")
```

ENDNOTES

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