Efficacy and Effectiveness of a Hunger Reduction Program

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Psych 308d: Assignment 4

Efficacy and Effectiveness of a Hunger Reduction Program

Study 1

Results

Data analysis is in Appendix A. Observations in the dataset (*N* = 9) were independent and did not contain any missing parameters. Analysis continued with hypothesis one (independent samples t-test): does the meal program significantly decrease the hunger compared to those on the waitlist? The first assumption of normal distribution for the dependent variable was met (Group 1 - treatment, *skew* = 0.75, *kurtosis* = 0.34; Group 2 - waitlist, *skew* = 1.80, *kurtosis* = 3.26) although the distribution for treatment had a long positive tail and the distribution for waitlist was distributed unevenly on the extreme positive and negative ends. Levene's test for homogeneity of variance passed, $F(1) = 4.43$, $p = .073$.

A Mann-Whitney's U independent samples t-test was performed and was significant, $U = 1.00$, $p = .032$, Cliff's $d = -.90$, a large effect size indicating low overlap between treatment (*Mdn* = 2.50) and waitlist (*Mdn* = 15.00) groups, with waitlist group having a higher median value of hunger.

Analysis continued with hypothesis two (paired samples t-test): does participants' weight significantly increase from baseline to the end of the program? The first assumption of normal distribution for the dependent variable was met (Time 1 - Pre, *skew* = 0.13, *kurtosis* = -1.14; Time 2 - Post, *skew* = -0.04, *kurtosis* = -0.55) although the distributions for Pre and Post appeared to be bimodal. The assumption for normality of difference scores (*skew* = 1.53, *kurtosis* = 1.50) was violated according to Shapiro-Wilk's test, $W = 0.81$, $p = .024$, which had a positive tail.

A Wilcoxon T paired samples t-test was performed and was significant, *positive Σ of rank = 42, negative Σ of rank = 3, p = .020*, Pearson's *r* = .64, a large effect size indicating the probability of a Time 2 score (*Mdn* = 148.00) being higher than a Time 1 score (*Mdn* = 141.00), reflecting a median increase of 7 pounds at the end of two weeks.

Discussion

Hypothesis one was supported as evidenced by the waitlist group having more hunger than the group that received the meal program, however there were a substantial amount of low hunger scores for the waitlist group which may indicate that they had other sources of food outside of the meal program. Hypothesis two was also supported as evidenced by a significant median increase in weight following two weeks of the meal program. The results of the pilot study led to a larger investment into a longer study with a larger amount of participants testing the effects of a meal program with one, two, or three daily meals.

Study 2

Results

Data analysis is in Appendix A. Observations in the dataset (*N* = 180) were independent and did not contain any missing parameters. Analysis continued with hypothesis one (one-way ANOVA): Is there a difference in the number of calories above the minimum consumed between the meal program conditions? The first assumption of normal distribution for the dependent variable was violated (One Meal, *skew* = 5.54, *kurtosis* = 32.90; Two Meals, *skew* = 4.16, *kurtosis* = 17.30; Three Meals, *skew* = 4.70, *kurtosis* = 22.80) with all three groups having a positive tail. Levene's test for homogeneity of variance passed, $F(2, 177) = 0.77$, $p = .463$.

A Kruskal-Wallis one-way ANOVA was performed and was significant, $H(2) = 98.70$, $p < .001$, $\varepsilon^2 = .55$, indicating a large effect size across all conditions. Dwass-Steel-Critchlow-

Fligner pairwise comparisons indicated significant differences between one (*Mdn* = 6.00) and two (*Mdn* = 10.00) meal programs, $W = 8.61$, $p < .001$; three (*Mdn* = 17.00) and two meal programs, $W = -10.07$, $p < .001$; and, three (*Mdn* = 17.00) and one meal programs, $W = -11.68$, $p < .001$. Overall, the highest calorie group (i.e., three meal group) gained a median of 11.00 calories per day over the lowest calorie group (i.e., one meal group).

Discussion

Hypothesis one was supported as evidenced by the three meal group gaining a higher number of calories over the daily minimum suggested than the one meal group. However, given a cost-benefit analysis, the additional calories provided, although statistically significant, may in practice be trivial and may not be deemed sufficient enough rationale for the diminishing returns on higher costs. In summary, the one meal per day plan may be of the highest utility to maintain the health of individuals in the program.

Conclusion

Our first study indicated two primary insights: from our sample population, many may have sources of food above and beyond that provided by the program, and that our program did assist in participants gaining a significant amount of weight over the course of two weeks overall. Our second study took those initial insights and focused on the most useful number of meals per day, with three being significant, but one per day being of highest utility.

The implications of our overall findings is that given continuously limited budgets for these types of programs, this study was able to indicate the highest benefit for the highest number of people, considering costs. Major limitations of this study are that, although we were able to determine the program works we are unable to predict future needs, and we cannot account for other needs that affect the health of this population such as health care, child care, and job search services. Given the aforementioned limitations, future directions and recommendations to program administrators and policymakers include building predictive models of future needs using certain indicators of poverty such as median salary, health care costs, inflation, and commodity prices. In addition, cost savings from this study can be used to pilot other programs that target other high risk areas of concern, such as health care, child care, and job search services.

Appendix A

Statistical Analysis in R

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** IMPORTANT NOTES: PLEASE READ BEFORE STARTING ** The structure of your write-up should be: - *Study 1 Results & Discussion:* typical results section + one paragraph discussion interpreting the results of your analyses - *Study 2 Results & Discussion:* typical results section + one paragraph discussion interpreting the results of your analyses - *Conclusion:* an INTEGRATED discussion of the two studies findings (do not simply repeat what has already been reported), implications, limitations, and future directions.

Additionally, all write-ups should be in APA format and your write-up should NOT exceed 4 pages.

Study 1: Pilot Study

```
dat <- read.csv("https://www.dropbox.com/s/qhx6mb45e1njvk4/PSY.308d.DA4_1.csv?dl=1")


#load libraries used
library(pacman)
p_load(jmv, psych, car, effsize)


#make dataset more readable
dat$GroupNum <- factor(dat$GroupNum,
 levels = c(1,2),
 labels = c("Not Hungry", "Very Hungry"))
```

McCormick & Co. is proposing a new chartiable foundation, FeedForward, which hopes to set-up meal program interventions in small towns to fight hunger amongst under-resourced citizens. While McCormick is a large company and rather successful, they want evidence before investing more money into the programs and other ideas. They recently hired you as an (sadly unpaid) intern to generate some data and give them the scoop and you have to do it on a budget (A.K.A. no funding for participants - just for supplies). You decide to put up some flyers in a couple nearby apartment buildings to recruit volunteers to join your pilot study for a meal program - luckily you got 9 people to participate!

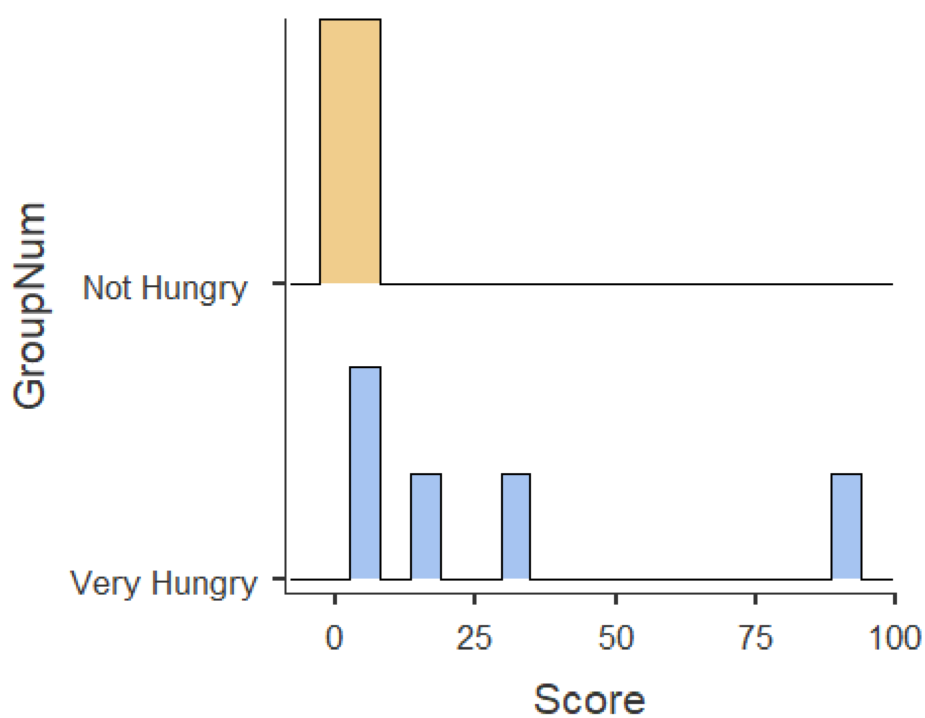
Research Question(s): 1. Does the meal program significantly decrease the hunger compared to those on the waitlist? 2. Does participants' weight significantly increase from baseline to the end of the program?

Variables: Score: self-reported hunger at the end of the program (1 = Not hungry, 100 = very hungry). Group: program assignment (GroupNum; 1 = Program, 2 = Waitlist). Pre: weight in pounds prior at baseline. Post: weight in pounds at the end of two weeks.

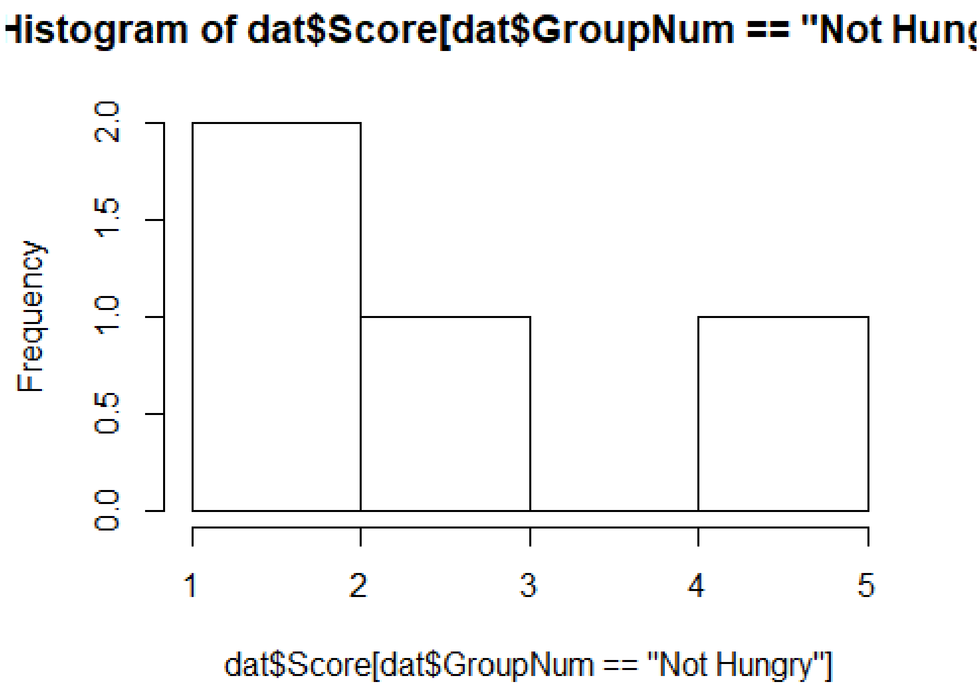
Question #1 Assumptions: 1. Independence of observations 2. Normal distribution of dependent variable by condition 3. Homogeneity of variance

```
# Descriptives by Condition
descriptives(data = dat,
        vars = 'Score',
        splitBy = 'GroupNum',
        sd = TRUE,
        min = TRUE,
        max = TRUE,
        skew = TRUE,
        kurt = TRUE,
        hist = TRUE)

##
##  DESCRIPTIVES
##
##  Descriptives
##  ----------------------------------------------
##                          GroupNum       Score
##  ----------------------------------------------
##    N                      Not Hungry        4
##                          Very Hungry       5
##    Missing                Not Hungry        0
##                          Very Hungry       0
##    Mean                   Not Hungry     2.75
##                          Very Hungry     29.6
##    Median                 Not Hungry     2.50
##                          Very Hungry       15
##    Standard deviation     Not Hungry     1.71
```

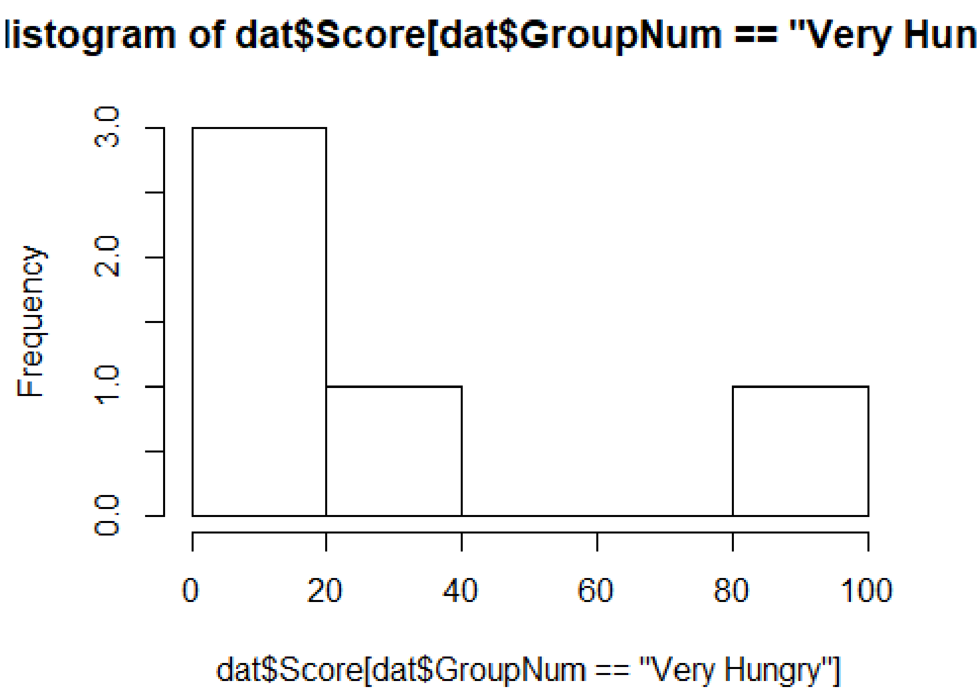
```
##                        Very Hungry     36.5
##    Minimum               Not Hungry        1
##                        Very Hungry        4
##    Maximum               Not Hungry        5
##                        Very Hungry       92
##    Skewness              Not Hungry     0.753
##                        Very Hungry     1.80
##    Std. error skewness   Not Hungry      1.01
##                        Very Hungry    0.913
##    Kurtosis              Not Hungry     0.343
##                        Very Hungry     3.26
##    Std. error kurtosis   Not Hungry      2.62
##                        Very Hungry     2.00
##  ------------------------------------------------
```




```
hist(dat$Score [dat$GroupNum== 'Not Hungry'])
```




```
hist(dat$Score [dat$GroupNum== 'Very Hungry'])
```



```
# Mann-Whitney test (with Levene's)
ttestIS(data = dat,
      vars = 'Score',      # DV
      group = 'GroupNum',  # IV
      desc = TRUE,
      mann = TRUE,         # Mann-Whitney U
      eqv = TRUE,          # Levene's test
      meanDiff = FALSE,
      ci = FALSE,
      effectSize = FALSE)   # Cohen's d

##
## INDEPENDENT SAMPLES T-TEST
##
## Independent Samples T-Test
## --------------------------------------------------------
##                        statistic    df     p
## --------------------------------------------------------
##   Score    Student's t       -1.45    7.00    0.190
##            Mann-Whitney U     1.00            0.032
## --------------------------------------------------------
##
##
## ASSUMPTIONS
##
## Test of Equality of Variances (Levene's)
## ---------------------------------------
##            F      df    p
## ---------------------------------------
##   Score    4.43    1    0.073
## ---------------------------------------
##   Note. A low p-value suggests a
##   violation of the assumption of
##   equal variances
```

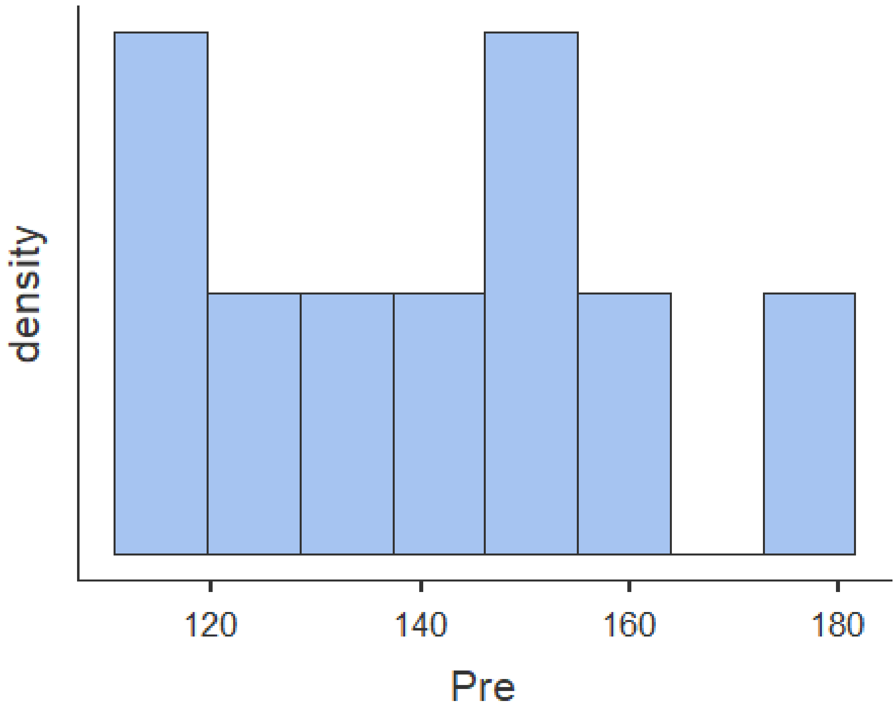
```
##
##
##  Group Descriptives
##  ----------------------------------------------------------------
##           Group         N    Mean    Median    SD      SE
##  ----------------------------------------------------------------
##   Score    Not Hungry    4    2.75     2.50    1.71    0.854
##           Very Hungry    5    29.6     15.0    36.5     16.3
##  ----------------------------------------------------------------
```

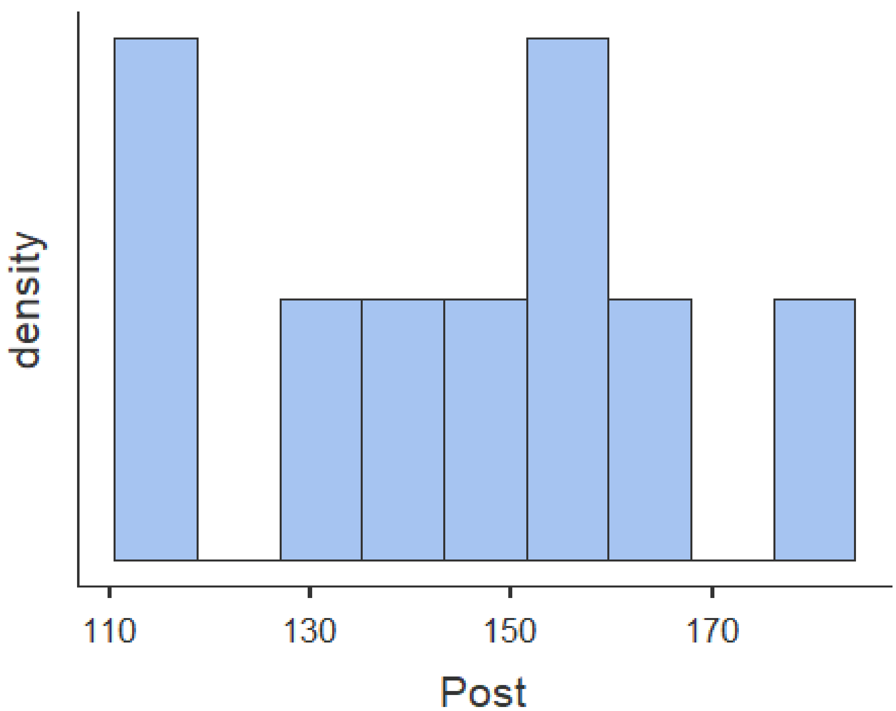
Effect Size

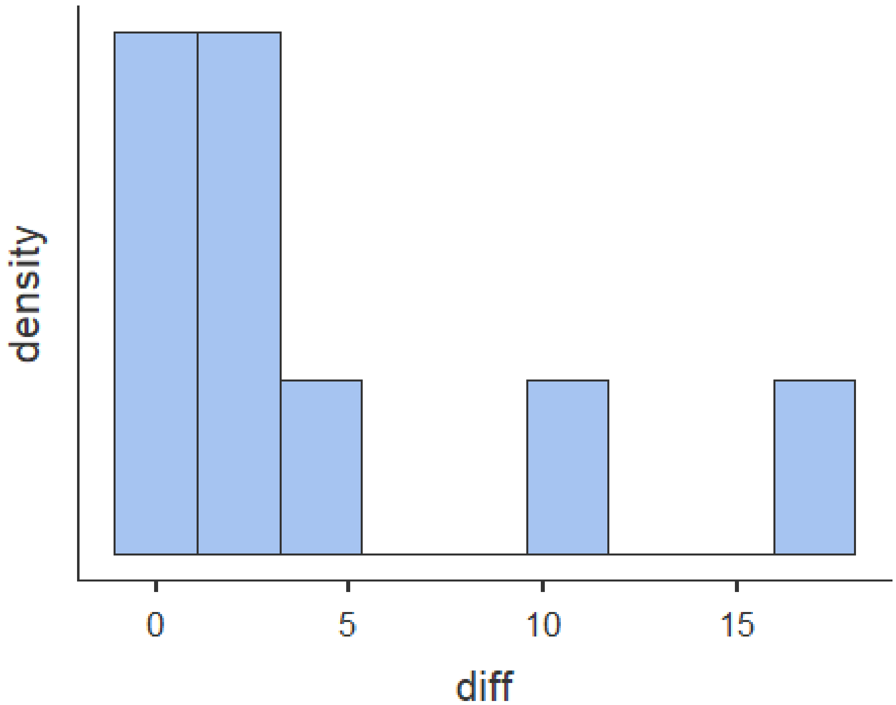
```
# Cliff's Delta (non-parametric effect size) - a more robust version of Cohen's d which considers the ordinal nature, as opposed to interval, of most behavioral science and psych data (e.g., Likert scale). It is more powerful under conditions such as skewed distributions, etc. Essentially, it computes the dominance (overlap between two distributions) based on the probability that a selected score in Group 1 being greater than Group 2 minus the probability of a selected score in Group 1 being less than Group 2 divided by the product of the n of Group 1 and Group 2. The value range is between -1.0 and +1.0, where anything closer to the absolute value of 1 is no overlap (good) and closer to 0 is complete overlap (not so good).

cliff.delta(Score ~ GroupNum, data = dat, conf.level = .95, magnitude = TRUE, method = "Cliff's Delta")

##
## Cliff's Delta
##
## delta estimate: -0.9 (large)
## 95 percent confidence interval:
##      lower      upper
## -0.9870433 -0.4036840

# Because this package is nice - it gives you the Delta estimate and an interpretation.
```

Question #2 Assumptions: 1. Independence of observations 2. Normal distribution of dependent variable by time 3. Normal distribution of difference scores (Shapiro-Wilk)

```
# Compute difference scores
dat$diff <- (dat$Post - dat$Pre)

# Descriptives
descriptives(data = dat,
        vars = c('Pre', 'Post', 'diff'),
        sd = TRUE,
        range = TRUE,
        min = TRUE,
        max = TRUE,
        skew = TRUE,
        kurt = TRUE,
        hist = TRUE)

##
## DESCRIPTIVES
##
## Descriptives
## ---------------------------------------------------
##                      Pre      Post     diff
## ---------------------------------------------------
##  N                     9         9       9
##  Missing               0         0       0
##  Mean                140       144    4.12
##  Median              141       148    2.00
##  Standard deviation  21.9      21.5    5.66
##  Range                 62      65.5    17.0
##  Minimum             113       114   -1.00
##  Maximum             175       179    16.0
##  Skewness           0.131   -0.0414    1.53
##  Std. error skewness 0.717     0.717   0.717
##  Kurtosis           -1.14    -0.552    1.50
##  Std. error kurtosis  1.40      1.40    1.40
## ---------------------------------------------------
```


density
120
140
160
180
Pre


density
110
130
150
170
Post




```
# Wilcoxan Signed Rank Test (with Shapiro-Wilk)

#Pre/Post
ttestPS(dat,
    pairs = list(
        list(i1 = 'Pre', i2 = 'Post')),
    wilcoxon = TRUE,
    norm = TRUE,
    meanDiff = FALSE)

##
##  PAIRED SAMPLES T-TEST
##
##  Paired Samples T-Test
##  -------------------------------------------------------------
##                            statistic   df     p
##  -------------------------------------------------------------
##    Pre    Post    Student's t       -2.18    8.00    0.061
```

```
##                 Wilcoxon W        3.00          0.020
##  -----------------------------------------------------------------
##
##
##  Test of Normality (Shapiro-Wilk)
##  -----------------------------------------
##                        W        p
##  -----------------------------------------
##    Pre    -    Post    0.806    0.024
##  -----------------------------------------
##    Note. A low p-value suggests a
##    violation of the assumption of
##    normality
```

```
#Post/Pre
ttestPS(dat,
        pairs = list(
                list(i1 = 'Post', i2 = 'Pre')),
        wilcoxon = TRUE,
        norm = FALSE,
        meanDiff = FALSE)
```

```
##
##  PAIRED SAMPLES T-TEST
##
##  Paired Samples T-Test
##  -----------------------------------------------------------------
##                               statistic    df      p
##  -----------------------------------------------------------------
##    Post    Pre    Student's t        2.18    8.00    0.061
##                   Wilcoxon W        42.0            0.020
##  -----------------------------------------------------------------
```

Effect Size

```
# Effect size for non-parametric related-samples t-test
# http://yatani.jp/teaching/doku.php?id=hcistats:wilcoxonsigned
# r = z/sqrt(N) where n is the total number of observations (cases x 2)

# To get number of cases(n):
n <- dim(dat)[1] # number of cases/rows
print(paste("Number of cases/rows(n):", n))

## [1] "Number of cases/rows(n): 9"

# To get sum of ranks(W)
W <- n*(n+1) / 2 # you can verify this by running Wilcoxon W in both directions and summing
both scores
print(paste("Sum of ranks(W):", W))

## [1] "Sum of ranks(W): 45"

# z = (W - mW + .5)/o
# https://www.statisticssolutions.com/how-to-conduct-the-wilcox-sign-test/
mW <- 0 #the null that there is no difference between T1 and T2

  #first we need to find sd
  cat("\n")

  sd = sqrt((n*(n+1)*((2*n)+1))/6)
  print("sd = sqrt((n*(n+1)*((2*n)+1))/6)")

## [1] "sd = sqrt((n*(n+1)*((2*n)+1))/6)"

  print(paste("sd = sqrt((", n, "*(", n, "+1)*((2*", n, ")+1))/6)", sep = ""))

## [1] "sd = sqrt((9*(9+1)*((2*9)+1))/6)"

  print(paste("sd =", round(sd,2)))

## [1] "sd = 16.88"

  # now to find z:
  cat("\n")
```

```
  z = (W - mW + .5)/sd # technically this should be +- .5 dependening on directionality of W-score.
  print("z = (W - mW + .5)/sd")

## [1] "z = (W - mW + .5)/sd"

  print("mW = the null that there is no difference between time 1 and time 2")

## [1] "mW = the null that there is no difference between time 1 and time 2"

  print(paste( "z = (", round(W,2), " - ", mW, " + .5)/", round(sd,2), sep = ""))

## [1] "z = (45 - 0 + .5)/16.88"

  print(paste("z =", round(z,2)))

## [1] "z = 2.7"

#r is the Pearson value reported for the non-parametric paired-sample t-test
cat("\n")

N = n*2 #total number of scores (2 x number of cases)
print(paste("Total number of scores(N):", N))

## [1] "Total number of scores(N): 18"

r = z/sqrt(N)
print("r = z/sqrt(n) = Effect size = the probability of a time 2 score being greater than a time 1 score")

## [1] "r = z/sqrt(n) = Effect size = the probability of a time 2 score being greater than a time 1 score"

print(paste("r = ", round(z,2), "/sqrt(", N, ")", sep = ""))

## [1] "r = 2.7/sqrt(18)"

print(paste("r =", round(r,2)))

## [1] "r = 0.64"
```

```
# Based on Cohen's criteria of evaluating effect size: .10 = small, .30 = medium, and .50 = large

# This z score above is iffy but was provided in full. R also calculates z scores for this test automagically, but I am not sure what is under the hood. See below

  # Wilcoxon signed rank test with z-score
  wilcoxon <- stats::wilcox.test(dat$Post, dat$Pre, paired = TRUE, exact = TRUE)
  wilcoxon.z <- stats::qnorm(wilcoxon$p.value) # z score estimate
  cat("\n")

  print("Wilcoxon test run from library(stats):")

## [1] "Wilcoxon test run from library(stats):"

  wilcoxon

##
##  Wilcoxon signed rank test
##
## data:  dat$Post and dat$Pre
## V = 42, p-value = 0.01953
## alternative hypothesis: true location shift is not equal to 0

  print(paste("Wilcoxon z-score run from library(stats):", round(wilcoxon.z, 2)))

## [1] "Wilcoxon z-score run from library(stats): -2.06"

  wilcoxon.r <- abs(wilcoxon.z/sqrt(N))
  print(paste("library(stats) effect size calculated as abs(", round(wilcoxon.z, 2), "/sqrt(", N, ")):
", round(wilcoxon.r, 2), sep = ""))

## [1] "library(stats) effect size calculated as abs(-2.06/sqrt(18)): 0.49"

  # This runs what is called Exact Wilcoxon-Pratt Signed-Rank Test with a z-score
  library(coin)

## Loading required package: survival

  cat("\n")
```

```
wilcoxon.coin <- coin::wilcoxsign_test(dat$Post ~ dat$Pre, distribution = "exact")
wilcoxon.coin.z = as.numeric(statistic(wilcoxon.coin, type="standardized"))
names(wilcoxon.coin.z) = "Z"
print("Wilcoxon test run from library(coin):")

## [1] "Wilcoxon test run from library(coin):"

wilcoxon.coin

##
##  Exact Wilcoxon-Pratt Signed-Rank Test
##
## data:  y by x (pos, neg)
##   stratified by block
## Z = 2.3102, p-value = 0.01953
## alternative hypothesis: true mu is not equal to 0

print(paste("Wilcoxon z-score run from library(coin):", round(wilcoxon.coin.z, 2)))

## [1] "Wilcoxon z-score run from library(coin): 2.31"

wilcoxon.coin.r <- abs(wilcoxon.coin.z/sqrt(N))
print(paste("library(coin) effect size calculated as abs(", round(wilcoxon.coin.z, 2), "/sqrt(", N,
")): ", round(wilcoxon.coin.r, 2), sep = ""))

## [1] "library(coin) effect size calculated as abs(2.31/sqrt(18)): 0.54"
```

Study 2: Intervention

```
dat2 <- read.csv("https://www.dropbox.com/s/78onrh7icd92cs4/PSY.308d.DA4_2.csv?dl=1")


library(pacman)
p_load(jmv, psych, car)
```

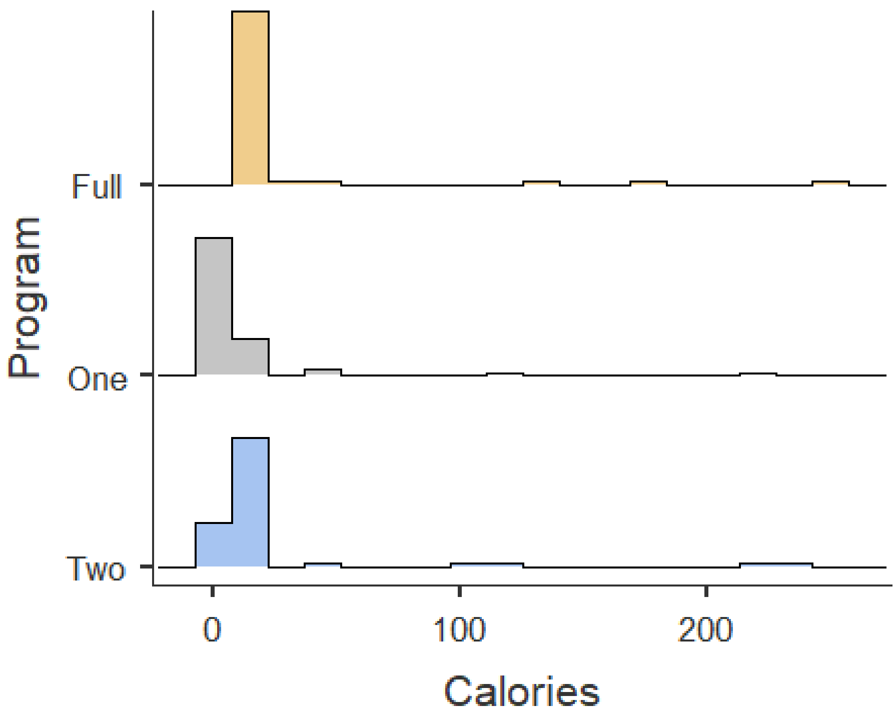
McCormick & Co. was impressed with your pilot study - meal programs seem to be worthwhile. They have invested $10,000 in your research account to do a bigger study where you can recruit and pay participants, gain more supplies, and extend your findings. You decide to set-up three different meal plan programs: Full Day (3 meals per day), Two-A-Day (2 meals per day), and One-A-Day (1 meal per day), and measure the average calorie intake above the noted minimum of 1,200 calories per day for each participant at the end of a two-week period. Given that these are under-resourced participants, they are encouraged to consume above the minimum calorie intake recommended by the health board.

Research Question(s): 1. Is there a difference in the number of calories above the minimum consumed between the meal program conditions?

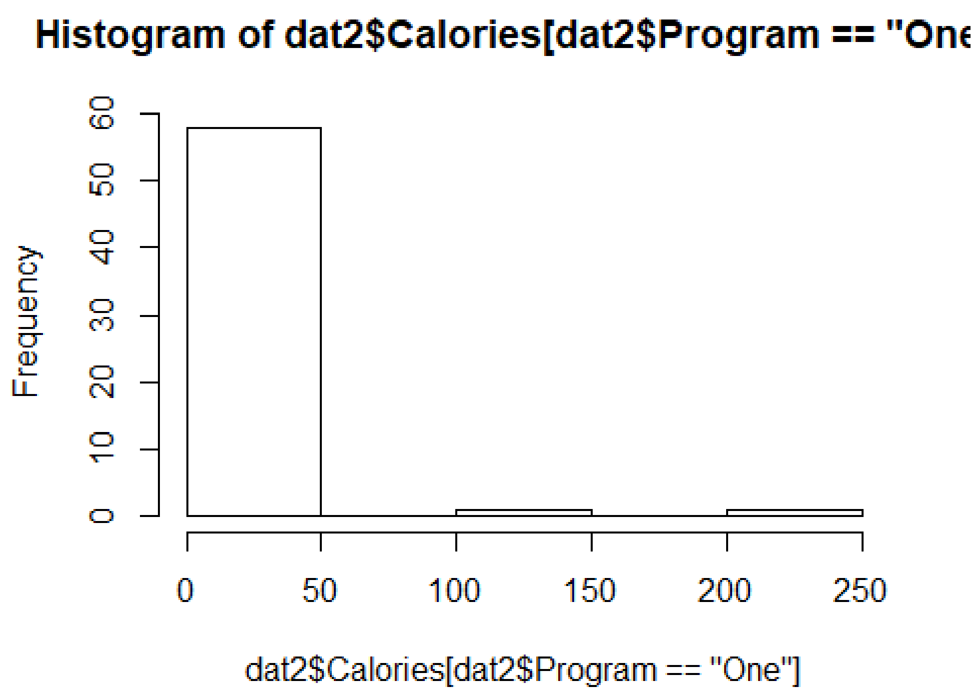
Assumptions: 1. Independence of observations - pass 2. Normal distribution of dependent variable by condition - fail 3. Homogeneity of variance - pass

```
# Descriptives by Team
descriptives(data = dat2,
         vars = 'Calories',
         splitBy = 'Program',
         sd = TRUE,
         min = TRUE,
         max = TRUE,
         skew = TRUE,
         kurt = TRUE,
         hist = TRUE)

##
##  DESCRIPTIVES
##
##  Descriptives
##  --------------------------------------------
##                       Program    Calories
##  --------------------------------------------
##    N                   Full          60
##                        One           60
##                        Two           60
##    Missing             Full           0
##                        One            0
##                        Two            0
##    Mean                Full        25.7
##                        One         12.0
##                        Two         20.9
##    Median              Full        17.0
```

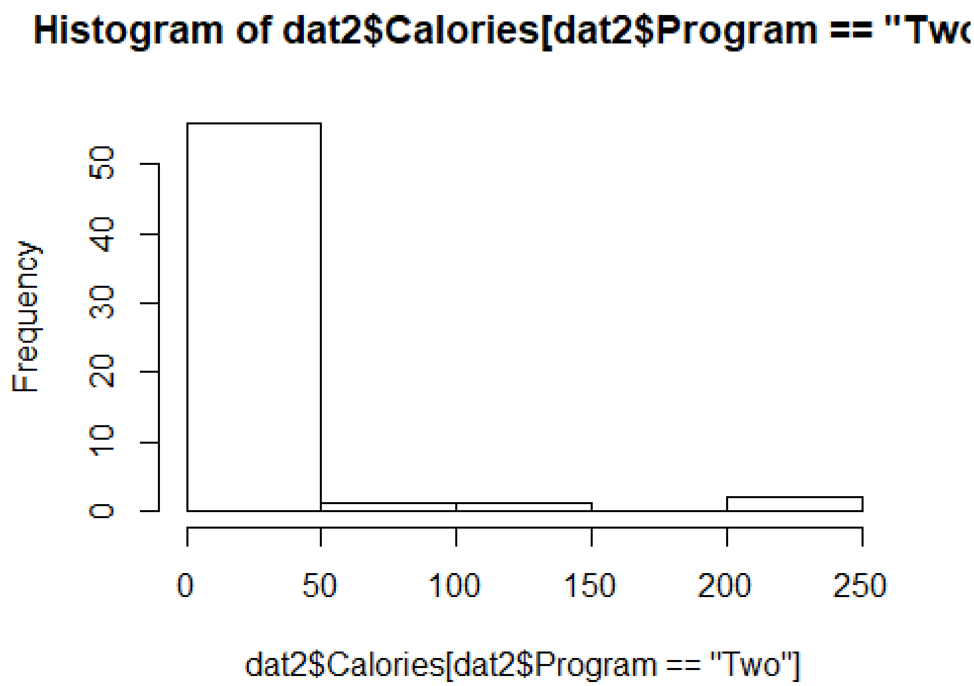
```
##                     One         6.00
##                     Two         10.0
##   Standard deviation    Full        38.9
##                     One         31.9
##                     Two         42.9
##   Minimum              Full         12
##                     One            1
##                     Two            5
##   Maximum              Full        251
##                     One          219
##                     Two          229
##   Skewness             Full        4.70
##                     One         5.54
##                     Two         4.16
##   Std. error skewness   Full        0.309
##                     One        0.309
##                     Two        0.309
##   Kurtosis             Full        22.8
##                     One         32.9
##                     Two         17.3
##   Std. error kurtosis   Full        0.608
##                     One        0.608
##                     Two        0.608
## ---------------------------------------------
```



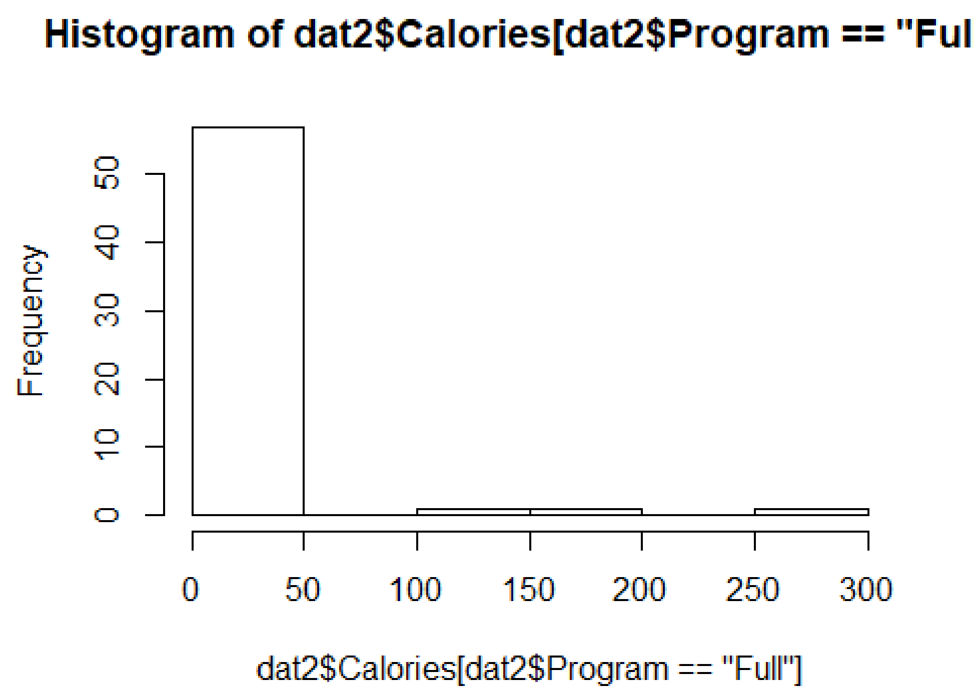

```
hist(dat2$Calories [dat2$Program== 'One'])
```



```
hist(dat2$Calories [dat2$Program== 'Two'])
```




```
hist(dat2$Calories [dat2$Program== 'Full'])
```




```
# ANOVA with each Program on Calories (with Levene's Test)
INTaov <- jmv::ANOVA(data = dat2,
                dep = 'Calories',
                factors = c('Program'),
                effectSize = 'partEta',
                postHoc = c('Program'),
                postHocCorr = 'tukey',
                homo = TRUE)
INTaov

##
##  ANOVA
##
##  ANOVA
##  ------------------------------------------------------------------------------
##              Sum of Squares    df    Mean Square    F       p        <U+03B7>²p
##  ------------------------------------------------------------------------------
##    Program             5796     2           2898    1.99    0.140    0.022
```

```
##    Residuals           258073    177          1458
##  -----------------------------------------------------------------------------
##
##
##  ASSUMPTION CHECKS
##
##  Test for Homogeneity of Variances (Levene's)
##  -------------------------------------------
##    F        df1    df2    p
##  -------------------------------------------
##    0.774      2    177    0.463
##  -------------------------------------------
##
##
##  POST HOC TESTS
##
##  Post Hoc Comparisons - Program
##  --------------------------------------------------------------------------------
##    Program         Program    Mean Difference    SE      df     t         p-tukey
##  --------------------------------------------------------------------------------
##    Full       -    One                 13.70    6.97    177     1.965      0.124
##               -    Two                  4.82    6.97    177     0.691      0.769
##    One        -    Two                 -8.88    6.97    177    -1.274      0.412
##  --------------------------------------------------------------------------------
```

```
# Kruskal-Wallis including pairwise comparisons (Dwass-Steel-Critchlow-Fligner)
KW_INT_aov <- anovaNP(data = dat2,
              dep = 'Calories',
              group = c('Program'),
              pairs = TRUE)
KW_INT_aov
```

```
##
##  ONE-WAY ANOVA (NON-PARAMETRIC)
```

```
##
## Kruskal-Wallis
## -----------------------------------
##              <U+03C7>²    df   p
## -----------------------------------
##   Calories    98.7    2   < .001
## -----------------------------------
##
##
## DWASS-STEEL-CRITCHLOW-FLIGNER PAIRWISE COMPARISONS
##
## Pairwise comparisons - Calories
## ----------------------------------
##                  W       p
## ----------------------------------
##   Full   One   -11.68   < .001
##   Full   Two   -10.07   < .001
##   One    Two     8.61   < .001
## ----------------------------------
```

```
# Epsilon-squared estimate of effect size
# .1 .3 .5 --- .2 .4 .6 are good estimates for small/med/large

# EpiSq = (H)/((n^2-1)/(n+1))

H <- KW_INT_aov$table$asDF[ , "chiSq"]
print(paste("H =", round(H, 2)))

## [1] "H = 98.7"

N2 <- dim(dat2)[1]
print(paste("N =", N2))

## [1] "N = 180"
```

```
EpiSq = (H)/((N2^2-1)/(N2+1))
print(paste("EpiSq = ", round(H, 2), "/((", N2, "^2-1)/(", N2, "+1)) = ", round(EpiSq, 2), sep =
""))

## [1] "EpiSq = 98.7/((180^2-1)/(180+1)) = 0.55"
```