Katie's Thesis Stats

Contents

Data Prep

The code shown below implements the following process:

1. Read in full IFPS dataset
2. Subset the dataset to fields relevant to the study and apply necessary transformations
3. Fit a multinomial logistic regression model to the data in order to ascertain the significance of perception of support on breast feeding intensity.

```
data.directory <- "C:/Users/James/Documents/R/Katies_Thesis/0_Data/"

ifps_dt <- "ifps2.sas7bdat" %>%
           paste0(data.directory, .) %>%
           read_sas() %>%
           as.data.table()


modeling_dt <- ifps_dt[, .(SAMPMIQ)]

# Breastfeeding difficulties, question 36 ---------------------------

N36_cols <- colnames(ifps_dt)[colnames(ifps_dt) %like% "N36"]

N36_dt <- melt(ifps_dt[, .SD, .SDcols = c("SAMPMIQ", N36_cols)],
               id.vars = "SAMPMIQ",
               value.name = "response",
               variable.name = "question")

N36_dt %<>% .[, .(response = sum(response, na.rm = TRUE)), keyby = .(SAMPMIQ)]

N36_dt[, breast_feeding_difficulties := FALSE]
N36_dt[response > 0, breast_feeding_difficulties := TRUE]

modeling_dt[N36_dt,
        breast_feeding_difficulties := i.breast_feeding_difficulties,
        on = .(SAMPMIQ)]

rm(N36_dt, N36_cols)

# ------------------------------------------------------------------------

# Breast feeding support, question 38 -----------------------------------

N38_dt <- ifps_dt[, .(N38, SAMPMIQ)]
N38_dt[, breast_feeding_support := FALSE]
N38_dt[N38 == 1, breast_feeding_support := TRUE]

modeling_dt[N38_dt,
            breast_feeding_support := i.breast_feeding_support,
            on = .(SAMPMIQ)]

rm(N38_dt)

# ------------------------------------------------------------------------
```

```r
# Perception of support, question 39

N39_dt <- ifps_dt[, .(N39, SAMPMIQ)]

N39_dt[N39 %in% c(1, 2), perception_of_support := "Unhelfpul"]
N39_dt[N39 %in% c(3), perception_of_support := "Inconclusive"]
N39_dt[N39 %in% c(4, 5), perception_of_support := "Helpful"]

modeling_dt[N39_dt,
            perception_of_support := i.perception_of_support,
            on = .(SAMPMIQ)]

rm(N39_dt)

# ------------------------------------------------------------------------

# Breast Feeding Intensity at 2 - 6 months ----------------------------

months <- 1:6

for(i in months){

  if (i == 1) {
    feeding_cols <- colnames(ifps_dt)[colnames(ifps_dt) %like% "N40"]

    bf_feeding_col <- "N40A"
  } else {
    feeding_cols <- paste0("M", i, "A1", LETTERS[1:10])

    bf_feeding_col <- paste0("M", i, "A1A")
  }


  temp_dt <- melt(ifps_dt[, .SD, .SDcols = c("SAMPMIQ", feeding_cols)],
                  id.vars = "SAMPMIQ",
                  value.name = "response",
                  variable.name = "question")

  temp_dt[is.na(response) & question == bf_feeding_col, response := 0]

  temp_dt %<>% .[, .(breast_feeding_intensity = response[question == bf_feeding_col]/sum(response,
                                                                                         na.rm = TRUE)),
                 keyby = .(SAMPMIQ)]

  temp_dt[is.nan(breast_feeding_intensity), breast_feeding_intensity := NA]

  modeling_dt[temp_dt, breast_feeding_intensity := i.breast_feeding_intensity, on = .(SAMPMIQ)]

  setnames(modeling_dt, "breast_feeding_intensity", paste0("breast_feeding_intensity_", i, "_mo"))

  rm(feeding_cols, bf_feeding_col, temp_dt)
}
```

```r
# ------------------------------------------------------------------------

# BFHI Exposure ----------------------------------------------------------

BFHI_dt <- ifps_dt[, .SD, .SDcols = c("N20",
                                      "N11",
                                      "N25",
                                      "N28",
                                      paste0("N29", c("A", "B", "C")),
                                      "N32",
                                      "SAMPMIQ")]

number_BFHI_criteria <- 6

# Time until mother breastfed for the first time
BFHI_dt[N20 %in% 1:2, BFHI_exp_1 := TRUE]
BFHI_dt[N20 %in% 3:9, BFHI_exp_1 := FALSE]

# No Pacifiers
BFHI_dt[N11 %in% c(1, 3), BFHI_exp_2 := FALSE]
BFHI_dt[N11 %in% c(2), BFHI_exp_2 := TRUE]

# Rooming in
BFHI_dt[N25 %in% c(1), BFHI_exp_3 := TRUE]
BFHI_dt[N25 %in% c(2, 3), BFHI_exp_3 := FALSE]

# BF on Demand
BFHI_dt[N28 %in% c(1), BFHI_exp_4 := TRUE]
BFHI_dt[N28 %in% c(2, 3), BFHI_exp_4 := FALSE]

# Only BM
BFHI_dt[N29A == 2 & N29B == 2 & N29C == 2, BFHI_exp_5 := TRUE]
BFHI_dt[N29A %in% c(1, 3) | N29B %in% c(1, 3) | N29C %in% c(1, 3), BFHI_exp_5 := FALSE]

# Fostering support groups
BFHI_dt[N32 == 1, BFHI_exp_6 := TRUE]
BFHI_dt[N32 == 2, BFHI_exp_6 := FALSE]

BFHI_dt %<>% melt(., measure.vars = paste0("BFHI_exp_", 1:number_BFHI_criteria),
                  variable.name = "question",
                  value.name = "response")

BFHI_dt %<>% .[, .(BFHI_score = sum(response, na.rm = TRUE),
                   BFHI_all_missing = all(is.na(response))), by = .(SAMPMIQ)]

BFHI_dt[BFHI_all_missing == TRUE, BFHI_score := NA]

modeling_dt[BFHI_dt, BFHI_score := i.BFHI_score, on = .(SAMPMIQ)]

rm(BFHI_dt, number_BFHI_criteria)
# ------------------------------------------------------------------------

# Maternal Age -----------------------------------------------------------
```

```r
P9_dt <- ifps_dt[, .(P9, SAMPMIQ)]

P9_dt[, unique(P9)] %>% sort()

P9_dt[, maternal_age := cut(P9,
                            breaks = c(18, 25, 30, 35, Inf),
                            labels = c("18-24", "25-29", "30-34", "35+"),
                            include.lowest = TRUE,
                            right = FALSE)]

modeling_dt[P9_dt, maternal_age := i.maternal_age, on = .(SAMPMIQ)]

rm(P9_dt)
# ------------------------------------------------------------------------

# Race/Ethnicity ---------------------------------------------------------

race_dt <- ifps_dt[, .(RACE_ETH, SAMPMIQ)]

race_dt[RACE_ETH == 1, race_eth := "White, Non-Hispanic"]
race_dt[RACE_ETH == 2, race_eth := "Black, Non-Hispanic"]
race_dt[RACE_ETH == 3, race_eth := "Hispanic"]
race_dt[RACE_ETH %in% c(4, 5), race_eth := "Other"]

modeling_dt[race_dt, race_eth := i.race_eth, on = .(SAMPMIQ)]

rm(race_dt)
# ------------------------------------------------------------------------

# Education --------------------------------------------
edu_dt <- ifps_dt[, .(EDUC, SAMPMIQ)]

edu_dt[EDUC %in% c(1, 2, 3), education := "Less Than High School"]
edu_dt[EDUC %in% c(4), education := "High School"]
edu_dt[EDUC %in% c(5), education := "1-3 Years College"]
edu_dt[EDUC %in% c(6, 7), education := "College Graduate"]

modeling_dt[edu_dt, education := i.education, on = .(SAMPMIQ)]

rm(edu_dt)
# ------------------------------------------------------------

# Parity -----------------------------------------------
parity_dt <- ifps_dt[, .(P41_1, P41_2, SAMPMIQ)]

parity_dt[P41_1 == 0 & P41_2 == 0, parity := "nullipara"]
parity_dt[P41_1 %in% 1:12 | P41_2 %in% 1:12, parity := "primipara"]

modeling_dt[parity_dt, parity := i.parity, on = .(SAMPMIQ)]

parity_dt[, .N, by = .(keyby = P41_1)]
parity_dt[, .N, by = .(keyby = P41_2)]
rm(parity_dt)
```

```r
# ------------------------------------------------------

# Income Level ------------------------------------------

income_dt <- ifps_dt[, .(INCOME, SAMPMIQ)]

income_dt[INCOME %in% 31:37, income := "<$20,000"]
income_dt[INCOME %in% 38:46, income := "$20,000-$49,999"]
income_dt[INCOME %in% 47:57, income := ">$50,000"]

modeling_dt[income_dt, income := i.income, on = .(SAMPMIQ)]

rm(income_dt)
# ------------------------------------------------------

# BMI ---------------------------------------------------
bmi_dt <- ifps_dt[, .(P7, P8FT, P8IN, SAMPMIQ)]

bmi_dt[, bmi := (P7/((P8FT * 12 + P8IN)^2)) * 703]

bmi_dt[bmi < 18.5, bmi_class := "Underweight"]
bmi_dt[bmi >= 18.5 & bmi <= 24.9, bmi_class := "Normal Weight"]
bmi_dt[bmi >= 25 & bmi <= 29.9, bmi_class := "Overweight"]
bmi_dt[bmi >= 30, bmi_class := "Obese"]

modeling_dt[bmi_dt, bmi := i.bmi_class, on = .(SAMPMIQ)]

rm(bmi_dt)
# ------------------------------------------------------------

# WIC Participation -------------------------------------------

wic_dt <- ifps_dt[, .(P6_1, P6_2, P6_3, SAMPMIQ)]

wic_dt[P6_1 == 1 | P6_2 == 1, wic_participation := TRUE]
wic_dt[P6_3 == 1, wic_participation := FALSE]

modeling_dt[wic_dt, wic_participation := i.wic_participation, on = .(SAMPMIQ)]


rm(wic_dt)
# ------------------------------------------------------------------------

# Attitude toward breast feeding ----------------------------------

attitude_dt <- ifps_dt[, .(P35E, SAMPMIQ)]

attitude_dt[P35E == 1, breast_feeding_attitude := "Positive"]
attitude_dt[P35E %in% c(2:5), breast_feeding_attitude := "Negative"]

modeling_dt[attitude_dt, breast_feeding_attitude := i.breast_feeding_attitude, on = .(SAMPMIQ)]
```

```r
rm(attitude_dt)

# ------------------------------------------------------------------

# Modeling ---------------------------------------------------------

modeling_cols <- paste0("bf_intens_", 1:6, "_mo")

break_options <- c(0, .2, .8, 1)
# break_options <- c(0, .25, .75, 1)

modeling_dt[, (modeling_cols) := lapply(.SD,
                                        cut,
                                        breaks = break_options,
                                        labels = c("Low", "Medium", "High"),
                                        include.lowest = TRUE),
            .SDcols = paste0("breast_feeding_intensity_", 1:6, "_mo")]

modeling_dt[, (paste0("breast_feeding_intensity_", 1:6, "_mo")) := NULL]

modeling_dt %<>% .[breast_feeding_difficulties == TRUE &
                     breast_feeding_support == TRUE &
                     !is.na(perception_of_support)]

setnames(modeling_dt, modeling_cols, paste0(1:6, "_month"))

modeling_dt %<>% melt(., measure.vars = paste0(1:6, "_month"),
                      variable.name = "time_of_bf_intens_meas",
                      value.name = "breast_feeding_intensity")

# modeling_dt %<>% .[!is.na(breast_feeding_intensity)]
modeling_dt %<>% na.omit(.)

factor_cols <- modeling_dt[, .SD, .SDcols = -c("SAMPMIQ")] %>% colnames()

modeling_dt[, (factor_cols) := lapply(.SD, as.factor), .SDcols = factor_cols]
```

```r
# Relevel Factors --------------------------------------------------------

modeling_dt[, `:=` (perception_of_support = relevel(perception_of_support, ref = "Inconclusive"),
                    breast_feeding_intensity = relevel(breast_feeding_intensity, ref = "Low"))]
# ------------------------------------------------------------------------

modeling_data_list <- split(modeling_dt, by = "time_of_bf_intens_meas")

response_var <- "perception_of_support"

control_vars <- modeling_dt[, .SD, .SDcols = -c("SAMPMIQ",
                                                "breast_feeding_difficulties",
                                                "breast_feeding_support",
                                                response_var,
                                                "breast_feeding_intensity",
                                                "time_of_bf_intens_meas")] %>% colnames()
```

```r
control_formula <- as.formula(paste("breast_feeding_intensity ~ ",
                        paste(control_vars, collapse = "+")))

univariate_fits <- list()

 for(i in seq_along(modeling_data_list)){
      temp_dt <- modeling_data_list[[i]]
  temp_model_list <- lapply(control_vars, function(y){

    temp_formula <- as.formula(paste0("breast_feeding_intensity ~ ", y))
    temp_model <- multinom(temp_formula, data = temp_dt)
    temp_lr_test <- lrtest(temp_model)

    return(list(univariate_model = temp_model,
                likelihood_ratio_test = temp_lr_test))
  })

  names(temp_model_list) <- control_vars

  univariate_fits[[i]] <- temp_model_list
 }

names(univariate_fits) <- names(modeling_data_list)

# ------------------------------------------------------

model_fit <- list()

for(i in seq_along(modeling_data_list)){

  temp_dt <- modeling_data_list[[i]]

  temp_controlModel <- multinom(control_formula, data = temp_dt)

  temp_stepwiseModel <- stepAIC(temp_controlModel)

  optimal_control_variable_subset <- temp_stepwiseModel$xlevels %>% names()


full_formula <- as.formula(paste("breast_feeding_intensity ~ ",
                        paste(c(response_var, optimal_control_variable_subset), collapse = "+")))

  temp_fullModel <- multinom(full_formula,
            data = temp_dt)

  aic_table <- data.table(Model = c("Full_Model",
                                    "Control_Model"),
                          AIC = c(temp_fullModel$AIC, temp_controlModel$AIC),
                          Relative_Likelihood = c(exp(-abs(temp_fullModel$AIC - temp_controlModel$AIC)/2
                                                  NA))
  model_fit[[i]] <- list(full_model = temp_fullModel,
       control_model = temp_stepwiseModel,
       stepwise_results = temp_stepwiseModel$anova,
```

```
      optimal_control_variables = optimal_control_variable_subset,
      likelihood_ratio_test = lrtest(temp_fullModel,
           temp_stepwiseModel),
      AIC_table = aic_table)
}

names(model_fit) <- names(modeling_data_list)
# Plots ------------------------------------------------------------

dist_plot <- ggplot(modeling_dt, aes(x = breast_feeding_intensity, fill = perception_of_support)) +
  geom_bar(stat = "count", position = "dodge") +
  facet_wrap(~ time_of_bf_intens_meas, ncol = 2)
# ------------------------------------------------------------------------
```

Model Fit Summaries: Breast Feeding Intensity At Each Time Period

Modeling results are shown below. For each month (1:6), a full and control model are fit, according to the following structure.

$$\text{Full Model: Breast Feeding Intensty at } i_{th} \text{ Month} \sim \text{Perception of Support} + \text{Control Variables}$$

$$\text{Control Model: Breast Feeding Intensty at } i_{th} \text{ Month} \sim \text{Control Variables}$$

Each model is a **Multinomial Logistic Regression**. The control variables to be used are determined from a **bidirectional stepwise regression** using the Akaike Information Criterion.

Once the full and control models are fit, a likelihood ratio test is peformed between the two.
The likelihood ratio test yields the following statistic:

$$\lambda_{\text{LR}} = -2 \ln \left[\frac{\sup_{\theta \in \Theta_0} \mathcal{L}(\theta)}{\sup_{\theta \in \Theta} \mathcal{L}(\theta)} \right]$$

According to Wilks' theorem, this statistic will asymptotically be chi-squared distributed (χ^2) with degrees of freedom equal to the difference in dimensionality of Θ and Θ_0

Leveraging this result, we can draw conclusions about the significance of perception of support in predicting breast feeding intensity.

1 Month

The control variables determined are: BFHI_score, education, parity, bmi, breast_feeding_attitude

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 152.621261

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 1080

This corresponds to a model p-value of: $5.5841038 \times 10^{-32}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High    0.41925534                    1.429683                     -1.1268859
## Medium -0.08169756                    0.978902                     -0.8724908
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High    -0.6828167  -0.7037062  -0.3002482   0.2453586   0.9106528   1.2354802
## Medium  -0.4452355  -1.0080675  -0.5532701  -0.5087105  -0.3636416   0.0466207
##        educationCollege Graduate educationHigh School
## High                   0.9943788          -0.52405123
## Medium                 0.8725732          -0.01038139
##        educationLess Than High School parityprimipara   bmiObese bmiOverweight
## High                       -1.01981732      0.56429981 -0.3526375   -0.10336136
```

```
## Medium                     0.03275318      0.07824822  0.4372047    0.02787971
##        bmiUnderweight breast_feeding_attitudePositive
## High       -0.2710080                     -0.9925435
## Medium     -0.7701587                     -0.8480809
##
## Residual Deviance: 1645.806
## AIC: 1713.806
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + education +
##     parity + bmi + breast_feeding_attitude, data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High     0.2589372 -0.12835025 -0.05523653   0.3142013   1.0122587  1.50806304
## Medium  -0.3156562 -0.07706337 -0.57374149  -0.1404169   0.0207168  0.02958342
##        BFHI_score6 educationCollege Graduate educationHigh School
## High     1.8221633                1.1010963          -0.38510249
## Medium   0.4006838                0.9460871           0.08649009
##        educationLess Than High School parityprimipara   bmiObese bmiOverweight
## High                       -0.85815509      0.40113656 -0.4561049   -0.12608792
## Medium                      0.04875041     -0.03059019  0.3461506    0.01692666
##        bmiUnderweight breast_feeding_attitudePositive
## High       -0.5838362                     -0.9785104
## Medium     -1.0543074                     -0.8209589
##
## Residual Deviance: 1798.427
## AIC: 1858.427
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     education + parity + bmi + breast_feeding_attitude
## Model 2: breast_feeding_intensity ~ BFHI_score + education + parity +
##     bmi + breast_feeding_attitude
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1  34 -822.90
## 2  30 -899.21 -4 152.62  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

2 Month

The control variables determined are: BFHI_score, maternal_age, education, parity, breast_feeding_attitude

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 142.4040172

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 939

This corresponds to a model p-value of: $8.6279942 \times 10^{-30}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High    -0.8519935                   1.4043792                    -0.9950717
## Medium  -1.5759805                   0.9844148                    -1.2779137
##        BFHI_score1 BFHI_score2  BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High    -0.6841001  -0.1635528  0.007370355 0.579804714  1.07614839   0.8679929
## Medium  -0.5234093  -0.4753202 -0.020607684 0.005078796  0.03902746  -1.0178890
##        maternal_age25-29 maternal_age30-34 maternal_age35+
## High           0.4622651      -0.005021654       0.1716173
## Medium         0.6025374       0.747717987       1.2122431
##        educationCollege Graduate educationHigh School
## High                   1.0331396          -0.68574191
## Medium                 0.5577408          -0.08866185
##        educationLess Than High School parityprimipara
## High                       -0.8445597       0.7733733
## Medium                     -0.9196647       0.2221948
##        breast_feeding_attitudePositive
## High                        -0.8847142
## Medium                      -0.3563427
##
## Residual Deviance: 1436.52
## AIC: 1504.52
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + maternal_age +
##     education + parity + breast_feeding_attitude, data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High    -0.8078939 -0.14104679  0.32524875   0.5194656    1.267571   1.5060555
## Medium  -1.8373303 -0.01773872 -0.01079937   0.4656744    0.645868   0.4096223
##        BFHI_score6 maternal_age25-29 maternal_age30-34 maternal_age35+
## High     1.5020527         0.4662739        -0.1006102       0.2059181
## Medium  -0.4515013         0.5881531         0.6635675       1.2511500
##        educationCollege Graduate educationHigh School
## High                   1.1252795          -0.50775050
## Medium                 0.6387634           0.06018388
##        educationLess Than High School parityprimipara
## High                       -0.4172955      0.58649897
## Medium                     -0.6200743      0.07673009
##        breast_feeding_attitudePositive
```

```
## High                         -0.9404306
## Medium                       -0.3559830
##
## Residual Deviance: 1578.924
## AIC: 1638.924
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     maternal_age + education + parity + breast_feeding_attitude
## Model 2: breast_feeding_intensity ~ BFHI_score + maternal_age + education +
##     parity + breast_feeding_attitude
##   #Df  LogLik Df Chisq Pr(>Chisq)
## 1  34 -718.26
## 2  30 -789.46 -4 142.4  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

3 Month

The control variables determined are: BFHI_score, education, parity, income, wic_participation, breast_feeding_attitude

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 107.5468793

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 878

This corresponds to a model p-value of: 2.426956×10^{-22}

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High    -0.1412237                   1.0538597                     -1.052461
## Medium  -0.1261282                   0.5254677                     -1.513226
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High    -0.7219882  -0.3601848  -0.2522217   0.1071303   0.9616126   1.1872937
## Medium  -0.8647175  -0.6504392  -0.7984565  -0.4477358   0.1665843  -0.6142217
##        educationCollege Graduate educationHigh School
## High                   0.8572446          -0.6552431
## Medium                 0.1377068          -0.6446117
##        educationLess Than High School parityprimipara income<$20,000
## High                       -0.7015571       0.7280193     -0.3853383
## Medium                    -12.6872847       0.1542267     -1.2336820
```

```
##        income>$50,000 wic_participationTRUE breast_feeding_attitudePositive
## High       -0.3777262           -0.36547692                       -0.8885342
## Medium     -0.1032536            0.03566761                       -1.7314919
##
## Residual Deviance: 1379.108
## AIC: 1447.108
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + education +
##     parity + income + wic_participation + breast_feeding_attitude,
##     data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1  BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High    -0.3802009 -0.02318897  0.346801513  0.50127639   0.9532081   1.6034182
## Medium  -0.7509807 -0.23661721 -0.008160253 -0.09344107   0.3272507   0.7386754
##        BFHI_score6 educationCollege Graduate educationHigh School
## High    1.95795431                 0.8994939           -0.5217168
## Medium  0.07956999                 0.1789556           -0.5431394
##        educationLess Than High School parityprimipara income<$20,000
## High                       -0.5266907      0.57572876      -0.359714
## Medium                    -12.6315446      0.04363591      -1.217770
##        income>$50,000 wic_participationTRUE breast_feeding_attitudePositive
## High       -0.4122550            -0.5032526                       -1.019437
## Medium     -0.1287376            -0.1048587                       -1.800304
##
## Residual Deviance: 1486.655
## AIC: 1546.655
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     education + parity + income + wic_participation + breast_feeding_attitude
## Model 2: breast_feeding_intensity ~ BFHI_score + education + parity +
##     income + wic_participation + breast_feeding_attitude
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1  34 -689.55
## 2  30 -743.33 -4 107.55  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

4 Month

The control variables determined are: BFHI_score, maternal_age, race_eth, education, parity, bmi, breast_feeding_attitude

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 89.6741979

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 835

This corresponds to a model p-value of: $1.5442317 \times 10^{-18}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High     -2.822747                   0.9066787                      -1.085919
## Medium   -1.856751                   0.8261841                      -1.157135
##         BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High    0.004139213   0.4084132  0.65689031   0.9653213   1.5405643   2.0988192
## Medium -0.179969703   0.2476164  0.04387779   0.6675529   0.8933779   0.2359022
##        maternal_age25-29 maternal_age30-34 maternal_age35+ race_ethHispanic
## High           0.8755112         0.4338425       0.5262977        0.4452888
## Medium         0.3111903         0.3932721       0.4693489        0.5708648
##        race_ethOther race_ethWhite, Non-Hispanic educationCollege Graduate
## High       0.3347858                   1.1464850               0.67398546
## Medium     0.6797495                   0.2883296              -0.03424905
##        educationHigh School educationLess Than High School parityprimipara
## High            -0.19468729                       -1.462932       0.6921597
## Medium          -0.02545251                       -1.548536       0.2443018
##          bmiObese bmiOverweight bmiUnderweight breast_feeding_attitudePositive
## High   -0.5013482    -0.2155689      0.6218125                       -0.6396572
## Medium -0.7489678    -0.3241723     -1.1684178                       -0.5234913
##
## Residual Deviance: 1389.846
## AIC: 1481.846
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + maternal_age +
##     race_eth + education + parity + bmi + breast_feeding_attitude,
##     data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High     -2.594593   0.3696411   0.8212743   1.1141747    1.481849    1.885284
## Medium   -1.804207   0.2961532   0.7777243   0.6052347    1.270915    1.319396
##        BFHI_score6 maternal_age25-29 maternal_age30-34 maternal_age35+
## High     2.5627237         0.8644034         0.3455905       0.5403320
## Medium   0.7828034         0.2617903         0.2772989       0.4618864
##        race_ethHispanic race_ethOther race_ethWhite, Non-Hispanic
## High          0.2642847     0.2282210                  0.84880796
## Medium        0.4110066     0.5690682                  0.01529515
##        educationCollege Graduate educationHigh School
```

```
## High                   0.8262969          -0.10528310
## Medium                 0.1316366           0.06058934
##        educationLess Than High School parityprimipara   bmiObese bmiOverweight
## High                       -0.995868       0.5519669 -0.5804228    -0.1963826
## Medium                     -1.176927       0.1099031 -0.8179310    -0.2851799
##        bmiUnderweight breast_feeding_attitudePositive
## High        0.2382044                      -0.7738715
## Medium     -1.5520030                      -0.6401735
##
## Residual Deviance: 1479.521
## AIC: 1563.521
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     maternal_age + race_eth + education + parity + bmi + breast_feeding_attitude
## Model 2: breast_feeding_intensity ~ BFHI_score + maternal_age + race_eth +
##     education + parity + bmi + breast_feeding_attitude
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1  46 -694.92
## 2  42 -739.76 -4 89.674  < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

5 Month

The control variables determined are: BFHI_score, maternal_age, race_eth, education, parity, bmi

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 55.8542611

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 814

This corresponds to a model p-value of: $2.1513282 \times 10^{-11}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High     -3.749243                   0.6411920                     -1.1314839
## Medium   -1.476151                   0.7000679                     -0.5503067
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High     0.1061630   0.1891600   0.7808141   0.8406161   1.5187112   1.4925136
## Medium  -0.6138766  -0.3667113   0.1219521   0.2063752   0.5906727   0.6119784
##        maternal_age25-29 maternal_age30-34 maternal_age35+ race_ethHispanic
```

```
## High          0.68831291         0.4703798       0.5725129        1.1082369
## Medium        0.08430704         0.4392281       0.5435253       -0.6865366
##        race_ethOther race_ethWhite, Non-Hispanic educationCollege Graduate
## High       0.7057972                   1.4333026                0.8026193
## Medium    -0.7912054                   0.3387039                0.3188749
##        educationHigh School educationLess Than High School parityprimipara
## High             -0.0502398                     -0.8978823       0.7852547
## Medium           -0.4757619                     -0.3591631       0.0686270
##          bmiObese bmiOverweight bmiUnderweight
## High   -0.4060689    -0.1788524      1.0324530
## Medium -0.4084086    -0.5564980     -0.5047497
##
## Residual Deviance: 1511.322
## AIC: 1599.322
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + maternal_age +
##     race_eth + education + parity + bmi, data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High     -3.734622   0.4695174  0.61145572   1.2335219   1.3895374   1.9487178
## Medium   -1.349751  -0.2509219  0.01831591   0.5213522   0.6916865   0.9942391
##        BFHI_score6 maternal_age25-29 maternal_age30-34 maternal_age35+
## High      1.973408        0.74898778         0.4396032       0.6083403
## Medium    1.059459        0.09081718         0.3738187       0.5317863
##        race_ethHispanic race_ethOther race_ethWhite, Non-Hispanic
## High          0.9840460     0.6514557                   1.2059832
## Medium       -0.7512238    -0.8427965                   0.1651211
##        educationCollege Graduate educationHigh School
## High                   0.8937803          0.003031808
## Medium                 0.4011550         -0.430772669
##        educationLess Than High School parityprimipara   bmiObese bmiOverweight
## High                       -0.7409935     0.685043304 -0.5198367    -0.1906171
## Medium                     -0.3226657    -0.002256088 -0.4906850    -0.5656271
##        bmiUnderweight
## High        0.6443685
## Medium     -0.8499868
##
## Residual Deviance: 1567.176
## AIC: 1647.176
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     maternal_age + race_eth + education + parity + bmi
## Model 2: breast_feeding_intensity ~ BFHI_score + maternal_age + race_eth +
##     education + parity + bmi
##   #Df  LogLik Df  Chisq Pr(>Chisq)
```

```
## 1  44 -755.66
## 2  40 -783.59 -4 55.854  2.151e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

6 Month

The control variables determined are: BFHI_score, education, parity, wic_participation, breast_feeding_attitude

The likelihood ratio test is performed between the model fit with only the control variables (Control Model) and the model fit with both the control variables and perception of support (Full Model).

The test statistic derived from the likelihood ratios of each model is: 44.0675878

This asymptotically approaches a chi-squared distribution with degrees of freedom: 4

The sample size for this test is: 793

This corresponds to a model p-value of: 6.2116986×10^{-9}

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## High     -1.670376                   0.3372018                      -1.100974
## Medium   -1.412841                   0.7114499                      -0.537357
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## High    -0.2108323   0.1464155  0.34888627   0.6139753    1.219566   1.3229840
## Medium  -1.1134291  -0.1870944 -0.03791468   0.1764139    0.554329   0.3110198
##        educationCollege Graduate educationHigh School
## High                   0.5071729           -0.1051046
## Medium                 0.6301360            0.1106441
##        educationLess Than High School parityprimipara wic_participationTRUE
## High                       -0.6070879       0.7942965           -0.64850914
## Medium                    -14.0254033       0.4661557           -0.07663916
##        breast_feeding_attitudePositive
## High                       -1.52604158
## Medium                      0.01472529
##
## Residual Deviance: 1525.905
## AIC: 1585.905
```

Control Model

```
## Call:
## multinom(formula = breast_feeding_intensity ~ BFHI_score + education +
##     parity + wic_participation + breast_feeding_attitude, data = temp_dt)
##
## Coefficients:
##        (Intercept) BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5
## High     -2.044173   0.1451783   0.5613185   0.7713926   1.0980738   1.6102366
```

```
## Medium   -1.453745  -0.7542214   0.2077673   0.3795923   0.6602722   0.9530483
##        BFHI_score6 educationCollege Graduate educationHigh School
## High     1.8187086                 0.5663862          -0.04938992
## Medium   0.8044964                 0.6901106           0.18041085
##        educationLess Than High School parityprimipara wic_participationTRUE
## High                       -0.4053588       0.7171032            -0.6910881
## Medium                    -13.2337558       0.3860089            -0.1154459
##        breast_feeding_attitudePositive
## High                       -1.60304962
## Medium                     -0.05703578
##
## Residual Deviance: 1569.972
## AIC: 1621.972
```

Likelihood Ratio Test

```
## Likelihood ratio test
##
## Model 1: breast_feeding_intensity ~ perception_of_support + BFHI_score +
##     education + parity + wic_participation + breast_feeding_attitude
## Model 2: breast_feeding_intensity ~ BFHI_score + education + parity +
##     wic_participation + breast_feeding_attitude
##   #Df  LogLik Df  Chisq Pr(>Chisq)
## 1  30 -762.95
## 2  26 -784.99 -4 44.068  6.212e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```