ASSESSING THE IMPACT OF MOTHER'S PERCEPTION OF SUPPORT ON BREASTFEEDING INTENSITY THROUGH SIX MONTHS: STATISTICAL ANALYSIS

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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 <- file.path(rprojroot::find_rstudio_root_file(), "0_Data")
project.directory <- rprojroot::find_rstudio_root_file()
ifps_dt <- "ifps2.sas7bdat" %>%
           file.path(data.directory, .) %>%
           read_sas() %>%
           as.data.table()


ifps_subset_dt <- ifps_dt[, .(SAMPMIQ)]

######################################################################
#DATA TRANSFORMATIONS
######################################################################
# 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]

ifps_subset_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]

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

```r
rm(N38_dt)

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

# 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"]

ifps_subset_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]

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

```
  setnames(ifps_subset_dt,
           "breast_feeding_intensity",
           paste0("breast_feeding_intensity_", i, "_mo"))

  rm(feeding_cols, bf_feeding_col, temp_dt)
}

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

# 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)]
```

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

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

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

# Maternal Age ----------------------------------------------------------
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)]

ifps_subset_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"]

ifps_subset_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"]

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

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

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

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

ifps_subset_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)
# ------------------------------------------------------

# 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"]

ifps_subset_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"]

ifps_subset_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]

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


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

```r
# 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"]

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


rm(attitude_dt)

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

```r
# Reshaping data before going into modeling
modeling_dt <- melt(ifps_subset_dt,
                    measure.vars = paste0("breast_feeding_intensity_", 1:6, "_mo"),
                      variable.name = "time_of_bf_intens_meas",
                      value.name = "numeric_bf_intensity")

# Setting the boundaries for "low", "medium", and "high" breast feeding intensity
break_options <- c(0, .2, .8, 1)

modeling_dt[, breast_feeding_intensity := cut(numeric_bf_intensity,
                                              breaks = break_options,
                                              labels = c("Low", "Medium", "High"),
                                              include.lowest = TRUE)]

# Perform chi-squared test

chi_sq_dt <- modeling_dt[!is.na(perception_of_support) &
                           !is.na(breast_feeding_intensity), .(breast_feeding_intensity,
                                                               perception_of_support,
                                                               time_of_bf_intens_meas)]

chi_sq_dt[, time_of_bf_intens_meas := gsub("breast_feeding_intensity_", "",
                                           time_of_bf_intens_meas)]
chi_sq_dt[, time_of_bf_intens_meas := paste0(time_of_bf_intens_meas, "nth")]

chi_sq_test_list <- lapply(split(chi_sq_dt, by = "time_of_bf_intens_meas"), function(x){
  temp_table <- table(x$breast_feeding_intensity, x$perception_of_support)

  chi_sq_test <- chisq.test(temp_table)

  return(list(contingency_table = temp_table,
              chi_sq_test = chi_sq_test))
})


# Filtering down the dataset to mothers that had difficulties and support and responded
# with a perception of the support.  Also filtering out all rows that contain an NA
```

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

modeling_dt[, numeric_bf_intensity := NULL]
modeling_dt[, time_of_bf_intens_meas := gsub("breast_feeding_intensity_", "",
                                             time_of_bf_intens_meas)]
modeling_dt[, time_of_bf_intens_meas := paste0(time_of_bf_intens_meas, "nth")]

# Setting categorical variable columns to be 'factor' type in data for modeling
factor_cols <- modeling_dt[, .SD, .SDcols = -c("SAMPMIQ")] %>% colnames()

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

# Relevel Factors ----------------------------------------------------------------

# Setting the reference level for all variables
modeling_dt[, `:=` (perception_of_support = relevel(perception_of_support,
                                                    ref = "Inconclusive"),
                    breast_feeding_intensity = relevel(breast_feeding_intensity,
                                                       ref = "Low"),
                    BFHI_score = relevel(BFHI_score,
                                         ref = "0"),
                    maternal_age = relevel(maternal_age,
                                           ref = "25-29"),
                    race_eth = relevel(race_eth,
                                       ref = "White, Non-Hispanic"),
                    education = relevel(education,
                                        ref = "High School"),
                    parity = relevel(parity,
                                     ref = "primipara"),
                    income = relevel(income,
                                     ref = "$20,000-$49,999"),
                    bmi = relevel(bmi,
                                  ref = "Normal Weight"),
                    wic_participation = relevel(wic_participation,
                                                ref = "FALSE"),
                    breast_feeding_attitude = relevel(breast_feeding_attitude,
                                                      ref = "Negative"))]

base_levels <- lapply(modeling_dt, function(x){
  data.table(reference_level = levels(x)[1])
}) %>% rbindlist(., idcol = 'variable')
# --------------------------------------------------------------------------------

# List of datasets for 1-6 months to sequence along for modeling
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()

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

# Check for multi collinearity ------------------------------------------------
  # Computes multicollinearity diagnostic using generalized variance inflation
  # factors.  Metrics are computed for all control variables + perception of
  # support
multi_col_model <- multinom(as.formula(paste("breast_feeding_intensity ~ ",
                          paste(c(response_var, control_vars), collapse = "+"))),
                               data = modeling_dt[time_of_bf_intens_meas == "1_month"],
                               model = TRUE)

vif_dt <- vif(multi_col_model) %>% as.data.table()
```

```
## Warning in vif.default(multi_col_model): No intercept: vifs may not be sensible.
```

```
vif_dt[, Variable := rownames(vif(multi_col_model))]
```

```
## Warning in vif.default(multi_col_model): No intercept: vifs may not be sensible.
```

```
vif_dt[, `:=` (GVIF = round(GVIF, 2),
                      `GVIF^(1/(2*Df))` = round(`GVIF^(1/(2*Df))`, 2))]

fwrite(vif_dt, file.path(project.directory, "2_Outputs/Coefficient_Tables/vif_dt.csv"))
# -----------------------------------------------------

model_fit <- list()

# This loop fits a model at each month 1-6
for(i in seq_along(modeling_data_list)){

  temp_dt <- modeling_data_list[[i]]

  # Fits a regression model using all control variables
  temp_controlModel <- multinom(control_formula, data = temp_dt)

  # Applies stepwise regression to find an optimal control variable subset for
  # the iteration
  temp_stepwiseModel <- stepAIC(temp_controlModel)

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

  # Fits the full regression model using perception of support + optimized control
  # variables
  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)

  # Create a table of variable coefficients and their associated odds ratios at
  # different levels of the variable

   coef_dt <- coef(temp_fullModel) %>% as.data.table()

   coef_dt[, response_level := attributes(coef(temp_fullModel))$dimnames[[1]]]

   coef_dt %<>% melt(., id.vars = "response_level", variable.name = "variable", value.name = "coefficie

   model_levels <- temp_fullModel$xlevels %>%
    lapply(., as.data.table) %>%
    rbindlist(., idcol = "variable")

   setnames(model_levels, "V1", "level")

   model_levels[, combined_name := paste0(variable, level)]

   coef_dt[model_levels, `:=` (variable_name = i.variable,
                               variable_level = i.level), on = .(variable = combined_name)]
   coef_dt[base_levels, reference_level := i.reference_level, on = .(variable_name = variable)]

   coef_dt %<>% .[!is.na(variable_name)]

   coef_dt[, odds_ratio := exp(coefficient)]

   confint_dt <- confint(temp_fullModel) %>% as.data.table()

  confint_dt %<>% dcast(., ... ~ V2, value.var = "value")

  setnames(confint_dt, c("variable", "response_level", "lower_log_odds_interval", "upper_log_odds_inter

  confint_dt[, `:=` (lower_odds_ratio_interval = exp(lower_log_odds_interval),
                     upper_odds_ratio_interval = exp(upper_log_odds_interval))]
  coef_dt <- merge(coef_dt,
                   confint_dt,
                   by = c("variable", "response_level"),
                          all.x = TRUE)

  coef_dt[, variable := NULL]
# Returns list of iteration results
  model_fit[[i]] <- list(full_model = temp_fullModel,
                         full_model_summary = summary(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),
       coef_dt = coef_dt)
```

```
}

names(model_fit) <- names(modeling_data_list)

saveRDS(model_fit, file.path(project.directory, "2_Outputs/R_Objects/model_fit.RDS"))

fwrite(modeling_dt, file.path(data.directory, "modeling_dt.csv"))
```

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.

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

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

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.

Multicollinearity between the predictors was measured through generalized variance inflation factors (Cox and Monette Citation)

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: 152.6212563

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: $5.5841168 \times 10^{-32}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -0.0138623                    0.9788665                     -0.8725202
## High     0.4594915                    1.4296641                     -1.1268962
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## Medium  -0.4452068  -1.0080376  -0.5532182  -0.5086780  -0.3636077  0.04684917
## High    -0.6827954  -0.7036692  -0.3001999   0.2453935   0.9106883  1.23565523
##        education1-3 Years College educationCollege Graduate
## Medium                0.01037884                0.8829022
```

```
## High                   0.52402595                 1.5183682
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                     0.04313044      -0.0782227  0.4372239    0.02789186
## High                      -0.49591415      -0.5642831 -0.3526216   -0.10334683
##        bmiUnderweight breast_feeding_attitudePositive
## Medium     -0.7700416                      -0.8480540
## High       -0.2708775                      -0.9925298
##
## 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
## Medium  -0.2598538 -0.07660189 -0.57346254  -0.1399831  0.02105644  0.02971873
## High     0.2748865 -0.12794852 -0.05499423   0.3145135  1.01250303  1.50814167
##        BFHI_score6 education1-3 Years College educationCollege Graduate
## Medium   0.4006353                -0.08668363                 0.8593959
## High     1.8221076                 0.38500155                 1.4860665
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                     -0.03786449      0.03052586  0.3460351     0.0168030
## High                       -0.47303247     -0.40117172 -0.4561887    -0.1262089
##        bmiUnderweight breast_feeding_attitudePositive
## Medium     -1.0550613                      -0.8208175
## High       -0.5844698                      -0.9783816
##
## 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
```

Coefficient Table

```
##     response_level coefficient           variable_name        variable_level
##  1:           High -0.68279539              BFHI_score                     1
```

```
##  2:         Medium -0.44520680             BFHI_score                   1
##  3:           High -0.70366923             BFHI_score                   2
##  4:         Medium -1.00803764             BFHI_score                   2
##  5:           High -0.30019994             BFHI_score                   3
##  6:         Medium -0.55321818             BFHI_score                   3
##  7:           High  0.24539346             BFHI_score                   4
##  8:         Medium -0.50867804             BFHI_score                   4
##  9:           High  0.91068834             BFHI_score                   5
## 10:         Medium -0.36360772             BFHI_score                   5
## 11:           High  1.23565523             BFHI_score                   6
## 12:         Medium  0.04684917             BFHI_score                   6
## 13:           High -0.35262160                    bmi               Obese
## 14:         Medium  0.43722389                    bmi               Obese
## 15:           High -0.10334683                    bmi          Overweight
## 16:         Medium  0.02789186                    bmi          Overweight
## 17:           High -0.27087750                    bmi         Underweight
## 18:         Medium -0.77004164                    bmi         Underweight
## 19:           High -0.99252976 breast_feeding_attitude            Positive
## 20:         Medium -0.84805404 breast_feeding_attitude            Positive
## 21:           High  0.52402595              education     1-3 Years College
## 22:         Medium  0.01037884              education     1-3 Years College
## 23:           High  1.51836823              education      College Graduate
## 24:         Medium  0.88290220              education      College Graduate
## 25:           High -0.49591415              education Less Than High School
## 26:         Medium  0.04313044              education Less Than High School
## 27:           High -0.56428315                 parity            nullipara
## 28:         Medium -0.07822270                 parity            nullipara
## 29:           High  1.42966411   perception_of_support              Helpful
## 30:         Medium  0.97886653   perception_of_support              Helpful
## 31:           High -1.12689617   perception_of_support            Unhelfpul
## 32:         Medium -0.87252024   perception_of_support            Unhelfpul
##     response_level coefficient          variable_name        variable_level
##     reference_level odds_ratio lower_log_odds_interval upper_log_odds_interval
##  1:               0  0.5052028           -1.927413997              0.56182322
##  2:               0  0.6406918           -1.767094644              0.87668104
##  3:               0  0.4947666           -1.888366354              0.48102789
##  4:               0  0.3649344           -2.289585334              0.27351005
##  5:               0  0.7406701           -1.478888158              0.87848829
##  6:               0  0.5750961           -1.821681958              0.71524560
##  7:               0  1.2781241           -0.949054299              1.43984122
##  8:               0  0.6012899           -1.807066392              0.78971031
##  9:               0  2.4860332           -0.355382021              2.17675871
## 10:               0  0.6951638           -1.770689242              1.04347380
## 11:               0  3.4406322           -0.335227428              2.80653790
## 12:               0  1.0479639           -1.706469229              1.80016757
## 13:   Normal Weight  0.7028431           -0.799373331              0.09413013
## 14:   Normal Weight  1.5484027           -0.064129056              0.93857683
## 15:   Normal Weight  0.9018141           -0.557186887              0.35049324
## 16:   Normal Weight  1.0282845           -0.517743795              0.57352751
## 17:   Normal Weight  0.7627099           -1.250810381              0.70905539
## 18:   Normal Weight  0.4629938           -2.155091650              0.61500838
## 19:        Negative  0.3706379           -1.653052385             -0.33200714
## 20:        Negative  0.4282475           -1.652951689             -0.04315640
## 21:     High School  1.6888131            0.009882923              1.03816898
```

```
## 22:     High School  1.0104329           -0.576894490             0.59765217
## 23:     High School  4.5647705            0.964601598             2.07213486
## 24:     High School  2.4179068            0.264018624             1.50178578
## 25:     High School  0.6090139           -1.778574568             0.78674626
## 26:     High School  1.0440741           -1.279718394             1.36597927
## 27:       primipara  0.5687677           -0.940670788            -0.18789551
## 28:       primipara  0.9247585           -0.508738992             0.35229360
## 29:    Inconclusive  4.1772958            0.963823625             1.89550459
## 30:    Inconclusive  2.6614379            0.430976066             1.52675700
## 31:    Inconclusive  0.3240375           -1.616397702            -0.63739464
## 32:    Inconclusive  0.4178970           -1.464431286            -0.28060919
##     reference_level odds_ratio lower_log_odds_interval upper_log_odds_interval
##     lower_odds_ratio_interval upper_odds_ratio_interval
##  1:                 0.1455240                 1.7538673
##  2:                 0.1708286                 2.4029113
##  3:                 0.1513188                 1.6177364
##  4:                 0.1013085                 1.3145706
##  5:                 0.2278909                 2.4072579
##  6:                 0.1617535                 2.0446888
##  7:                 0.3871069                 4.2200257
##  8:                 0.1641349                 2.2027582
##  9:                 0.7009056                 8.8176792
## 10:                 0.1702156                 2.8390622
## 11:                 0.7151754                16.5525124
## 12:                 0.1815055                 6.0506613
## 13:                 0.4496106                 1.0987027
## 14:                 0.9378840                 2.5563407
## 15:                 0.5728182                 1.4197677
## 16:                 0.5958634                 1.7745156
## 17:                 0.2862727                 2.0320708
## 18:                 0.1158926                 1.8496721
## 19:                 0.1914646                 0.7174822
## 20:                 0.1914839                 0.9577616
## 21:                 1.0099319                 2.8240414
## 22:                 0.5616398                 1.8178458
## 23:                 2.6237421                 7.9417596
## 24:                 1.3021524                 4.4896995
## 25:                 0.1688787                 2.1962388
## 26:                 0.2781156                 3.9195595
## 27:                 0.3903659                 0.8287013
## 28:                 0.6012533                 1.4223261
## 29:                 2.6217017                 6.6559061
## 30:                 1.5387587                 4.6032243
## 31:                 0.1986129                 0.5286680
## 32:                 0.2312094                 0.7553235
##     lower_odds_ratio_interval upper_odds_ratio_interval
```

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: 142.4039367

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: $8.6283368 \times 10^{-30}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -0.8439529                    0.9845895                     -1.2772594
## High    -0.3049678                    1.4044424                     -0.9948526
##        BFHI_score1 BFHI_score2  BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## Medium  -0.5180133  -0.4719143 -0.016757691 0.009083122  0.04367779  -1.0137215
## High    -0.6814904  -0.1618762  0.009334441 0.581871593  1.07855822   0.8715902
##        maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium        -0.6029313         0.1453383       0.6093710
## High          -0.4623580        -0.4669722      -0.2906949
##        education1-3 Years College educationCollege Graduate
## Medium                   0.0884754                 0.6459188
## High                     0.6862602                 1.7191280
##        educationLess Than High School paritynullipara
## Medium                      -0.8309637      -0.2217353
## High                        -0.1567405      -0.7730123
##        breast_feeding_attitudePositive
## Medium                       -0.3569204
## High                         -0.8847283
##
## 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
## Medium  -1.1128326 -0.01714679 -0.01021714   0.4662055   0.6463949   0.4102403
## High    -0.2631806 -0.14075799  0.32547402   0.5196883   1.2677795   1.5063008
##        BFHI_score6 maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium  -0.4524963        -0.5881140        0.07536571       0.6628798
## High     1.5017088        -0.4662058       -0.56688262      -0.2603723
##        education1-3 Years College educationCollege Graduate
## Medium                -0.06002677                  0.578789
## High                   0.50786575                  1.633140
##        educationLess Than High School paritynullipara
## Medium                     -0.68036776     -0.07678941
## High                        0.09053182     -0.58651971
##        breast_feeding_attitudePositive
```

```
## Medium                       -0.3559735
## High                         -0.9403434
##
## 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: 107.5468823

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: $2.4269525 \times 10^{-22}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -0.6165658                   0.5254519                      -1.513267
## High    -0.0684540                   1.0538432                      -1.052466
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## Medium  -0.8647416  -0.6504192  -0.7984589  -0.4477310   0.1665694  -0.6141569
## High    -0.7220260  -0.3601878  -0.2522491   0.1071132   0.9615728   1.1873432
##        education1-3 Years College educationCollege Graduate
## Medium                  0.6446439                0.7823663
## High                    0.6552588                1.5125067
##        educationLess Than High School paritynullipara income<$20,000
## Medium                    -12.13114135      -0.1542112     -1.2336301
## High                       -0.04617887      -0.7280019     -0.3853355
```

```
##        income>$50,000 wic_participationTRUE breast_feeding_attitudePositive
## Medium     -0.1032504            0.03568936                       -1.7314095
## High       -0.3777242           -0.36546419                       -0.8885289
##
## 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
## Medium  -1.2504255 -0.23667596 -0.008213213 -0.09348726   0.3271856   0.7386566
## High    -0.3261573 -0.02324604  0.346735151  0.50122021   0.9531380   1.6033679
##        BFHI_score6 education1-3 Years College educationCollege Graduate
## Medium  0.07954725                  0.5431474                 0.7221084
## High    1.95789187                  0.5217109                 1.4212075
##        educationLess Than High School paritynullipara income<$20,000
## Medium                  -11.918757270     -0.04363083     -1.2178192
## High                     -0.005036037     -0.57571893     -0.3597286
##        income>$50,000 wic_participationTRUE breast_feeding_attitudePositive
## Medium     -0.1287525            -0.1048463                        -1.800499
## High       -0.4122519            -0.5032220                        -1.019435
##
## 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: 89.6741977

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: $1.5442318 \times 10^{-18}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -1.0379685                   0.8261718                      -1.157627
## High    -0.3028838                   0.9064421                      -1.086357
##         BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## Medium -0.180079362   0.2473348  0.04363267   0.6673407    0.893345   0.2358818
## High    0.003847364   0.4079742  0.65651316   0.9648640    1.540329   2.0985056
##        maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium        -0.3110884        0.08201945       0.1582488
## High          -0.8754652       -0.44176411      -0.3492439
##        race_ethBlack, Non-Hispanic race_ethHispanic race_ethOther
## Medium                  -0.2885354        0.2820050     0.3915950
## High                    -1.1463913       -0.7013685    -0.8115947
##        education1-3 Years College educationCollege Graduate
## Medium                0.02539152                -0.0088503
## High                  0.19494537                 0.8689077
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                      -1.523951      -0.2444323 -0.7489698    -0.3241959
## High                        -1.268125      -0.6922133 -0.5012849    -0.2155584
##        bmiUnderweight breast_feeding_attitudePositive
## Medium     -1.1696910                      -0.5232184
## High        0.6219217                      -0.6398411
##
## 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
## Medium  -1.3557665   0.2948746   0.7768683   0.6043726    1.270105    1.318541
## High    -0.4346053   0.3694362   0.8212371   1.1141557    1.481830    1.885413
##        BFHI_score6 maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium   0.7812003        -0.2618447        0.01549564       0.1999526
## High     2.5621854        -0.8644166       -0.51881749      -0.3241663
##        race_ethBlack, Non-Hispanic race_ethHispanic race_ethOther
```

```
## Medium                  -0.0149664        0.3958450     0.5537887
## High                    -0.8486210       -0.5844132    -0.6206701
##        education1-3 Years College educationCollege Graduate
## Medium                -0.06065954                0.07108468
## High                   0.10517408                0.93168366
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                      -1.2376614      -0.1099372 -0.8179699    -0.2849731
## High                        -0.8912046      -0.5521237 -0.5803604    -0.1962082
##        bmiUnderweight breast_feeding_attitudePositive
## Medium     -1.5527249                      -0.6400901
## High        0.2379298                      -0.7740436
##
## 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: 55.8542557

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: $2.1513338 \times 10^{-11}$

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -1.4599357                    0.7002114                     -0.5500734
## High    -0.8921212                    0.6411545                     -1.1315517
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
```

```
## Medium  -0.6147097  -0.3674178   0.1212188   0.2057755   0.5899097   0.6112258
## High     0.1054278   0.1884573   0.7800807   0.8399955   1.5179842   1.4916505
##        maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium        -0.0840991         0.3549348       0.4590868
## High          -0.6881010        -0.2179056      -0.1159345
##        race_ethBlack, Non-Hispanic race_ethHispanic race_ethOther
## Medium                  -0.3386765       -1.0252539    -1.1299382
## High                    -1.4330618       -0.3247655    -0.7277537
##        education1-3 Years College educationCollege Graduate
## Medium                 0.47578752                 0.7948221
## High                   0.05025695                 0.8530679
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                       0.1167817     -0.06860125 -0.4081087    -0.5563470
## High                        -0.8477036     -0.78531374 -0.4058040    -0.1787254
##        bmiUnderweight
## Medium     -0.5047747
## High        1.0321955
##
## 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
## Medium   -1.527219  -0.2504072  0.01864237   0.5216734   0.6920569   0.9945373
## High     -1.092104   0.4697776  0.61159324   1.2336851   1.3897258   1.9488520
##        BFHI_score6 maternal_age18-24 maternal_age30-34 maternal_age35+
## Medium    1.059877       -0.09097232         0.2829557       0.4409128
## High      1.973546       -0.74889496        -0.3093805      -0.1406696
##        race_ethBlack, Non-Hispanic race_ethHispanic race_ethOther
## Medium                  -0.1654867       -0.9156492    -1.0086447
## High                    -1.2057402       -0.2216399    -0.5544973
##        education1-3 Years College educationCollege Graduate
## Medium                0.430937229                 0.8320524
## High                 -0.002684187                 0.8911063
##        educationLess Than High School paritynullipara   bmiObese bmiOverweight
## Medium                       0.1079934      0.00227044 -0.4907037    -0.5657038
## High                        -0.7440011     -0.68505299 -0.5197281    -0.1905656
##        bmiUnderweight
## Medium     -0.8501933
## High        0.6448180
##
## 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: 44.067581

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: 6.2117187×10^{-9}

Full Model

```
## Call:
## multinom(formula = full_formula, data = temp_dt)
##
## Coefficients:
##        (Intercept) perception_of_supportHelpful perception_of_supportUnhelfpul
## Medium  -0.8359758                   0.7114572                     -0.5373398
## High    -0.9811014                   0.3372067                     -1.1009581
##        BFHI_score1 BFHI_score2 BFHI_score3 BFHI_score4 BFHI_score5 BFHI_score6
## Medium  -1.1135066  -0.1871546 -0.03798082   0.1763498   0.5542448   0.3109669
## High    -0.2108983   0.1463532  0.34881558   0.6139083   1.2194792   1.3229189
##        education1-3 Years College educationCollege Graduate
## Medium                -0.1106402                0.5194893
## High                   0.1050900                0.6122665
##        educationLess Than High School paritynullipara wic_participationTRUE
## Medium                     -13.7142044      -0.4661623           -0.07665814
## High                        -0.5020559      -0.7943058           -0.64851072
##        breast_feeding_attitudePositive
## Medium                      0.01470685
## High                       -1.52610532
##
## 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
## Medium  -0.8872428  -0.7543070   0.2077108   0.3795163   0.6601895   0.9529569
## High    -1.3760473   0.1448146   0.5609146   0.7709868   1.0976509   1.6098030
##        BFHI_score6 education1-3 Years College educationCollege Graduate
## Medium   0.8044008                -0.18041995                 0.5096893
## High     1.8183353                 0.04937147                 0.6157491
##        educationLess Than High School paritynullipara wic_participationTRUE
## Medium                     -13.6229180      -0.3860040            -0.1154495
## High                        -0.3559629      -0.7171135            -0.6910866
##        breast_feeding_attitudePositive
## Medium                      -0.05697779
## High                        -1.60309478
##
## 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
```