MEDI504B_ML_Project

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1. Introduction and Background

1.1 Introduction

Our overarching goal for this project is to produce a machine learning (ML) model which can accurately predict polycystic ovary syndrome (PCOS) status (presence or absence of disease). PCOS is an endocrine (hormonal) disorder that affects females of a reproductive age. Given the widespread nature of this condition and the troubling symptoms which accompany it, including infertility, it would be helpful for physicians to be able to predict individuals more likely to experience PCOS thereby enabling them to therapeutically intervene and provide care and support in a timely manner.

1.2 Background

Polycystic ovarian syndrome (PCOS) is a common endocrine disorder affecting approximately 10-15% of reproductive-age women worldwide (Teede, H., Misso, M., Tassone, E. C., Dewailly, D., Ng, E. H., Azziz, R., ... & Norman, R. J. (2018). Recommendations from the international evidence-based guideline for the assessment and management of polycystic ovary syndrome. Human Reproduction, 33(9), 1602-1618. https://doi.org/10.1093/humrep/dey256). The condition is characterized by a complex set of symptoms, including hyperandrogenism, menstrual irregularities, and polycystic ovaries (Bozdag et al., 2016). The diagnosis of PCOS is typically based on clinical and biochemical assessments, as well as ultrasound imaging of the ovaries (Teede et al., 2018). However, the diagnosis of PCOS can be challenging due to the heterogeneous presentation of symptoms and the lack of a single diagnostic criterion (Bozdag, G., Mumusoglu, S., Zengin, D., & Karabulut, E. (2016). The prevalence and phenotypic features of polycystic ovary syndrome: a systematic review and meta-analysis. Human Reproduction, 31(12), 2841–2855. https://doi.org/10.1093/humrep/dew218).

Machine learning models have shown promise as a potential tool for the accurate prediction of PCOS. Compared to traditional diagnostic methods, machine learning models can utilize large amounts of data from various sources and provide more accurate predictions. This is particularly beneficial in the case of PCOS, as traditional diagnostic methods such as tissue biopsy can be expensive and invasive. Furthermore, machine learning models can assist clinicians in identifying patients who may benefit from early intervention, which can improve long-term health outcomes (Teede et al., 2018).

Overall, the use of machine learning models to predict PCOS has the potential to improve the accuracy of diagnosis and reduce the cost and invasiveness of traditional diagnostic methods. We sought to evaluate the comparative accuracy of multiple machine learning classifiers to select the optimal model for predicting PCOS, given considerations surrounding false positive and false negatives.

Ethics

** include something about the target population and who is at risk ** what to do if someone is pregnant –> follow up with study doctor* **what to do if you have a suspicion that the patient is at risk for**

a life threatening medical disorder? people taking hormone therapy ** identification of patients given the data

Labels and predictors

1.3 Data

The dataset consists of physical and clinical parameters collected from 10 hospitals across Kerala, India, to determine PCOS and infertility-related issues. The dataset contains information that can be used to analyze and understand the diagnosis and treatment of PCOS and infertility.

2. Objectives

Our objectives were twofold:

1: Develop a simple model that can predict PCOS status using clinical and physiologic data that can be acquired using a routine blood test and assessment by a general practitioner clinician.

2: Optimize the model for specificity, thus minimizing the risk of a false positive in model predications.

The rationale for objective one was based on the motivation to provide a data-based method of diagnosis that is cheaper and less invasive than current methods. As discussed in the background section of this report, current diagnosis of PCOS can be time-consuming and invasive, and replacing these methods with a model is advantaegous for reasons related to clinical care and resource utilization. This influenced our variable selection, as we did not consider the inclusion of predictors that can not be measured in the above stated context in model development.

Optimizing model specificity for the prediction of PCOS is important because PCOS is associated with several negative health outcomes, including infertility, insulin resistance, and metabolic disorders. Early diagnosis and treatment of PCOS can help prevent or manage these conditions, which can ultimately improve the overall health and quality of life of those affected. However, given that PCOS is not a life-threatening condition in and of itself, it is important to balance the trade-off between maximizing sensitivity and specificity in order to minimize the number of false positives and prevent unnecessary and potentially invasive follow-up testing. By optimizing model specificity, we can ensure that those who are diagnosed with PCOS are more likely to truly have the condition, while also reducing the risk of unnecessary medical interventions for those who do not have PCOS.

3. Methods

3.1 Splitting our dataset into training and testing datasets

Following our EDA (please refer to EDA section), we start by splitting our dataset into the training set and the validation set, followed by building a simple model aimed at using our data to find factors that predict PCOS status (our outcome variable). We chose to partition our data into only two sets based on the relatively small overall sample size of our data and small effective sample size of our data. Further, to help determine generalizability, we believe it would be ideal for our predictive model to be validated on an external dataset derived from a different population than our training and test data.

3.2 Building logistic regression models

We first attempted to model our data with PCOS status as the outcome variable using three different logistic regression models. At this stage of variable selection, we relied on the Akaike Information Criteria (AIC) to assess model fit. Of the tested logistic regression models, we prespecified that we would select the model with the lowest AIC. The three tested models utilized the following construction:

- (1) Model 1 included all the features in our dataset
- (2) Model 2 only includes physiological variables we think are of interest in PCOS, namely the hormone measurements (n=5 different types of hormones)
- (3) Model 3 includes the n=5 the hormone measurement levels we in our dataset, and in addition to these features, the clinical symptoms that have been known to be associated with PCOS: weight gain, hair growth + skin darkening, hair loss and pimples.

Of our three logistic regression models, Model 3 had the lowest AIC score of 566.45. We also assessed autocorrelation and collinearity among the variables in model three. *NEED TO ADD*

Results

4. Results

4a. Exploratory Data Analysis

This section contains the steps and output for the EDA performed on the PCOS dataset. The section proceeds sequentially with each step of EDA. Please refer to bullet points, figure titles and figure captions for more details. The first steps in our EDA involved getting a high-level overview of our dataset and determining the dimension of our data: n=541 rows and n=45 columns. Further checking of the dataset reveals an additional column (column 45). This column does not contain any useful information and is not one of our 44 features, therefore the column was removed. We find that our dataset has the following variables: Sl. No, Patient File No., PCOS (Y/N), Age (yrs), Weight (Kg), Height(Cm), BMI, Blood Group, Pulse rate(bpm), RR(breaths/min), Hb(g/dl), Cycle(R/I), Cycle length(days), Marriage Status (Yrs), Pregnant(Y/N), No. of aborptions, I beta-HCG(mIU/mL), II beta-HCG(mIU/mL), FSH(mIU/mL), LH(mIU/mL), FSH/LH, Hip(inch), Waist(inch), Waist:Hip Ratio, TSH (mIU/L), AMH(ng/mL), PRL(ng/mL), Vit D3 (ng/mL), PRG(ng/mL), RBS(mg/dl), Weight gain(Y/N), hair growth(Y/N), Skin darkening (Y/N), Hair loss(Y/N), Pimples(Y/N), Fast food (Y/N), Reg.Exercise(Y/N), BP _Systolic (mmHg), BP _Diastolic (mmHg), Follicle No. (L), Follicle No. (R), Avg. F size (L) (mm), Avg. F size (R) (mm), Endometrium (mm).

Data Wrangling

Next, we formatted the data to ensure the variables are the appropriate class type, this will enable us to perform our EDA. Specifically we converted binary variables (1 or 0) into the character class type.

Bivariate associations

We examined associations for categorical predictors and the outcome (PCOS) by constructing bivariate plots for the predictors stratified by PCOS status.

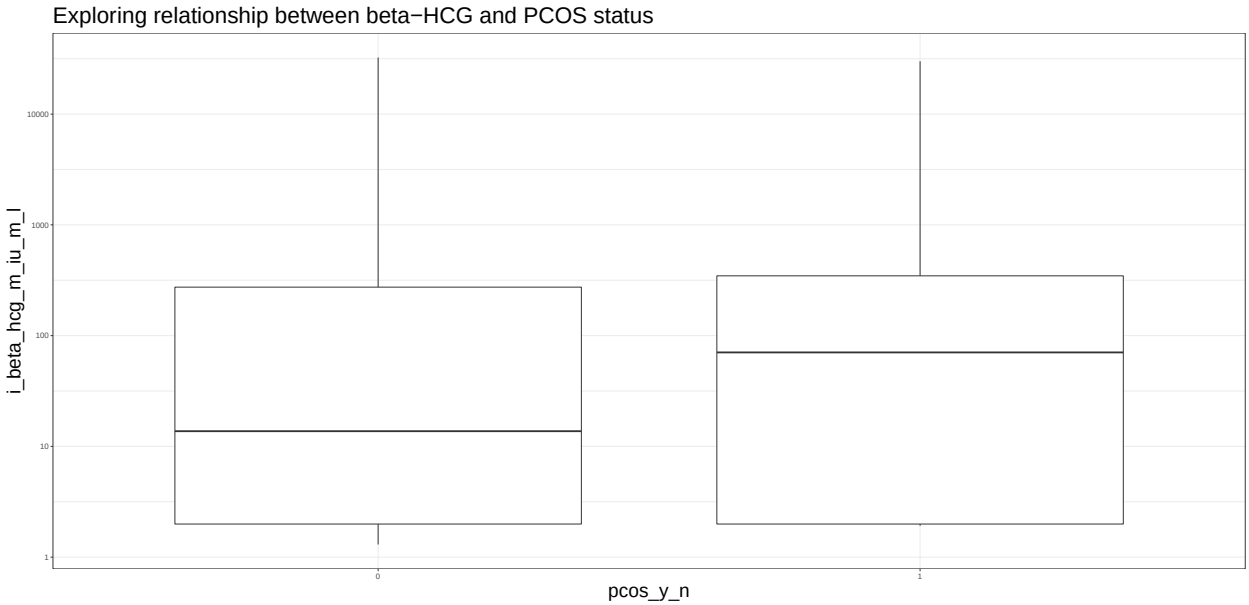
From the figure, we can see that the proportion of individuals with weight gain and a positive PCOS status is greater than the proportion of individuals with no weight gain and a positive PCOS status. We observe similar associations for hair growth and skin darkening. We also observe a similar but much weaker association for the categorical variables of hair loss and pimples. Interestingly, we observe the inverse trend for the categorical variable for fast food consumption. As these predictors appear to be visually associated with the outcome, as well as physiologically feasible to be associated with PCOS, they should be considered for inclusion in the predictive model.

The bar plots for regular exercise and pregnancy do not appear to show a signfiicant difference in proportion of positive PCOS cases, but we would need to perform a statistical analyses (such as an unpaired t-test) to know for sure.

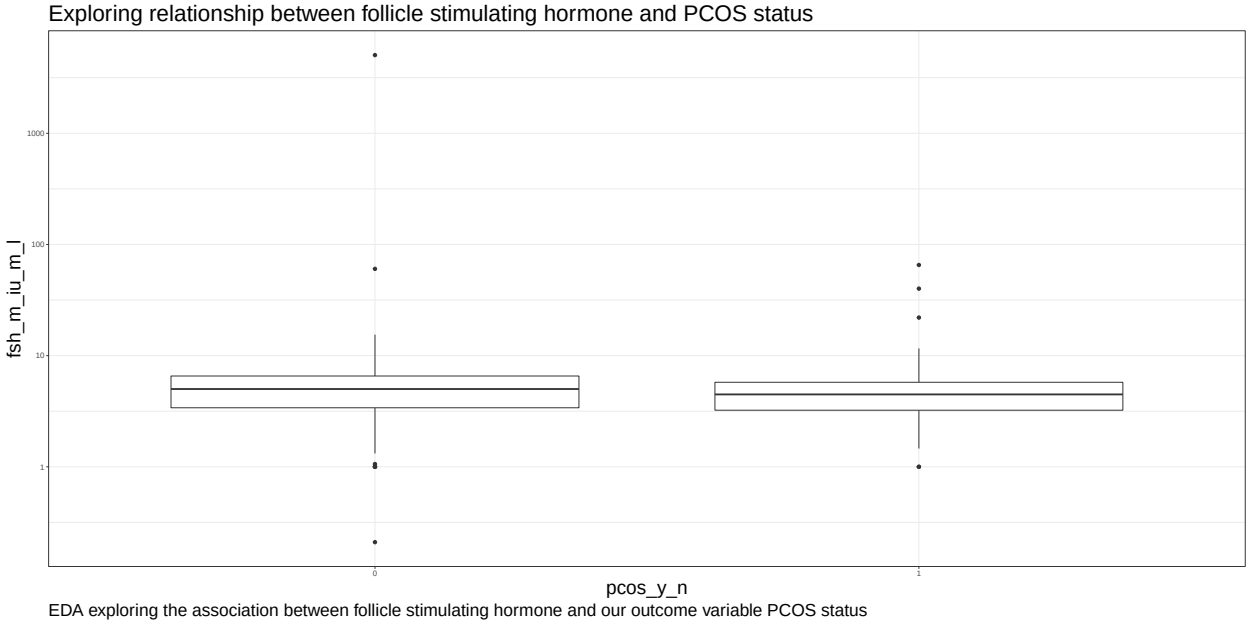
To ascertain the relationship between PCOS status and continuous predictors, we also plotted boxplots to visualize any associations between PCOS status and a continuous variable. Please refer to the appendix for these boxplots.

- For this section of the EDA, we looked more closely at the relationships between selected variables and our outcome variable of interest (for this project: yes or no for PCOS), based on how our boxplots looked initially (please refer to Appendix for all boxplots) and on some knowledge gained via our literature survey, we will highlight the relatiionship of select variables with our outcome variable (PCOS status).
- While the etiology for PCOS is not known, my literature survey suggests PCOS is associated with abnormal hormone levels. Thus, to look into this further as part of the EDA, we compared measurements of hormone levels and PCOS status to get a sense of the relationships between these variables.

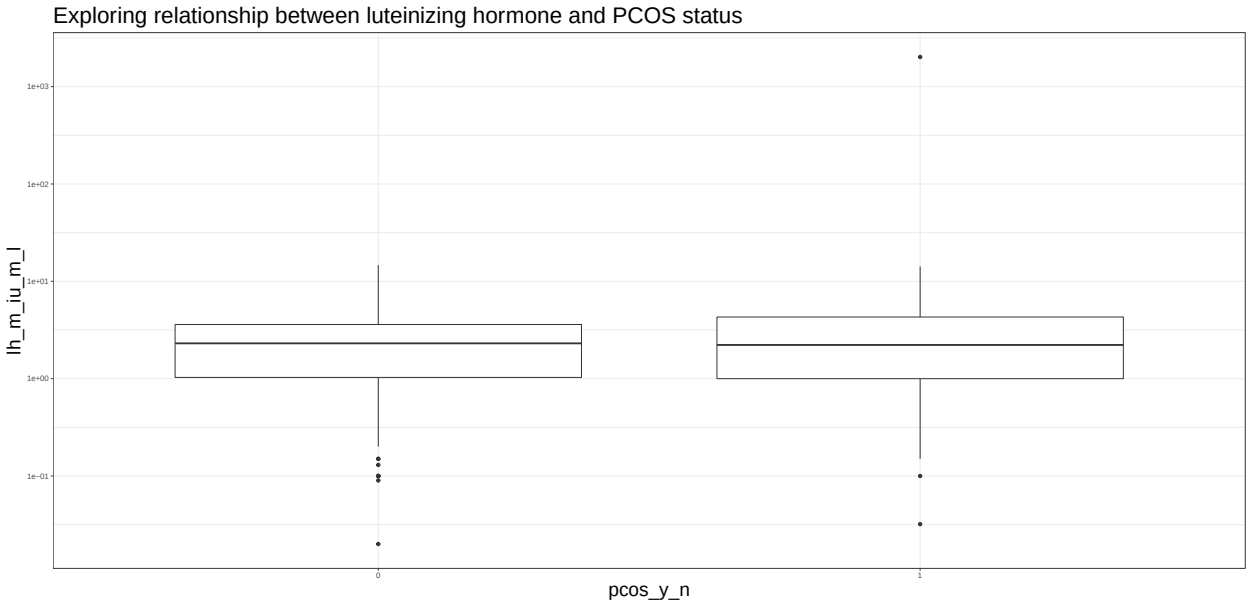
Boxplots looking at relationship of hormones and PCOS status



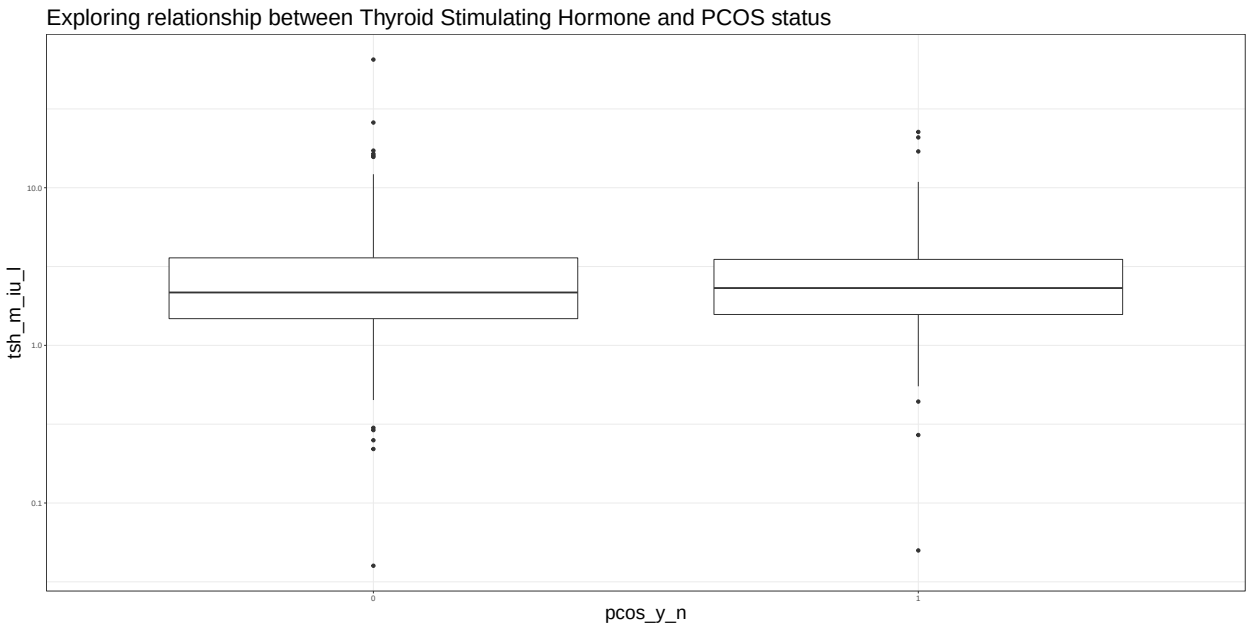
EDA exploring the associationg between beta−HCG hormone and our outocme variable PCOS status



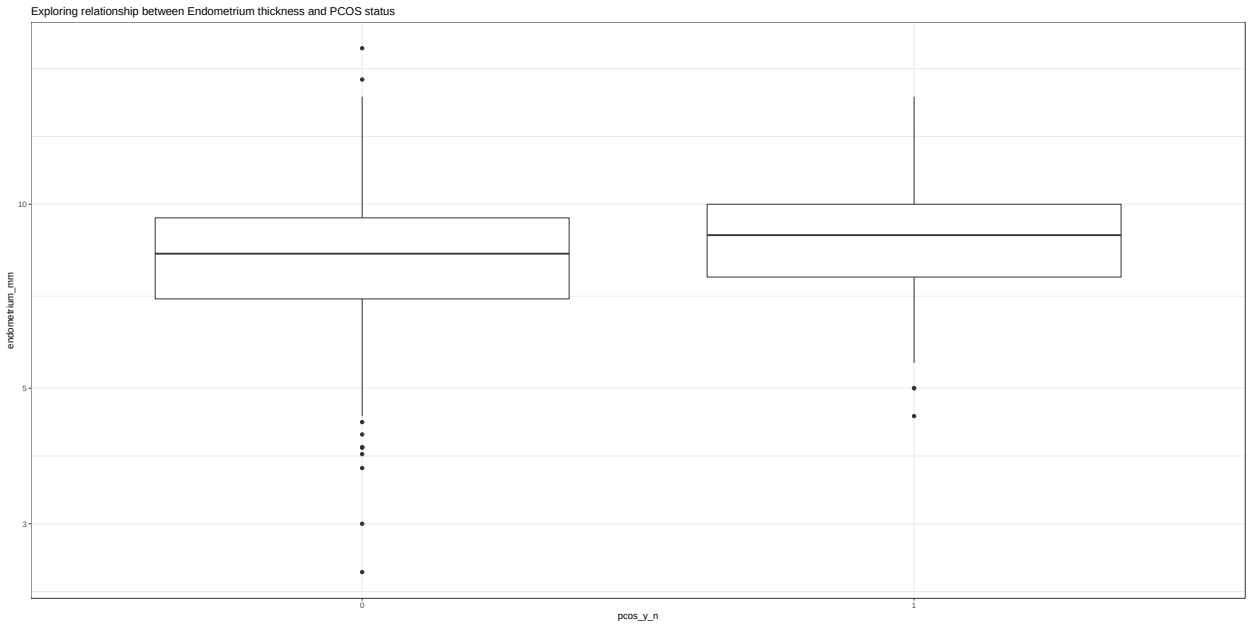
EDA exploring the association between follicle stimulating hormone and our outcome variable PCOS status



EDA exploring the association between Lutenizing hormone and PCOS status.



- From the literature, we know that PCOS diagnosis often involves an ultrasound and endometrium thickness is measured as part of this process. Therefore, as part of our EDA, we also sought to look at the relationship between endometrium thickness and PCOS status.



- From this series of boxplots, we did not observe (visually) any significant difference in the association of PCOS status and hormone levels. However, given what we know about the association of PCOS and hormone imbalances from the literature, I think it would still be useful to include these variables when we build our model.
- From the literature[2], there is also evidence that miscarriages are associated with PCOS. Therefore, as part of our EDA, we sought to look at the relationship between PCOS status and number of abortions.

Modelling

```
#####
## setting the seed (enables randomization in a reproducible way)
set.seed(504)

data_split <- caret::createDataPartition(PCOS_data_without_infertility_formatted_final$pcos_y_n, p=0.7,

train.data <- PCOS_data_without_infertility_formatted_final[data_split,]
dim(train.data)
```

```
## [1] 379  44
```

```
test.data <- PCOS_data_without_infertility_formatted_final[-data_split,]
dim(test.data)
```

```
## [1] 160  44
```

```
table(train.data$pcos_y_n)
```

```
##
##   0   1
## 255 124
```

```r
# the first model we will build will include all the variables
#library(glmnet)

logistic_model1 <- glm(pcos_y_n ~ .,
                       data = train.data,
                       family = binomial(link="logit"))
```

```
## Warning: glm.fit: algorithm did not converge
```

```r
summary(logistic_model1)
```

```
##
## Call:
## glm(formula = pcos_y_n ~ ., family = binomial(link = "logit"),
##     data = train.data)
##
## Deviance Residuals:
##   [1]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [26]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [51]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
##  [76]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [101]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [126]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [151]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [176]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [201]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [226]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [251]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [276]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [301]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [326]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [351]  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
## [376]  0  0  0  0
##
## Coefficients: (805 not defined because of singularities)
##                               Estimate Std. Error z value Pr(>|z|)
## (Intercept)                 -2.657e+01  3.561e+05       0        1
## sl_no4                      -2.990e-12  5.036e+05       0        1
## sl_no7                      -2.925e-12  5.036e+05       0        1
## sl_no8                      -2.674e-12  5.036e+05       0        1
## sl_no10                     -2.722e-12  5.036e+05       0        1
## sl_no11                     -2.968e-12  5.036e+05       0        1
## sl_no12                     -3.104e-12  5.036e+05       0        1
## sl_no13                      5.313e+01  5.036e+05       0        1
## sl_no15                     -3.046e-12  5.036e+05       0        1
## sl_no16                     -3.085e-12  5.036e+05       0        1
## sl_no18                     -3.135e-12  5.036e+05       0        1
## sl_no19                     -3.119e-12  5.036e+05       0        1
## sl_no20                      5.313e+01  5.036e+05       0        1
## sl_no21                     -3.267e-12  5.036e+05       0        1
## sl_no22                     -3.403e-12  5.036e+05       0        1
## sl_no23                     -3.200e-12  5.036e+05       0        1
```

```
## sl_no24                  -3.267e-12  5.036e+05       0        1
## sl_no28                  -3.326e-12  5.036e+05       0        1
## sl_no30                   5.313e+01  5.036e+05       0        1
## sl_no31                  -3.225e-12  5.036e+05       0        1
## sl_no32                   5.313e+01  5.036e+05       0        1
## sl_no33                  -3.138e-12  5.036e+05       0        1
## sl_no34                  -3.237e-12  5.036e+05       0        1
## sl_no36                  -3.351e-12  5.036e+05       0        1
## sl_no37                  -3.335e-12  5.036e+05       0        1
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## sl_no41                  -3.175e-12  5.036e+05       0        1
## sl_no42                  -3.248e-12  5.036e+05       0        1
## sl_no43                  -3.152e-12  5.036e+05       0        1
## sl_no45                   5.313e+01  5.036e+05       0        1
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## sl_no54                  -3.071e-12  5.036e+05       0        1
## sl_no56                  -2.986e-12  5.036e+05       0        1
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## sl_no58                  -3.554e-12  5.036e+05       0        1
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## sl_no68                  -3.334e-12  5.036e+05       0        1
## sl_no69                   5.313e+01  5.036e+05       0        1
## sl_no70                   5.313e+01  5.036e+05       0        1
## sl_no71                  -3.124e-12  5.036e+05       0        1
## sl_no72                  -3.272e-12  5.036e+05       0        1
## sl_no73                  -3.203e-12  5.036e+05       0        1
## sl_no75                  -3.414e-12  5.036e+05       0        1
## sl_no76                  -2.961e-12  5.036e+05       0        1
## sl_no77                   5.313e+01  5.036e+05       0        1
## sl_no80                  -2.929e-12  5.036e+05       0        1
## sl_no82                  -2.795e-12  5.036e+05       0        1
## sl_no83                  -3.197e-12  5.036e+05       0        1
## sl_no84                  -2.858e-12  5.036e+05       0        1
## sl_no87                  -2.792e-12  5.036e+05       0        1
## sl_no88                  -3.212e-12  5.036e+05       0        1
## sl_no89                   5.313e+01  5.036e+05       0        1
## sl_no91                  -3.181e-12  5.036e+05       0        1
## sl_no92                  -3.085e-12  5.036e+05       0        1
## sl_no94                  -2.994e-12  5.036e+05       0        1
## sl_no97                   5.313e+01  5.036e+05       0        1
## sl_no99                  -2.984e-12  5.036e+05       0        1
## sl_no100                 -3.027e-12  5.036e+05       0        1
## sl_no101                 -3.090e-12  5.036e+05       0        1
## sl_no102                 -2.986e-12  5.036e+05       0        1
## sl_no103                  5.313e+01  5.036e+05       0        1
## sl_no104                 -3.056e-12  5.036e+05       0        1
```

```
## sl_no105                  -2.861e-12  5.036e+05       0        1
## sl_no106                   5.313e+01  5.036e+05       0        1
## sl_no107                  -3.016e-12  5.036e+05       0        1
## sl_no108                   5.313e+01  5.036e+05       0        1
## sl_no110                  -3.385e-12  5.036e+05       0        1
## sl_no111                  -3.096e-12  5.036e+05       0        1
## sl_no112                  -2.939e-12  5.036e+05       0        1
## sl_no114                   5.313e+01  5.036e+05       0        1
## sl_no115                   5.313e+01  5.036e+05       0        1
## sl_no116                  -3.091e-12  5.036e+05       0        1
## sl_no117                  -3.195e-12  5.036e+05       0        1
## sl_no118                   5.313e+01  5.036e+05       0        1
## sl_no121                  -2.786e-12  5.036e+05       0        1
## sl_no122                  -3.191e-12  5.036e+05       0        1
## sl_no123                   5.313e+01  5.036e+05       0        1
## sl_no124                   5.313e+01  5.036e+05       0        1
## sl_no125                   5.313e+01  5.036e+05       0        1
## sl_no126                  -3.122e-12  5.036e+05       0        1
## sl_no127                  -3.253e-12  5.036e+05       0        1
## sl_no129                  -3.162e-12  5.036e+05       0        1
## sl_no130                  -3.263e-12  5.036e+05       0        1
## sl_no132                  -3.265e-12  5.036e+05       0        1
## sl_no133                   5.313e+01  5.036e+05       0        1
## sl_no134                   5.313e+01  5.036e+05       0        1
## sl_no135                  -2.981e-12  5.036e+05       0        1
## sl_no136                  -3.039e-12  5.036e+05       0        1
## sl_no138                  -3.413e-12  5.036e+05       0        1
## sl_no139                  -3.168e-12  5.036e+05       0        1
## sl_no141                  -3.411e-12  5.036e+05       0        1
## sl_no142                   5.313e+01  5.036e+05       0        1
## sl_no143                   5.313e+01  5.036e+05       0        1
## sl_no144                  -3.231e-12  5.036e+05       0        1
## sl_no145                  -3.471e-12  5.036e+05       0        1
## sl_no146                  -3.464e-12  5.036e+05       0        1
## sl_no150                  -3.079e-12  5.036e+05       0        1
## sl_no151                   5.313e+01  5.036e+05       0        1
## sl_no152                   5.313e+01  5.036e+05       0        1
## sl_no153                   5.313e+01  5.036e+05       0        1
## sl_no158                  -3.145e-12  5.036e+05       0        1
## sl_no159                   5.313e+01  5.036e+05       0        1
## sl_no160                  -3.163e-12  5.036e+05       0        1
## sl_no162                  -3.245e-12  5.036e+05       0        1
## sl_no163                   5.313e+01  5.036e+05       0        1
## sl_no164                  -2.950e-12  5.036e+05       0        1
## sl_no166                  -2.935e-12  5.036e+05       0        1
## sl_no168                   5.313e+01  5.036e+05       0        1
## sl_no169                   5.313e+01  5.036e+05       0        1
## sl_no170                   5.313e+01  5.036e+05       0        1
## sl_no171                  -3.138e-12  5.036e+05       0        1
## sl_no172                   5.313e+01  5.036e+05       0        1
## sl_no173                  -3.043e-12  5.036e+05       0        1
## sl_no174                   5.313e+01  5.036e+05       0        1
## sl_no176                   5.313e+01  5.036e+05       0        1
## sl_no177                   5.313e+01  5.036e+05       0        1
```

```
## sl_no178                  5.313e+01  5.036e+05       0        1
## sl_no180                 -3.291e-12  5.036e+05       0        1
## sl_no181                  5.313e+01  5.036e+05       0        1
## sl_no182                 -3.107e-12  5.036e+05       0        1
## sl_no184                 -3.188e-12  5.036e+05       0        1
## sl_no185                 -2.889e-12  5.036e+05       0        1
## sl_no186                 -3.121e-12  5.036e+05       0        1
## sl_no188                 -3.082e-12  5.036e+05       0        1
## sl_no189                 -3.069e-12  5.036e+05       0        1
## sl_no190                  5.313e+01  5.036e+05       0        1
## sl_no192                  5.313e+01  5.036e+05       0        1
## sl_no193                 -3.021e-12  5.036e+05       0        1
## sl_no195                 -3.378e-12  5.036e+05       0        1
## sl_no199                 -3.039e-12  5.036e+05       0        1
## sl_no200                  5.313e+01  5.036e+05       0        1
## sl_no203                 -3.144e-12  5.036e+05       0        1
## sl_no206                  5.313e+01  5.036e+05       0        1
## sl_no209                 -3.067e-12  5.036e+05       0        1
## sl_no214                  5.313e+01  5.036e+05       0        1
## sl_no216                 -3.011e-12  5.036e+05       0        1
## sl_no217                  5.313e+01  5.036e+05       0        1
## sl_no218                  5.313e+01  5.036e+05       0        1
## sl_no219                 -3.086e-12  5.036e+05       0        1
## sl_no220                 -3.212e-12  5.036e+05       0        1
## sl_no221                 -3.151e-12  5.036e+05       0        1
## sl_no222                  5.313e+01  5.036e+05       0        1
## sl_no223                  5.313e+01  5.036e+05       0        1
## sl_no224                 -3.051e-12  5.036e+05       0        1
## sl_no225                 -3.011e-12  5.036e+05       0        1
## sl_no226                 -3.255e-12  5.036e+05       0        1
## sl_no227                 -3.348e-12  5.036e+05       0        1
## sl_no228                  5.313e+01  5.036e+05       0        1
## sl_no229                 -3.122e-12  5.036e+05       0        1
## sl_no230                 -3.185e-12  5.036e+05       0        1
## sl_no231                  5.313e+01  5.036e+05       0        1
## sl_no232                 -3.164e-12  5.036e+05       0        1
## sl_no233                  5.313e+01  5.036e+05       0        1
## sl_no234                 -3.279e-12  5.036e+05       0        1
## sl_no235                 -3.086e-12  5.036e+05       0        1
## sl_no237                 -3.249e-12  5.036e+05       0        1
## sl_no238                  5.313e+01  5.036e+05       0        1
## sl_no239                 -3.220e-12  5.036e+05       0        1
## sl_no240                 -3.153e-12  5.036e+05       0        1
## sl_no241                  5.313e+01  5.036e+05       0        1
## sl_no242                 -3.098e-12  5.036e+05       0        1
## sl_no243                 -3.206e-12  5.036e+05       0        1
## sl_no246                  5.313e+01  5.036e+05       0        1
## sl_no247                 -3.049e-12  5.036e+05       0        1
## sl_no248                  5.313e+01  5.036e+05       0        1
## sl_no251                  5.313e+01  5.036e+05       0        1
## sl_no252                 -3.003e-12  5.036e+05       0        1
## sl_no253                  5.313e+01  5.036e+05       0        1
## sl_no254                 -3.174e-12  5.036e+05       0        1
## sl_no255                 -2.956e-12  5.036e+05       0        1
```

```
## sl_no256                  -2.998e-12  5.036e+05       0        1
## sl_no257                  -3.042e-12  5.036e+05       0        1
## sl_no258                  -3.351e-12  5.036e+05       0        1
## sl_no259                  -3.041e-12  5.036e+05       0        1
## sl_no263                  -3.087e-12  5.036e+05       0        1
## sl_no264                  -3.135e-12  5.036e+05       0        1
## sl_no266                  -3.129e-12  5.036e+05       0        1
## sl_no267                  -3.142e-12  5.036e+05       0        1
## sl_no268                   5.313e+01  5.036e+05       0        1
## sl_no269                  -3.202e-12  5.036e+05       0        1
## sl_no270                   5.313e+01  5.036e+05       0        1
## sl_no271                  -3.201e-12  5.036e+05       0        1
## sl_no272                  -3.084e-12  5.036e+05       0        1
## sl_no275                  -3.022e-12  5.036e+05       0        1
## sl_no277                   5.313e+01  5.036e+05       0        1
## sl_no278                   5.313e+01  5.036e+05       0        1
## sl_no280                  -3.160e-12  5.036e+05       0        1
## sl_no281                  -3.037e-12  5.036e+05       0        1
## sl_no282                  -3.113e-12  5.036e+05       0        1
## sl_no284                  -3.201e-12  5.036e+05       0        1
## sl_no286                  -3.166e-12  5.036e+05       0        1
## sl_no287                  -3.057e-12  5.036e+05       0        1
## sl_no288                   5.313e+01  5.036e+05       0        1
## sl_no289                  -3.204e-12  5.036e+05       0        1
## sl_no291                   5.313e+01  5.036e+05       0        1
## sl_no292                  -3.025e-12  5.036e+05       0        1
## sl_no293                  -3.193e-12  5.036e+05       0        1
## sl_no294                   5.313e+01  5.036e+05       0        1
## sl_no295                   5.313e+01  5.036e+05       0        1
## sl_no297                  -3.018e-12  5.036e+05       0        1
## sl_no298                  -3.056e-12  5.036e+05       0        1
## sl_no299                  -3.024e-12  5.036e+05       0        1
## sl_no300                  -3.145e-12  5.036e+05       0        1
## sl_no301                   5.313e+01  5.036e+05       0        1
## sl_no304                   5.313e+01  5.036e+05       0        1
## sl_no305                  -3.202e-12  5.036e+05       0        1
## sl_no306                  -2.905e-12  5.036e+05       0        1
## sl_no308                  -3.005e-12  5.036e+05       0        1
## sl_no309                   5.313e+01  5.036e+05       0        1
## sl_no310                   5.313e+01  5.036e+05       0        1
## sl_no311                  -3.074e-12  5.036e+05       0        1
## sl_no312                   5.313e+01  5.036e+05       0        1
## sl_no313                   5.313e+01  5.036e+05       0        1
## sl_no315                   5.313e+01  5.036e+05       0        1
## sl_no316                  -3.023e-12  5.036e+05       0        1
## sl_no317                  -3.288e-12  5.036e+05       0        1
## sl_no318                  -3.197e-12  5.036e+05       0        1
## sl_no321                   5.313e+01  5.036e+05       0        1
## sl_no322                  -3.218e-12  5.036e+05       0        1
## sl_no323                  -3.436e-12  5.036e+05       0        1
## sl_no324                   5.313e+01  5.036e+05       0        1
## sl_no326                  -3.254e-12  5.036e+05       0        1
## sl_no328                  -3.393e-12  5.036e+05       0        1
## sl_no329                   5.313e+01  5.036e+05       0        1
```

```
## sl_no330                  -3.169e-12  5.036e+05       0        1
## sl_no333                  -3.150e-12  5.036e+05       0        1
## sl_no336                  -3.169e-12  5.036e+05       0        1
## sl_no337                   5.313e+01  5.036e+05       0        1
## sl_no338                   5.313e+01  5.036e+05       0        1
## sl_no339                   5.313e+01  5.036e+05       0        1
## sl_no340                  -3.266e-12  5.036e+05       0        1
## sl_no341                   5.313e+01  5.036e+05       0        1
## sl_no342                   5.313e+01  5.036e+05       0        1
## sl_no343                   5.313e+01  5.036e+05       0        1
## sl_no344                  -3.135e-12  5.036e+05       0        1
## sl_no345                  -2.967e-12  5.036e+05       0        1
## sl_no346                  -3.113e-12  5.036e+05       0        1
## sl_no349                  -3.068e-12  5.036e+05       0        1
## sl_no350                  -3.029e-12  5.036e+05       0        1
## sl_no352                   5.313e+01  5.036e+05       0        1
## sl_no353                   5.313e+01  5.036e+05       0        1
## sl_no354                  -3.016e-12  5.036e+05       0        1
## sl_no355                  -3.152e-12  5.036e+05       0        1
## sl_no356                  -3.038e-12  5.036e+05       0        1
## sl_no357                   5.313e+01  5.036e+05       0        1
## sl_no358                  -2.987e-12  5.036e+05       0        1
## sl_no359                  -3.237e-12  5.036e+05       0        1
## sl_no361                  -3.014e-12  5.036e+05       0        1
## sl_no362                  -3.193e-12  5.036e+05       0        1
## sl_no363                  -3.135e-12  5.036e+05       0        1
## sl_no366                  -3.085e-12  5.036e+05       0        1
## sl_no369                   5.313e+01  5.036e+05       0        1
## sl_no370                  -3.182e-12  5.036e+05       0        1
## sl_no371                   5.313e+01  5.036e+05       0        1
## sl_no373                   5.313e+01  5.036e+05       0        1
## sl_no375                  -2.925e-12  5.036e+05       0        1
## sl_no376                   5.313e+01  5.036e+05       0        1
## sl_no378                  -2.976e-12  5.036e+05       0        1
## sl_no379                  -3.058e-12  5.036e+05       0        1
## sl_no380                  -3.122e-12  5.036e+05       0        1
## sl_no381                  -3.065e-12  5.036e+05       0        1
## sl_no382                  -3.054e-12  5.036e+05       0        1
## sl_no383                  -3.084e-12  5.036e+05       0        1
## sl_no384                  -3.137e-12  5.036e+05       0        1
## sl_no385                  -3.115e-12  5.036e+05       0        1
## sl_no386                  -2.886e-12  5.036e+05       0        1
## sl_no387                  -3.111e-12  5.036e+05       0        1
## sl_no388                   5.313e+01  5.036e+05       0        1
## sl_no389                  -3.075e-12  5.036e+05       0        1
## sl_no392                  -3.053e-12  5.036e+05       0        1
## sl_no393                   5.313e+01  5.036e+05       0        1
## sl_no394                  -3.120e-12  5.036e+05       0        1
## sl_no395                  -3.018e-12  5.036e+05       0        1
## sl_no397                  -3.107e-12  5.036e+05       0        1
## sl_no398                  -3.129e-12  5.036e+05       0        1
## sl_no399                   5.313e+01  5.036e+05       0        1
## sl_no400                  -3.046e-12  5.036e+05       0        1
## sl_no402                  -3.269e-12  5.036e+05       0        1
```

```
## sl_no403                    5.313e+01  5.036e+05       0        1
## sl_no404                    5.313e+01  5.036e+05       0        1
## sl_no405                   -2.978e-12  5.036e+05       0        1
## sl_no407                   -3.039e-12  5.036e+05       0        1
## sl_no408                   -2.913e-12  5.036e+05       0        1
## sl_no409                   -3.075e-12  5.036e+05       0        1
## sl_no410                   -3.008e-12  5.036e+05       0        1
## sl_no412                   -3.190e-12  5.036e+05       0        1
## sl_no413                    5.313e+01  5.036e+05       0        1
## sl_no414                   -3.249e-12  5.036e+05       0        1
## sl_no417                   -3.149e-12  5.036e+05       0        1
## sl_no418                   -3.214e-12  5.036e+05       0        1
## sl_no420                   -3.158e-12  5.036e+05       0        1
## sl_no421                    5.313e+01  5.036e+05       0        1
## sl_no423                    5.313e+01  5.036e+05       0        1
## sl_no425                   -3.104e-12  5.036e+05       0        1
## sl_no426                    5.313e+01  5.036e+05       0        1
## sl_no428                    5.313e+01  5.036e+05       0        1
## sl_no429                    5.313e+01  5.036e+05       0        1
## sl_no430                    5.313e+01  5.036e+05       0        1
## sl_no431                    5.313e+01  5.036e+05       0        1
## sl_no433                   -3.053e-12  5.036e+05       0        1
## sl_no436                   -3.138e-12  5.036e+05       0        1
## sl_no437                   -3.043e-12  5.036e+05       0        1
## sl_no439                    5.313e+01  5.036e+05       0        1
## sl_no441                   -3.105e-12  5.036e+05       0        1
## sl_no442                   -3.233e-12  5.036e+05       0        1
## sl_no444                    5.313e+01  5.036e+05       0        1
## sl_no446                    5.313e+01  5.036e+05       0        1
## sl_no447                   -2.966e-12  5.036e+05       0        1
## sl_no449                   -3.179e-12  5.036e+05       0        1
## sl_no450                    5.313e+01  5.036e+05       0        1
## sl_no451                    5.313e+01  5.036e+05       0        1
## sl_no453                    5.313e+01  5.036e+05       0        1
## sl_no454                    5.313e+01  5.036e+05       0        1
## sl_no455                    5.313e+01  5.036e+05       0        1
## sl_no456                    5.313e+01  5.036e+05       0        1
## sl_no457                    5.313e+01  5.036e+05       0        1
## sl_no461                   -3.222e-12  5.036e+05       0        1
## sl_no463                    5.313e+01  5.036e+05       0        1
## sl_no464                   -3.116e-12  5.036e+05       0        1
## sl_no465                    5.313e+01  5.036e+05       0        1
## sl_no466                   -3.121e-12  5.036e+05       0        1
## sl_no467                   -3.113e-12  5.036e+05       0        1
## sl_no468                    5.313e+01  5.036e+05       0        1
## sl_no469                   -3.003e-12  5.036e+05       0        1
## sl_no471                    5.313e+01  5.036e+05       0        1
## sl_no472                    5.313e+01  5.036e+05       0        1
## sl_no474                   -3.041e-12  5.036e+05       0        1
## sl_no475                   -3.108e-12  5.036e+05       0        1
## sl_no477                   -3.100e-12  5.036e+05       0        1
## sl_no479                   -3.065e-12  5.036e+05       0        1
## sl_no481                   -3.099e-12  5.036e+05       0        1
## sl_no482                   -3.080e-12  5.036e+05       0        1
```

```
## sl_no483                  -3.101e-12  5.036e+05       0        1
## sl_no484                   5.313e+01  5.036e+05       0        1
## sl_no485                  -3.011e-12  5.036e+05       0        1
## sl_no486                  -3.053e-12  5.036e+05       0        1
## sl_no487                   5.313e+01  5.036e+05       0        1
## sl_no488                  -3.095e-12  5.036e+05       0        1
## sl_no490                   5.313e+01  5.036e+05       0        1
## sl_no491                  -3.119e-12  5.036e+05       0        1
## sl_no492                  -3.099e-12  5.036e+05       0        1
## sl_no494                   5.313e+01  5.036e+05       0        1
## sl_no495                  -3.109e-12  5.036e+05       0        1
## sl_no496                   5.313e+01  5.036e+05       0        1
## sl_no500                  -3.062e-12  5.036e+05       0        1
## sl_no501                  -3.105e-12  5.036e+05       0        1
## sl_no502                  -3.050e-12  5.036e+05       0        1
## sl_no504                  -3.077e-12  5.036e+05       0        1
## sl_no506                  -3.099e-12  5.036e+05       0        1
## sl_no509                  -3.087e-12  5.036e+05       0        1
## sl_no510                   5.313e+01  5.036e+05       0        1
## sl_no512                  -3.030e-12  5.036e+05       0        1
## sl_no514                  -3.051e-12  5.036e+05       0        1
## sl_no518                  -3.076e-12  5.036e+05       0        1
## sl_no519                  -2.993e-12  5.036e+05       0        1
## sl_no520                  -3.103e-12  5.036e+05       0        1
## sl_no522                  -2.956e-12  5.036e+05       0        1
## sl_no524                   5.313e+01  5.036e+05       0        1
## sl_no526                  -3.015e-12  5.036e+05       0        1
## sl_no527                  -3.059e-12  5.036e+05       0        1
## sl_no528                  -3.101e-12  5.036e+05       0        1
## sl_no529                  -3.057e-12  5.036e+05       0        1
## sl_no530                  -3.062e-12  5.036e+05       0        1
## sl_no531                  -3.067e-12  5.036e+05       0        1
## sl_no533                  -3.043e-12  5.036e+05       0        1
## sl_no534                   5.313e+01  5.036e+05       0        1
## sl_no535                  -3.067e-12  5.036e+05       0        1
## sl_no536                  -3.076e-12  5.036e+05       0        1
## sl_no539                  -3.072e-12  5.036e+05       0        1
## sl_no540                  -3.015e-12  5.036e+05       0        1
## sl_no541                   5.313e+01  5.036e+05       0        1
## patient_file_no4                  NA         NA      NA       NA
## patient_file_no7                  NA         NA      NA       NA
## patient_file_no8                  NA         NA      NA       NA
## patient_file_no10                 NA         NA      NA       NA
## patient_file_no11                 NA         NA      NA       NA
## patient_file_no12                 NA         NA      NA       NA
## patient_file_no13                 NA         NA      NA       NA
## patient_file_no15                 NA         NA      NA       NA
## patient_file_no16                 NA         NA      NA       NA
## patient_file_no18                 NA         NA      NA       NA
## patient_file_no19                 NA         NA      NA       NA
## patient_file_no20                 NA         NA      NA       NA
## patient_file_no21                 NA         NA      NA       NA
## patient_file_no22                 NA         NA      NA       NA
## patient_file_no23                 NA         NA      NA       NA
```

```
## patient_file_no24                  NA         NA       NA       NA
## patient_file_no28                  NA         NA       NA       NA
## patient_file_no30                  NA         NA       NA       NA
## patient_file_no31                  NA         NA       NA       NA
## patient_file_no32                  NA         NA       NA       NA
## patient_file_no33                  NA         NA       NA       NA
## patient_file_no34                  NA         NA       NA       NA
## patient_file_no36                  NA         NA       NA       NA
## patient_file_no37                  NA         NA       NA       NA
## patient_file_no39                  NA         NA       NA       NA
## patient_file_no41                  NA         NA       NA       NA
## patient_file_no42                  NA         NA       NA       NA
## patient_file_no43                  NA         NA       NA       NA
## patient_file_no45                  NA         NA       NA       NA
## patient_file_no46                  NA         NA       NA       NA
## patient_file_no48                  NA         NA       NA       NA
## patient_file_no49                  NA         NA       NA       NA
## patient_file_no50                  NA         NA       NA       NA
## patient_file_no52                  NA         NA       NA       NA
## patient_file_no54                  NA         NA       NA       NA
## patient_file_no56                  NA         NA       NA       NA
## patient_file_no57                  NA         NA       NA       NA
## patient_file_no58                  NA         NA       NA       NA
## patient_file_no59                  NA         NA       NA       NA
## patient_file_no60                  NA         NA       NA       NA
## patient_file_no64                  NA         NA       NA       NA
## patient_file_no66                  NA         NA       NA       NA
## patient_file_no67                  NA         NA       NA       NA
## patient_file_no68                  NA         NA       NA       NA
## patient_file_no69                  NA         NA       NA       NA
## patient_file_no70                  NA         NA       NA       NA
## patient_file_no71                  NA         NA       NA       NA
## patient_file_no72                  NA         NA       NA       NA
## patient_file_no73                  NA         NA       NA       NA
## patient_file_no75                  NA         NA       NA       NA
## patient_file_no76                  NA         NA       NA       NA
## patient_file_no77                  NA         NA       NA       NA
## patient_file_no80                  NA         NA       NA       NA
## patient_file_no82                  NA         NA       NA       NA
## patient_file_no83                  NA         NA       NA       NA
## patient_file_no84                  NA         NA       NA       NA
## patient_file_no87                  NA         NA       NA       NA
## patient_file_no88                  NA         NA       NA       NA
## patient_file_no89                  NA         NA       NA       NA
## patient_file_no91                  NA         NA       NA       NA
## patient_file_no92                  NA         NA       NA       NA
## patient_file_no94                  NA         NA       NA       NA
## patient_file_no97                  NA         NA       NA       NA
## patient_file_no99                  NA         NA       NA       NA
## patient_file_no100                 NA         NA       NA       NA
## patient_file_no101                 NA         NA       NA       NA
## patient_file_no102                 NA         NA       NA       NA
## patient_file_no103                 NA         NA       NA       NA
## patient_file_no104                 NA         NA       NA       NA
```

```
## patient_file_no105                NA         NA       NA       NA
## patient_file_no106                NA         NA       NA       NA
## patient_file_no107                NA         NA       NA       NA
## patient_file_no108                NA         NA       NA       NA
## patient_file_no110                NA         NA       NA       NA
## patient_file_no111                NA         NA       NA       NA
## patient_file_no112                NA         NA       NA       NA
## patient_file_no114                NA         NA       NA       NA
## patient_file_no115                NA         NA       NA       NA
## patient_file_no116                NA         NA       NA       NA
## patient_file_no117                NA         NA       NA       NA
## patient_file_no118                NA         NA       NA       NA
## patient_file_no121                NA         NA       NA       NA
## patient_file_no122                NA         NA       NA       NA
## patient_file_no123                NA         NA       NA       NA
## patient_file_no124                NA         NA       NA       NA
## patient_file_no125                NA         NA       NA       NA
## patient_file_no126                NA         NA       NA       NA
## patient_file_no127                NA         NA       NA       NA
## patient_file_no129                NA         NA       NA       NA
## patient_file_no130                NA         NA       NA       NA
## patient_file_no132                NA         NA       NA       NA
## patient_file_no133                NA         NA       NA       NA
## patient_file_no134                NA         NA       NA       NA
## patient_file_no135                NA         NA       NA       NA
## patient_file_no136                NA         NA       NA       NA
## patient_file_no138                NA         NA       NA       NA
## patient_file_no139                NA         NA       NA       NA
## patient_file_no141                NA         NA       NA       NA
## patient_file_no142                NA         NA       NA       NA
## patient_file_no143                NA         NA       NA       NA
## patient_file_no144                NA         NA       NA       NA
## patient_file_no145                NA         NA       NA       NA
## patient_file_no146                NA         NA       NA       NA
## patient_file_no150                NA         NA       NA       NA
## patient_file_no151                NA         NA       NA       NA
## patient_file_no152                NA         NA       NA       NA
## patient_file_no153                NA         NA       NA       NA
## patient_file_no158                NA         NA       NA       NA
## patient_file_no159                NA         NA       NA       NA
## patient_file_no160                NA         NA       NA       NA
## patient_file_no162                NA         NA       NA       NA
## patient_file_no163                NA         NA       NA       NA
## patient_file_no164                NA         NA       NA       NA
## patient_file_no166                NA         NA       NA       NA
## patient_file_no168                NA         NA       NA       NA
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## patient_file_no174                NA         NA       NA       NA
## patient_file_no176                NA         NA       NA       NA
## patient_file_no177                NA         NA       NA       NA
```

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## patient_file_no180                NA         NA       NA       NA
## patient_file_no181                NA         NA       NA       NA
## patient_file_no182                NA         NA       NA       NA
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## patient_file_no186                NA         NA       NA       NA
## patient_file_no188                NA         NA       NA       NA
## patient_file_no189                NA         NA       NA       NA
## patient_file_no190                NA         NA       NA       NA
## patient_file_no192                NA         NA       NA       NA
## patient_file_no193                NA         NA       NA       NA
## patient_file_no195                NA         NA       NA       NA
## patient_file_no199                NA         NA       NA       NA
## patient_file_no200                NA         NA       NA       NA
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## patient_file_no206                NA         NA       NA       NA
## patient_file_no209                NA         NA       NA       NA
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## patient_file_no216                NA         NA       NA       NA
## patient_file_no217                NA         NA       NA       NA
## patient_file_no218                NA         NA       NA       NA
## patient_file_no219                NA         NA       NA       NA
## patient_file_no220                NA         NA       NA       NA
## patient_file_no221                NA         NA       NA       NA
## patient_file_no222                NA         NA       NA       NA
## patient_file_no223                NA         NA       NA       NA
## patient_file_no224                NA         NA       NA       NA
## patient_file_no225                NA         NA       NA       NA
## patient_file_no226                NA         NA       NA       NA
## patient_file_no227                NA         NA       NA       NA
## patient_file_no228                NA         NA       NA       NA
## patient_file_no229                NA         NA       NA       NA
## patient_file_no230                NA         NA       NA       NA
## patient_file_no231                NA         NA       NA       NA
## patient_file_no232                NA         NA       NA       NA
## patient_file_no233                NA         NA       NA       NA
## patient_file_no234                NA         NA       NA       NA
## patient_file_no235                NA         NA       NA       NA
## patient_file_no237                NA         NA       NA       NA
## patient_file_no238                NA         NA       NA       NA
## patient_file_no239                NA         NA       NA       NA
## patient_file_no240                NA         NA       NA       NA
## patient_file_no241                NA         NA       NA       NA
## patient_file_no242                NA         NA       NA       NA
## patient_file_no243                NA         NA       NA       NA
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## patient_file_no248                NA         NA       NA       NA
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## patient_file_no253                NA         NA       NA       NA
## patient_file_no254                NA         NA       NA       NA
## patient_file_no255                NA         NA       NA       NA
```

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## patient_file_no263                NA         NA       NA       NA
## patient_file_no264                NA         NA       NA       NA
## patient_file_no266                NA         NA       NA       NA
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## patient_file_no268                NA         NA       NA       NA
## patient_file_no269                NA         NA       NA       NA
## patient_file_no270                NA         NA       NA       NA
## patient_file_no271                NA         NA       NA       NA
## patient_file_no272                NA         NA       NA       NA
## patient_file_no275                NA         NA       NA       NA
## patient_file_no277                NA         NA       NA       NA
## patient_file_no278                NA         NA       NA       NA
## patient_file_no280                NA         NA       NA       NA
## patient_file_no281                NA         NA       NA       NA
## patient_file_no282                NA         NA       NA       NA
## patient_file_no284                NA         NA       NA       NA
## patient_file_no286                NA         NA       NA       NA
## patient_file_no287                NA         NA       NA       NA
## patient_file_no288                NA         NA       NA       NA
## patient_file_no289                NA         NA       NA       NA
## patient_file_no291                NA         NA       NA       NA
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## patient_file_no293                NA         NA       NA       NA
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## patient_file_no313                NA         NA       NA       NA
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## patient_file_no318                NA         NA       NA       NA
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## patient_file_no322                NA         NA       NA       NA
## patient_file_no323                NA         NA       NA       NA
## patient_file_no324                NA         NA       NA       NA
## patient_file_no326                NA         NA       NA       NA
## patient_file_no328                NA         NA       NA       NA
## patient_file_no329                NA         NA       NA       NA
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## patient_file_no342                NA         NA       NA       NA
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## patient_file_no345                NA         NA       NA       NA
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## patient_file_no350                NA         NA       NA       NA
## patient_file_no352                NA         NA       NA       NA
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## patient_file_no356                NA         NA       NA       NA
## patient_file_no357                NA         NA       NA       NA
## patient_file_no358                NA         NA       NA       NA
## patient_file_no359                NA         NA       NA       NA
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## patient_file_no362                NA         NA       NA       NA
## patient_file_no363                NA         NA       NA       NA
## patient_file_no366                NA         NA       NA       NA
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## patient_file_no370                NA         NA       NA       NA
## patient_file_no371                NA         NA       NA       NA
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## patient_file_no386                NA         NA       NA       NA
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## patient_file_no395                NA         NA       NA       NA
## patient_file_no397                NA         NA       NA       NA
## patient_file_no398                NA         NA       NA       NA
## patient_file_no399                NA         NA       NA       NA
## patient_file_no400                NA         NA       NA       NA
## patient_file_no402                NA         NA       NA       NA
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## patient_file_no407                NA         NA       NA       NA
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## patient_file_no409                NA         NA       NA       NA
## patient_file_no410                NA         NA       NA       NA
## patient_file_no412                NA         NA       NA       NA
## patient_file_no413                NA         NA       NA       NA
## patient_file_no414                NA         NA       NA       NA
## patient_file_no417                NA         NA       NA       NA
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## patient_file_no423                NA         NA       NA       NA
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## patient_file_no454                NA         NA       NA       NA
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## patient_file_no461                NA         NA       NA       NA
## patient_file_no463                NA         NA       NA       NA
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## patient_file_no471                NA         NA       NA       NA
## patient_file_no472                NA         NA       NA       NA
## patient_file_no474                NA         NA       NA       NA
## patient_file_no475                NA         NA       NA       NA
## patient_file_no477                NA         NA       NA       NA
## patient_file_no479                NA         NA       NA       NA
## patient_file_no481                NA         NA       NA       NA
## patient_file_no482                NA         NA       NA       NA
```

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## patient_file_no483                NA         NA       NA       NA
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## patient_file_no492                NA         NA       NA       NA
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## patient_file_no527                NA         NA       NA       NA
## patient_file_no528                NA         NA       NA       NA
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## patient_file_no530                NA         NA       NA       NA
## patient_file_no531                NA         NA       NA       NA
## patient_file_no533                NA         NA       NA       NA
## patient_file_no534                NA         NA       NA       NA
## patient_file_no535                NA         NA       NA       NA
## patient_file_no536                NA         NA       NA       NA
## patient_file_no539                NA         NA       NA       NA
## patient_file_no540                NA         NA       NA       NA
## patient_file_no541                NA         NA       NA       NA
## age_yrs                           NA         NA       NA       NA
## weight_kg                         NA         NA       NA       NA
## height_cm                         NA         NA       NA       NA
## bmi                               NA         NA       NA       NA
## blood_group                       NA         NA       NA       NA
## pulse_rate_bpm                    NA         NA       NA       NA
## rr_breaths_min                    NA         NA       NA       NA
## hb_g_dl                           NA         NA       NA       NA
## cycle_r_i                         NA         NA       NA       NA
## cycle_length_days                 NA         NA       NA       NA
## marraige_status_yrs               NA         NA       NA       NA
## pregnant_y_n                      NA         NA       NA       NA
## no_of_aborptions                  NA         NA       NA       NA
## i_beta_hcg_m_iu_m_l               NA         NA       NA       NA
## ii_beta_hcg_m_iu_m_l1.65          NA         NA       NA       NA
```

```
## ii_beta_hcg_m_iu_m_l1.9             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1.99            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1.99.           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l10.0            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l10.4            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l10.84           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l100.09          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l100.51          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l102.3           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l102.87          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l108.66          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1082.82         NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l109.06          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l11.24           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l110.17          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1134.4          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l116.31          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l12.0            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l12.17           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l121.8           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1214.23         NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l122.58          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l127.2           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l13.0            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l13.12           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1390.58         NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l144.63          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l145.89          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l1455.0          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l147.6           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l148.52          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l15.0            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l150.91          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l154.48          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l155.3           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l158.51          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l159.71          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l16069.69        NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l161.49          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l161.77          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l167.41          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l168.99          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l169.33          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l173.66          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l174.37          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l177.57          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l177.58          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l18.13           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l18.36           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l18.49           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l180.3           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l181.23          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l183.06          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l184.42          NA         NA      NA       NA
```

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## ii_beta_hcg_m_iu_m_l187.79          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l19.44           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l2.0             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l2.8             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l20.0            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l204.69          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l21084.21        NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l213.14          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l218.65          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l229.86          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l230.5           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l230.53          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l232.64          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l232.71          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l236.5           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l237.5           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l238.14          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l25000.0         NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l255.02          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l268.37          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l272.78          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l277.28          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l278.32          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l278.52          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l288.72          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l297.21          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.01            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.05            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.888           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.9             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.98            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3.99            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l300.13          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l320.49          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l3350.19         NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l34.65           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l342.91          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l346.59          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l355.28          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l355.51          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l375.18          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l382.36          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l391.46          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l4.2             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l4.32            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l4.76            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l4.96            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l403.85          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l409.85          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l41.75           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l41.77           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l410.13          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l4176.0          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l45.9            NA         NA      NA       NA
```

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## ii_beta_hcg_m_iu_m_l459.63          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l464.12          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l475.04          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l479.66          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l48.86           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l482.21          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l497.41          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l5.39            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l5.81            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l515.53          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l528.5           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l53.82           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l54.08           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l569.1           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l569.3           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l57.08           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l586.06          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l596.2           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l6.19            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l6.921           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l600.23          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l61.98           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l638.52          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l67.2            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l70.42           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l728.01          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l739.13          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l749.98          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l75.51           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l75.62           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l756.61          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l764.83          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l768.03          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l785.95          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l8.0             NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l89.34           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l896.6           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l9.83            NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l90.67           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l900.6           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l97.63           NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l970.75          NA         NA      NA       NA
## ii_beta_hcg_m_iu_m_l99.69           NA         NA      NA       NA
## fsh_m_iu_m_l                        NA         NA      NA       NA
## lh_m_iu_m_l                         NA         NA      NA       NA
## fsh_lh                              NA         NA      NA       NA
## hip_inch                            NA         NA      NA       NA
## waist_inch                          NA         NA      NA       NA
## waist_hip_ratio                     NA         NA      NA       NA
## tsh_m_iu_l                          NA         NA      NA       NA
## amh_ng_m_l0.2                       NA         NA      NA       NA
## amh_ng_m_l0.28                      NA         NA      NA       NA
## amh_ng_m_l0.29                      NA         NA      NA       NA
## amh_ng_m_l0.3                       NA         NA      NA       NA
```

```
## amh_ng_m_l0.37                    NA         NA       NA       NA
## amh_ng_m_l0.45                    NA         NA       NA       NA
## amh_ng_m_l0.5                     NA         NA       NA       NA
## amh_ng_m_l0.56                    NA         NA       NA       NA
## amh_ng_m_l0.6                     NA         NA       NA       NA
## amh_ng_m_l0.69                    NA         NA       NA       NA
## amh_ng_m_l0.7                     NA         NA       NA       NA
## amh_ng_m_l0.71                    NA         NA       NA       NA
## amh_ng_m_l0.72                    NA         NA       NA       NA
## amh_ng_m_l0.78                    NA         NA       NA       NA
## amh_ng_m_l0.8                     NA         NA       NA       NA
## amh_ng_m_l0.85                    NA         NA       NA       NA
## amh_ng_m_l0.86                    NA         NA       NA       NA
## amh_ng_m_l0.87                    NA         NA       NA       NA
## amh_ng_m_l0.88                    NA         NA       NA       NA
## amh_ng_m_l0.89                    NA         NA       NA       NA
## amh_ng_m_l0.9                     NA         NA       NA       NA
## amh_ng_m_l0.91                    NA         NA       NA       NA
## amh_ng_m_l0.98                    NA         NA       NA       NA
## amh_ng_m_l0.99                    NA         NA       NA       NA
## amh_ng_m_l1.0                     NA         NA       NA       NA
## amh_ng_m_l1.01                    NA         NA       NA       NA
## amh_ng_m_l1.03                    NA         NA       NA       NA
## amh_ng_m_l1.04                    NA         NA       NA       NA
## amh_ng_m_l1.06                    NA         NA       NA       NA
## amh_ng_m_l1.1                     NA         NA       NA       NA
## amh_ng_m_l1.15                    NA         NA       NA       NA
## amh_ng_m_l1.2                     NA         NA       NA       NA
## amh_ng_m_l1.22                    NA         NA       NA       NA
## amh_ng_m_l1.25                    NA         NA       NA       NA
## amh_ng_m_l1.28                    NA         NA       NA       NA
## amh_ng_m_l1.3                     NA         NA       NA       NA
## amh_ng_m_l1.4                     NA         NA       NA       NA
## amh_ng_m_l1.42                    NA         NA       NA       NA
## amh_ng_m_l1.5                     NA         NA       NA       NA
## amh_ng_m_l1.54                    NA         NA       NA       NA
## amh_ng_m_l1.56                    NA         NA       NA       NA
## amh_ng_m_l1.58                    NA         NA       NA       NA
## amh_ng_m_l1.6                     NA         NA       NA       NA
## amh_ng_m_l1.61                    NA         NA       NA       NA
## amh_ng_m_l1.65                    NA         NA       NA       NA
## amh_ng_m_l1.67                    NA         NA       NA       NA
## amh_ng_m_l1.68                    NA         NA       NA       NA
## amh_ng_m_l1.69                    NA         NA       NA       NA
## amh_ng_m_l1.7                     NA         NA       NA       NA
## amh_ng_m_l1.8                     NA         NA       NA       NA
## amh_ng_m_l1.89                    NA         NA       NA       NA
## amh_ng_m_l1.9                     NA         NA       NA       NA
## amh_ng_m_l1.92                    NA         NA       NA       NA
## amh_ng_m_l10.0                    NA         NA       NA       NA
## amh_ng_m_l10.04                   NA         NA       NA       NA
## amh_ng_m_l10.07                   NA         NA       NA       NA
## amh_ng_m_l10.32                   NA         NA       NA       NA
## amh_ng_m_l10.53                   NA         NA       NA       NA
```

```
## amh_ng_m_l10.7                  NA         NA       NA       NA
## amh_ng_m_l10.8                  NA         NA       NA       NA
## amh_ng_m_l10.9                  NA         NA       NA       NA
## amh_ng_m_l11.0                  NA         NA       NA       NA
## amh_ng_m_l11.1                  NA         NA       NA       NA
## amh_ng_m_l11.2                  NA         NA       NA       NA
## amh_ng_m_l11.4                  NA         NA       NA       NA
## amh_ng_m_l11.48                 NA         NA       NA       NA
## amh_ng_m_l11.6                  NA         NA       NA       NA
## amh_ng_m_l11.9                  NA         NA       NA       NA
## amh_ng_m_l12.0                  NA         NA       NA       NA
## amh_ng_m_l12.7                  NA         NA       NA       NA
## amh_ng_m_l13.6                  NA         NA       NA       NA
## amh_ng_m_l14.6                  NA         NA       NA       NA
## amh_ng_m_l14.7                  NA         NA       NA       NA
## amh_ng_m_l15.0                  NA         NA       NA       NA
## amh_ng_m_l15.3                  NA         NA       NA       NA
## amh_ng_m_l15.7                  NA         NA       NA       NA
## amh_ng_m_l15.9                  NA         NA       NA       NA
## amh_ng_m_l16.0                  NA         NA       NA       NA
## amh_ng_m_l16.6                  NA         NA       NA       NA
## amh_ng_m_l16.7                  NA         NA       NA       NA
## amh_ng_m_l16.8                  NA         NA       NA       NA
## amh_ng_m_l17.0                  NA         NA       NA       NA
## amh_ng_m_l17.5                  NA         NA       NA       NA
## amh_ng_m_l17.6                  NA         NA       NA       NA
## amh_ng_m_l17.9                  NA         NA       NA       NA
## amh_ng_m_l18.0                  NA         NA       NA       NA
## amh_ng_m_l18.2                  NA         NA       NA       NA
## amh_ng_m_l18.4                  NA         NA       NA       NA
## amh_ng_m_l18.5                  NA         NA       NA       NA
## amh_ng_m_l18.9                  NA         NA       NA       NA
## amh_ng_m_l19.0                  NA         NA       NA       NA
## amh_ng_m_l19.3                  NA         NA       NA       NA
## amh_ng_m_l19.6                  NA         NA       NA       NA
## amh_ng_m_l19.8                  NA         NA       NA       NA
## amh_ng_m_l2.0                   NA         NA       NA       NA
## amh_ng_m_l2.01                  NA         NA       NA       NA
## amh_ng_m_l2.04                  NA         NA       NA       NA
## amh_ng_m_l2.06                  NA         NA       NA       NA
## amh_ng_m_l2.07                  NA         NA       NA       NA
## amh_ng_m_l2.1                   NA         NA       NA       NA
## amh_ng_m_l2.13                  NA         NA       NA       NA
## amh_ng_m_l2.14                  NA         NA       NA       NA
## amh_ng_m_l2.2                   NA         NA       NA       NA
## amh_ng_m_l2.23                  NA         NA       NA       NA
## amh_ng_m_l2.25                  NA         NA       NA       NA
## amh_ng_m_l2.26                  NA         NA       NA       NA
## amh_ng_m_l2.28                  NA         NA       NA       NA
## amh_ng_m_l2.3                   NA         NA       NA       NA
## amh_ng_m_l2.31                  NA         NA       NA       NA
## amh_ng_m_l2.33                  NA         NA       NA       NA
## amh_ng_m_l2.333                 NA         NA       NA       NA
## amh_ng_m_l2.34                  NA         NA       NA       NA
```

```
## amh_ng_m_l2.35                    NA         NA       NA       NA
## amh_ng_m_l2.36                    NA         NA       NA       NA
## amh_ng_m_l2.38                    NA         NA       NA       NA
## amh_ng_m_l2.4                     NA         NA       NA       NA
## amh_ng_m_l2.5                     NA         NA       NA       NA
## amh_ng_m_l2.53                    NA         NA       NA       NA
## amh_ng_m_l2.58                    NA         NA       NA       NA
## amh_ng_m_l2.6                     NA         NA       NA       NA
## amh_ng_m_l2.65                    NA         NA       NA       NA
## amh_ng_m_l2.69                    NA         NA       NA       NA
## amh_ng_m_l2.7                     NA         NA       NA       NA
## amh_ng_m_l2.78                    NA         NA       NA       NA
## amh_ng_m_l2.8                     NA         NA       NA       NA
## amh_ng_m_l2.83                    NA         NA       NA       NA
## amh_ng_m_l2.85                    NA         NA       NA       NA
## amh_ng_m_l2.9                     NA         NA       NA       NA
## amh_ng_m_l20.0                    NA         NA       NA       NA
## amh_ng_m_l21.0                    NA         NA       NA       NA
## amh_ng_m_l21.8                    NA         NA       NA       NA
## amh_ng_m_l21.9                    NA         NA       NA       NA
## amh_ng_m_l22.0                    NA         NA       NA       NA
## amh_ng_m_l26.4                    NA         NA       NA       NA
## amh_ng_m_l26.8                    NA         NA       NA       NA
## amh_ng_m_l28.6                    NA         NA       NA       NA
## amh_ng_m_l3.0                     NA         NA       NA       NA
## amh_ng_m_l3.02                    NA         NA       NA       NA
## amh_ng_m_l3.03                    NA         NA       NA       NA
## amh_ng_m_l3.05                    NA         NA       NA       NA
## amh_ng_m_l3.1                     NA         NA       NA       NA
## amh_ng_m_l3.14                    NA         NA       NA       NA
## amh_ng_m_l3.17                    NA         NA       NA       NA
## amh_ng_m_l3.18                    NA         NA       NA       NA
## amh_ng_m_l3.2                     NA         NA       NA       NA
## amh_ng_m_l3.22                    NA         NA       NA       NA
## amh_ng_m_l3.29                    NA         NA       NA       NA
## amh_ng_m_l3.3                     NA         NA       NA       NA
## amh_ng_m_l3.38                    NA         NA       NA       NA
## amh_ng_m_l3.4                     NA         NA       NA       NA
## amh_ng_m_l3.49                    NA         NA       NA       NA
## amh_ng_m_l3.5                     NA         NA       NA       NA
## amh_ng_m_l3.55                    NA         NA       NA       NA
## amh_ng_m_l3.56                    NA         NA       NA       NA
## amh_ng_m_l3.6                     NA         NA       NA       NA
## amh_ng_m_l3.63                    NA         NA       NA       NA
## amh_ng_m_l3.64                    NA         NA       NA       NA
## amh_ng_m_l3.65                    NA         NA       NA       NA
## amh_ng_m_l3.68                    NA         NA       NA       NA
## amh_ng_m_l3.7                     NA         NA       NA       NA
## amh_ng_m_l3.8                     NA         NA       NA       NA
## amh_ng_m_l3.81                    NA         NA       NA       NA
## amh_ng_m_l3.86                    NA         NA       NA       NA
## amh_ng_m_l3.88                    NA         NA       NA       NA
## amh_ng_m_l3.9                     NA         NA       NA       NA
## amh_ng_m_l3.91                    NA         NA       NA       NA
```

```
## amh_ng_m_l3.99                    NA         NA       NA       NA
## amh_ng_m_l32.0                    NA         NA       NA       NA
## amh_ng_m_l4.02                    NA         NA       NA       NA
## amh_ng_m_l4.07                    NA         NA       NA       NA
## amh_ng_m_l4.1                     NA         NA       NA       NA
## amh_ng_m_l4.13                    NA         NA       NA       NA
## amh_ng_m_l4.2                     NA         NA       NA       NA
## amh_ng_m_l4.27                    NA         NA       NA       NA
## amh_ng_m_l4.3                     NA         NA       NA       NA
## amh_ng_m_l4.33                    NA         NA       NA       NA
## amh_ng_m_l4.47                    NA         NA       NA       NA
## amh_ng_m_l4.5                     NA         NA       NA       NA
## amh_ng_m_l4.6                     NA         NA       NA       NA
## amh_ng_m_l4.63                    NA         NA       NA       NA
## amh_ng_m_l4.66                    NA         NA       NA       NA
## amh_ng_m_l4.71                    NA         NA       NA       NA
## amh_ng_m_l4.8                     NA         NA       NA       NA
## amh_ng_m_l4.9                     NA         NA       NA       NA
## amh_ng_m_l5.0                     NA         NA       NA       NA
## amh_ng_m_l5.1                     NA         NA       NA       NA
## amh_ng_m_l5.2                     NA         NA       NA       NA
## amh_ng_m_l5.23                    NA         NA       NA       NA
## amh_ng_m_l5.25                    NA         NA       NA       NA
## amh_ng_m_l5.4                     NA         NA       NA       NA
## amh_ng_m_l5.42                    NA         NA       NA       NA
## amh_ng_m_l5.5                     NA         NA       NA       NA
## amh_ng_m_l5.6                     NA         NA       NA       NA
## amh_ng_m_l5.67                    NA         NA       NA       NA
## amh_ng_m_l5.69                    NA         NA       NA       NA
## amh_ng_m_l5.7                     NA         NA       NA       NA
## amh_ng_m_l5.75                    NA         NA       NA       NA
## amh_ng_m_l5.76                    NA         NA       NA       NA
## amh_ng_m_l5.78                    NA         NA       NA       NA
## amh_ng_m_l5.8                     NA         NA       NA       NA
## amh_ng_m_l5.9                     NA         NA       NA       NA
## amh_ng_m_l5.96                    NA         NA       NA       NA
## amh_ng_m_l6.0                     NA         NA       NA       NA
## amh_ng_m_l6.2                     NA         NA       NA       NA
## amh_ng_m_l6.26                    NA         NA       NA       NA
## amh_ng_m_l6.3                     NA         NA       NA       NA
## amh_ng_m_l6.33                    NA         NA       NA       NA
## amh_ng_m_l6.41                    NA         NA       NA       NA
## amh_ng_m_l6.55                    NA         NA       NA       NA
## amh_ng_m_l6.6                     NA         NA       NA       NA
## amh_ng_m_l6.8                     NA         NA       NA       NA
## amh_ng_m_l66.0                    NA         NA       NA       NA
## amh_ng_m_l7.0                     NA         NA       NA       NA
## amh_ng_m_l7.2                     NA         NA       NA       NA
## amh_ng_m_l7.25                    NA         NA       NA       NA
## amh_ng_m_l7.3                     NA         NA       NA       NA
## amh_ng_m_l7.51                    NA         NA       NA       NA
## amh_ng_m_l7.6                     NA         NA       NA       NA
## amh_ng_m_l7.7                     NA         NA       NA       NA
## amh_ng_m_l7.8                     NA         NA       NA       NA
```

```
## amh_ng_m_l7.9                        NA         NA      NA       NA
## amh_ng_m_l7.94                       NA         NA      NA       NA
## amh_ng_m_l8.0                        NA         NA      NA       NA
## amh_ng_m_l8.1                        NA         NA      NA       NA
## amh_ng_m_l8.46                       NA         NA      NA       NA
## amh_ng_m_l8.5                        NA         NA      NA       NA
## amh_ng_m_l8.75                       NA         NA      NA       NA
## amh_ng_m_l8.8                        NA         NA      NA       NA
## amh_ng_m_l8.9                        NA         NA      NA       NA
## amh_ng_m_l9.0                        NA         NA      NA       NA
## amh_ng_m_l9.1                        NA         NA      NA       NA
## amh_ng_m_l9.2                        NA         NA      NA       NA
## amh_ng_m_l9.7                        NA         NA      NA       NA
## amh_ng_m_l9.8                        NA         NA      NA       NA
## amh_ng_m_l9.9                        NA         NA      NA       NA
## amh_ng_m_la                          NA         NA      NA       NA
## prl_ng_m_l                           NA         NA      NA       NA
## vit_d3_ng_m_l                        NA         NA      NA       NA
## prg_ng_m_l                           NA         NA      NA       NA
## rbs_mg_dl                            NA         NA      NA       NA
## weight_gain_y_n1                     NA         NA      NA       NA
## hair_growth_y_n1                     NA         NA      NA       NA
## skin_darkening_y_n1                  NA         NA      NA       NA
## hair_loss_y_n1                       NA         NA      NA       NA
## pimples_y_n1                         NA         NA      NA       NA
## fast_food_y_n1                       NA         NA      NA       NA
## reg_exercise_y_n1                    NA         NA      NA       NA
## bp_systolic_mm_hg                    NA         NA      NA       NA
## bp_diastolic_mm_hg                   NA         NA      NA       NA
## follicle_no_l                        NA         NA      NA       NA
## follicle_no_r                        NA         NA      NA       NA
## avg_f_size_l_mm                      NA         NA      NA       NA
## avg_f_size_r_mm                      NA         NA      NA       NA
## endometrium_mm                       NA         NA      NA       NA
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 4.7918e+02  on 378  degrees of freedom
## Residual deviance: 2.1988e-09  on   0  degrees of freedom
## AIC: 758
##
## Number of Fisher Scoring iterations: 25
```

```
# AIC = 758
# removed this as not super informative for logistic models
# plot(logistic_model1)

library(broom)

# the second model we will build will only include the following variables:
# 5 of the hormone measurement levels we possess

logistic_model2 <-glm(pcos_y_n ~ i_beta_hcg_m_iu_m_l + fsh_m_iu_m_l + lh_m_iu_m_l + tsh_m_iu_m_l + amh_ng
                      data = train.data,
```

```
                      family = binomial(link="logit"))
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```
summary(logistic_model2)
```

```
##
## Call:
## glm(formula = pcos_y_n ~ i_beta_hcg_m_iu_m_l + fsh_m_iu_m_l +
##     lh_m_iu_m_l + tsh_m_iu_l + amh_ng_m_l, family = binomial(link = "logit"),
##     data = train.data)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -1.76433  -0.00005  -0.00005   0.00005   1.73682
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)          2.034e+01  1.773e+04   0.001    0.999
## i_beta_hcg_m_iu_m_l -8.195e-05  1.320e-04  -0.621    0.535
## fsh_m_iu_m_l        -3.354e-02  6.423e-02  -0.522    0.602
## lh_m_iu_m_l          8.632e-02  1.391e-01   0.621    0.535
## tsh_m_iu_l           3.321e-02  8.993e-02   0.369    0.712
## amh_ng_m_l0.2       -2.124e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l0.28      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.29      -4.103e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.3       -4.086e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.37      -2.031e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l0.45      -4.109e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.5       -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.56      -4.115e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.6       -4.112e+01  2.170e+04  -0.002    0.998
## amh_ng_m_l0.69      -4.085e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.7        2.837e-01  2.507e+04   0.000    1.000
## amh_ng_m_l0.71      -4.091e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.72      -4.089e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.78       6.351e-02  2.507e+04   0.000    1.000
## amh_ng_m_l0.8       -2.136e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l0.85      -7.247e-02  2.507e+04   0.000    1.000
## amh_ng_m_l0.86      -4.165e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.87       1.128e-01  2.507e+04   0.000    1.000
## amh_ng_m_l0.88      -4.103e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.89      -2.032e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l0.9       -4.094e+01  2.047e+04  -0.002    0.998
## amh_ng_m_l0.91      -6.639e-02  2.169e+04   0.000    1.000
## amh_ng_m_l0.98      -4.104e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l0.99       3.182e-01  2.507e+04   0.000    1.000
## amh_ng_m_l1.0       -2.077e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.01      -2.046e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.03      -4.103e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.04      -4.121e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.06       2.690e-02  2.169e+04   0.000    1.000
```

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## amh_ng_m_l1.1       -1.968e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.15       2.286e-01  2.507e+04   0.000    1.000
## amh_ng_m_l1.2       -4.106e+01  2.046e+04  -0.002    0.998
## amh_ng_m_l1.22      -4.139e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.25       1.490e-01  2.507e+04   0.000    1.000
## amh_ng_m_l1.28      -4.107e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.3       -4.113e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l1.4       -2.147e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.42      -4.094e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.5       -2.043e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.54      -4.141e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.56       1.499e-01  2.507e+04   0.000    1.000
## amh_ng_m_l1.58      -4.095e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.6       -2.114e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.61      -4.117e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.65      -4.088e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.67      -4.103e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.68      -4.100e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.69      -4.104e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l1.7       -4.107e+01  2.047e+04  -0.002    0.998
## amh_ng_m_l1.8       -2.117e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l1.89      -3.072e-01  2.507e+04   0.000    1.000
## amh_ng_m_l1.9       -4.105e+01  1.982e+04  -0.002    0.998
## amh_ng_m_l1.92      -4.117e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l10.0      -2.035e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l10.04      2.238e-01  2.507e+04   0.000    1.000
## amh_ng_m_l10.07      3.228e-01  2.507e+04   0.000    1.000
## amh_ng_m_l10.32     -4.129e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l10.53     -1.605e-01  2.507e+04   0.000    1.000
## amh_ng_m_l10.7      -4.105e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l10.8      -1.937e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l10.9      -4.108e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l11.0      -4.102e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l11.1       2.305e+00  2.507e+04   0.000    1.000
## amh_ng_m_l11.2      -4.163e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l11.4      -4.093e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l11.48     -4.909e-01  2.507e+04   0.000    1.000
## amh_ng_m_l11.6      -1.308e-01  2.507e+04   0.000    1.000
## amh_ng_m_l11.9       2.221e-02  2.507e+04   0.000    1.000
## amh_ng_m_l12.0      -4.124e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l12.7       1.589e-01  2.507e+04   0.000    1.000
## amh_ng_m_l13.6       1.886e-01  2.507e+04   0.000    1.000
## amh_ng_m_l14.6      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l14.7       5.160e-02  2.507e+04   0.000    1.000
## amh_ng_m_l15.0      -5.801e-02  2.171e+04   0.000    1.000
## amh_ng_m_l15.3      -3.978e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l15.7      -8.254e-01  2.507e+04   0.000    1.000
## amh_ng_m_l15.9      -4.582e-01  2.507e+04   0.000    1.000
## amh_ng_m_l16.0      -4.115e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l16.6       3.194e-01  2.507e+04   0.000    1.000
## amh_ng_m_l16.7      -4.095e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l16.8      -2.155e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l17.0      -4.087e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l17.5      -5.258e-02  2.507e+04   0.000    1.000
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## amh_ng_m_l17.6      -2.584e-01  2.507e+04   0.000    1.000
## amh_ng_m_l17.9      -7.344e-02  2.507e+04   0.000    1.000
## amh_ng_m_l18.0       8.511e-02  2.507e+04   0.000    1.000
## amh_ng_m_l18.2      -4.160e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l18.4       1.684e-02  2.507e+04   0.000    1.000
## amh_ng_m_l18.5       1.385e-01  2.507e+04   0.000    1.000
## amh_ng_m_l18.9      -4.092e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l19.0       1.896e-02  2.507e+04   0.000    1.000
## amh_ng_m_l19.3      -4.166e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l19.6      -5.426e-02  2.507e+04   0.000    1.000
## amh_ng_m_l19.8      -1.097e-01  2.507e+04   0.000    1.000
## amh_ng_m_l2.0       -4.098e+01  2.170e+04  -0.002    0.998
## amh_ng_m_l2.01       3.048e-02  2.507e+04   0.000    1.000
## amh_ng_m_l2.04      -4.099e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.06      -3.942e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.07      -2.043e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l2.1       -4.096e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l2.13      -4.112e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.14       1.082e-01  2.171e+04   0.000    1.000
## amh_ng_m_l2.2       -4.105e+01  2.168e+04  -0.002    0.998
## amh_ng_m_l2.23      -4.093e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.25      -4.083e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.26      -4.091e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.28      -4.088e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.3       -4.116e+01  1.978e+04  -0.002    0.998
## amh_ng_m_l2.31      -4.111e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l2.33      -4.103e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.333     -4.088e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.34      -4.091e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.35      -4.123e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.36      -4.106e+01  1.982e+04  -0.002    0.998
## amh_ng_m_l2.38      -4.095e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.4       -4.103e+01  2.161e+04  -0.002    0.998
## amh_ng_m_l2.5       -4.096e+01  1.880e+04  -0.002    0.998
## amh_ng_m_l2.53      -1.627e-01  2.507e+04   0.000    1.000
## amh_ng_m_l2.58      -4.083e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.6       -4.108e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.65       2.413e-01  2.507e+04   0.000    1.000
## amh_ng_m_l2.69      -4.102e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.7       -2.039e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l2.78      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.8       -2.147e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l2.83      -2.064e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l2.85      -4.099e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l2.9       -2.156e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l20.0       4.377e-02  2.170e+04   0.000    1.000
## amh_ng_m_l21.0      -2.070e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l21.8      -5.156e-02  2.507e+04   0.000    1.000
## amh_ng_m_l21.9      -3.910e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l22.0       7.347e-02  2.507e+04   0.000    1.000
## amh_ng_m_l26.4      -4.497e-01  2.171e+04   0.000    1.000
## amh_ng_m_l26.8      -4.090e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l28.6      -1.560e-01  2.507e+04   0.000    1.000
## amh_ng_m_l3.0       -4.100e+01  2.170e+04  -0.002    0.998
```

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## amh_ng_m_l3.02      -4.039e+01  2.143e+04  -0.002    0.998
## amh_ng_m_l3.03      -4.093e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.05      -4.089e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.1       -4.115e+01  2.172e+04  -0.002    0.998
## amh_ng_m_l3.14      -4.121e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.17      -4.105e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.18      -4.099e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.2       -2.058e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l3.22      -4.098e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.29      -4.094e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.3       -4.124e+01  2.025e+04  -0.002    0.998
## amh_ng_m_l3.38      -4.099e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.4       -4.102e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.49       2.652e-01  2.507e+04   0.000    1.000
## amh_ng_m_l3.5       -3.968e+01  1.895e+04  -0.002    0.998
## amh_ng_m_l3.55      -2.034e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l3.56      -4.100e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.6       -2.162e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l3.63      -4.080e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.64      -4.081e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.65      -6.649e-03  2.045e+04   0.000    1.000
## amh_ng_m_l3.68      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.7       -4.097e+01  1.982e+04  -0.002    0.998
## amh_ng_m_l3.8       -4.102e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l3.81      -4.095e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.86      -4.104e+01  2.170e+04  -0.002    0.998
## amh_ng_m_l3.88      -4.090e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.9       -4.089e+01  1.982e+04  -0.002    0.998
## amh_ng_m_l3.91      -4.086e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l3.99      -4.109e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l32.0       2.211e-01  2.507e+04   0.000    1.000
## amh_ng_m_l4.02      -4.060e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.07      -4.105e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.1       -4.088e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.13      -4.105e+01  2.171e+04  -0.002    0.998
## amh_ng_m_l4.2       -2.118e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l4.27      -4.093e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.3       -2.117e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l4.33      -4.093e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.47      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.5       -2.050e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l4.6       -2.117e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l4.63       1.450e-01  2.507e+04   0.000    1.000
## amh_ng_m_l4.66      -4.095e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l4.71       4.215e-02  2.507e+04   0.000    1.000
## amh_ng_m_l4.8       -4.098e+01  1.941e+04  -0.002    0.998
## amh_ng_m_l4.9       -4.096e+01  2.170e+04  -0.002    0.998
## amh_ng_m_l5.0       -4.110e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l5.1       -4.099e+01  2.169e+04  -0.002    0.998
## amh_ng_m_l5.2       -4.120e+01  1.940e+04  -0.002    0.998
## amh_ng_m_l5.23      -4.117e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l5.25       2.473e-01  2.507e+04   0.000    1.000
## amh_ng_m_l5.4       -1.985e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l5.42      -4.152e+01  2.507e+04  -0.002    0.999
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## amh_ng_m_l5.5       -2.046e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l5.6       -4.086e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l5.67       1.646e-01  2.507e+04   0.000    1.000
## amh_ng_m_l5.69       1.253e-01  2.507e+04   0.000    1.000
## amh_ng_m_l5.7       -2.044e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l5.75       7.365e-02  2.507e+04   0.000    1.000
## amh_ng_m_l5.76      -4.096e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l5.78      -4.112e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l5.8       -4.108e+01  2.045e+04  -0.002    0.998
## amh_ng_m_l5.9       -1.273e-02  2.507e+04   0.000    1.000
## amh_ng_m_l5.96      -3.858e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l6.0       -2.093e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l6.2        1.564e+00  2.137e+04   0.000    1.000
## amh_ng_m_l6.26      -4.111e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l6.3       -4.100e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l6.33      -4.102e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l6.41       1.688e-01  2.507e+04   0.000    1.000
## amh_ng_m_l6.55      -4.090e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l6.6        2.436e-01  2.507e+04   0.000    1.000
## amh_ng_m_l6.8       -4.090e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l66.0       1.108e-01  2.507e+04   0.000    1.000
## amh_ng_m_l7.0       -4.100e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l7.2        2.164e-01  2.507e+04   0.000    1.000
## amh_ng_m_l7.25      -8.696e-02  2.507e+04   0.000    1.000
## amh_ng_m_l7.3       -2.048e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l7.51       2.319e-01  2.507e+04   0.000    1.000
## amh_ng_m_l7.6       -4.155e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l7.7       -2.105e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l7.8       -4.108e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l7.9       -4.111e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l7.94       4.315e-02  2.507e+04   0.000    1.000
## amh_ng_m_l8.0       -2.882e-01  2.507e+04   0.000    1.000
## amh_ng_m_l8.1       -4.111e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l8.46       1.678e-02  2.507e+04   0.000    1.000
## amh_ng_m_l8.5       -4.104e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l8.75      -4.142e+01  2.507e+04  -0.002    0.999
## amh_ng_m_l8.8       -1.580e-01  2.507e+04   0.000    1.000
## amh_ng_m_l8.9       -5.404e-02  2.167e+04   0.000    1.000
## amh_ng_m_l9.0       -5.904e-02  1.982e+04   0.000    1.000
## amh_ng_m_l9.1       -4.109e+01  1.982e+04  -0.002    0.998
## amh_ng_m_l9.2       -1.939e-01  2.507e+04   0.000    1.000
## amh_ng_m_l9.7       -2.052e+01  1.773e+04  -0.001    0.999
## amh_ng_m_l9.8       -4.210e-01  2.507e+04   0.000    1.000
## amh_ng_m_l9.9       -4.094e+01  2.507e+04  -0.002    0.999
## amh_ng_m_la         -4.137e+01  2.507e+04  -0.002    0.999
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 479.18  on 378  degrees of freedom
## Residual deviance: 127.28  on 138  degrees of freedom
## AIC: 609.28
##
## Number of Fisher Scoring iterations: 19
```

```
# AIC = 609.28

glimpse(PCOS_data_without_infertility_formatted_final)
```

```
## Rows: 539
## Columns: 44
## $ sl_no                <fct> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15~
## $ patient_file_no      <fct> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15~
## $ pcos_y_n             <fct> 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0~
## $ age_yrs              <dbl> 28, 36, 33, 37, 25, 36, 34, 33, 32, 36, 20, 26, 2~
## $ weight_kg            <dbl> 44.6, 65.0, 68.8, 65.0, 52.0, 74.1, 64.0, 58.5, 4~
## $ height_cm            <dbl> 152.0, 161.5, 165.0, 148.0, 161.0, 165.0, 156.0, ~
## $ bmi                  <dbl> 19.30000, 24.92116, 25.27089, 29.67495, 20.06095,~
## $ blood_group          <dbl> 15, 15, 11, 13, 11, 15, 11, 13, 11, 15, 15, 13, 1~
## $ pulse_rate_bpm       <dbl> 78, 74, 72, 72, 72, 78, 72, 72, 72, 80, 80, 72, 7~
## $ rr_breaths_min       <dbl> 22, 20, 18, 20, 18, 28, 18, 20, 18, 20, 20, 20, 1~
## $ hb_g_dl              <dbl> 10.48, 11.70, 11.80, 12.00, 10.00, 11.20, 10.90, ~
## $ cycle_r_i            <dbl> 2, 2, 2, 2, 2, 2, 2, 2, 2, 4, 2, 2, 4, 2, 2, 2, 2~
## $ cycle_length_days    <dbl> 5, 5, 5, 5, 5, 5, 5, 5, 5, 2, 5, 5, 2, 5, 5, 5, 5~
## $ marraige_status_yrs  <dbl> 7, 11, 10, 4, 1, 8, 2, 13, 8, 4, 4, 3, 7, 15, 9, ~
## $ pregnant_y_n         <dbl> 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 0, 1~
## $ no_of_aborptions     <dbl> 0, 0, 0, 0, 0, 0, 0, 2, 1, 0, 2, 1, 0, 0, 0, 0, 0~
## $ i_beta_hcg_m_iu_m_l  <dbl> 1.99, 60.80, 494.08, 1.99, 801.45, 237.97, 1.99, ~
## $ ii_beta_hcg_m_iu_m_l <chr> "1.99", "1.99", "494.08", "1.99", "801.45", "1.99~
## $ fsh_m_iu_m_l         <dbl> 7.95, 6.73, 5.54, 8.06, 3.98, 3.24, 2.85, 4.86, 3~
## $ lh_m_iu_m_l          <dbl> 3.68, 1.09, 0.88, 2.36, 0.90, 1.07, 0.31, 3.07, 3~
## $ fsh_lh               <dbl> 2.160326, 6.174312, 6.295455, 3.415254, 4.422222,~
## $ hip_inch             <dbl> 36, 38, 40, 42, 37, 44, 39, 44, 39, 40, 39, 39, 4~
## $ waist_inch           <dbl> 30, 32, 36, 36, 30, 38, 33, 38, 35, 38, 35, 33, 4~
## $ waist_hip_ratio      <dbl> 0.8333333, 0.8421053, 0.9000000, 0.8571429, 0.810~
## $ tsh_m_iu_l           <dbl> 0.68, 3.16, 2.54, 16.41, 3.57, 1.60, 1.51, 12.18,~
## $ amh_ng_m_l           <chr> "2.07", "1.53", "6.63", "1.22", "2.26", "6.74", "~
## $ prl_ng_m_l           <dbl> 45.16, 20.09, 10.52, 36.90, 30.09, 16.18, 26.41, ~
## $ vit_d3_ng_m_l        <dbl> 17.10, 61.30, 49.70, 33.40, 43.80, 52.40, 42.70, ~
## $ prg_ng_m_l           <dbl> 0.57, 0.97, 0.36, 0.36, 0.38, 0.30, 0.46, 0.26, 0~
## $ rbs_mg_dl            <dbl> 92, 92, 84, 76, 84, 76, 93, 91, 116, 125, 108, 10~
## $ weight_gain_y_n      <fct> 0, 0, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 0, 0, 1, 0~
## $ hair_growth_y_n      <fct> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0~
## $ skin_darkening_y_n   <fct> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0~
## $ hair_loss_y_n        <fct> 0, 0, 1, 0, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0~
## $ pimples_y_n          <fct> 0, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0~
## $ fast_food_y_n        <fct> 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0, 0~
## $ reg_exercise_y_n     <fct> 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0~
## $ bp_systolic_mm_hg    <dbl> 110, 120, 120, 120, 120, 110, 120, 120, 120, 110,~
## $ bp_diastolic_mm_hg   <dbl> 80, 70, 80, 70, 80, 70, 80, 80, 80, 80, 80, 80, 8~
## $ follicle_no_l        <dbl> 3, 3, 13, 2, 3, 9, 6, 7, 5, 1, 7, 4, 15, 3, 4, 1,~
## $ follicle_no_r        <dbl> 3, 5, 15, 2, 4, 6, 6, 6, 7, 1, 15, 2, 8, 3, 1, 3,~
## $ avg_f_size_l_mm      <dbl> 18, 15, 18, 15, 16, 16, 15, 15, 17, 14, 17, 18, 2~
## $ avg_f_size_r_mm      <dbl> 18, 14, 20, 14, 14, 20, 16, 18, 17, 17, 20, 19, 2~
## $ endometrium_mm       <dbl> 8.5, 3.7, 10.0, 7.5, 7.0, 8.0, 6.8, 7.1, 4.2, 2.5~
```

```
# the third model we will build will include the following variables:
# 5 of the hormone measurement levels we possess
```

```r
# as well as the following physiological variables (as these are clinical symptoms associated with PCOS

logistic_model3 <- glm(pcos_y_n ~
                         i_beta_hcg_m_iu_m_l +
                         fsh_m_iu_m_l +
                         lh_m_iu_m_l +
                         tsh_m_iu_l +
                         amh_ng_m_l +
                         weight_gain_y_n +
                         hair_growth_y_n +
                         skin_darkening_y_n +
                         hair_loss_y_n +
                         pimples_y_n,
                       data = train.data,
                       family = binomial(link="logit"))
```

```
## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
summary(logistic_model3)
```

```
##
## Call:
## glm(formula = pcos_y_n ~ i_beta_hcg_m_iu_m_l + fsh_m_iu_m_l +
##     lh_m_iu_m_l + tsh_m_iu_l + amh_ng_m_l + weight_gain_y_n +
##     hair_growth_y_n + skin_darkening_y_n + hair_loss_y_n + pimples_y_n,
##     family = binomial(link = "logit"), data = train.data)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -2.22538  -0.00003  -0.00003   0.00003   2.67333
##
## Coefficients:
##                       Estimate Std. Error z value Pr(>|z|)
## (Intercept)          1.477e+01  2.923e+04   0.001  0.99960
## i_beta_hcg_m_iu_m_l -1.241e-04  1.895e-04  -0.655  0.51253
## fsh_m_iu_m_l        -5.410e-02  7.903e-02  -0.685  0.49360
## lh_m_iu_m_l          1.093e-01  1.950e-01   0.561  0.57503
## tsh_m_iu_l           8.233e-02  1.443e-01   0.571  0.56821
## amh_ng_m_l0.2       -2.149e+01  2.923e+04  -0.001  0.99941
## amh_ng_m_l0.28      -3.874e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l0.29      -3.846e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l0.3       -3.838e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l0.37      -1.599e+01  2.923e+04  -0.001  0.99956
## amh_ng_m_l0.45      -4.255e+01  4.134e+04  -0.001  0.99918
## amh_ng_m_l0.5       -3.665e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l0.56      -3.670e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l0.6       -3.892e+01  3.573e+04  -0.001  0.99913
## amh_ng_m_l0.69      -3.794e+01  4.134e+04  -0.001  0.99927
## amh_ng_m_l0.7        4.458e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l0.71      -3.626e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l0.72      -3.641e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l0.78       4.881e+00  4.134e+04   0.000  0.99991
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## amh_ng_m_l0.8       -1.812e+01  2.923e+04  -0.001  0.99951
## amh_ng_m_l0.85       6.194e+00  4.134e+04   0.000  0.99988
## amh_ng_m_l0.86      -3.739e+01  4.134e+04  -0.001  0.99928
## amh_ng_m_l0.87       6.528e+00  4.134e+04   0.000  0.99987
## amh_ng_m_l0.88      -3.904e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l0.89      -1.696e+01  2.923e+04  -0.001  0.99954
## amh_ng_m_l0.9       -3.988e+01  3.280e+04  -0.001  0.99903
## amh_ng_m_l0.91       1.112e+00  3.511e+04   0.000  0.99997
## amh_ng_m_l0.98      -3.654e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l0.99       6.721e+00  4.134e+04   0.000  0.99987
## amh_ng_m_l1.0       -1.881e+01  2.923e+04  -0.001  0.99949
## amh_ng_m_l1.01      -1.811e+01  2.923e+04  -0.001  0.99951
## amh_ng_m_l1.03      -3.650e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l1.04      -3.682e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l1.06       3.852e-01  3.553e+04   0.000  0.99999
## amh_ng_m_l1.1       -2.089e+01  2.923e+04  -0.001  0.99943
## amh_ng_m_l1.15      -1.738e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l1.2       -3.850e+01  3.366e+04  -0.001  0.99909
## amh_ng_m_l1.22      -3.751e+01  4.134e+04  -0.001  0.99928
## amh_ng_m_l1.25       2.424e+00  4.134e+04   0.000  0.99995
## amh_ng_m_l1.28      -3.850e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l1.3       -3.846e+01  3.514e+04  -0.001  0.99913
## amh_ng_m_l1.4       -2.027e+01  2.923e+04  -0.001  0.99945
## amh_ng_m_l1.42      -3.642e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l1.5       -1.832e+01  2.923e+04  -0.001  0.99950
## amh_ng_m_l1.54      -3.914e+01  4.134e+04  -0.001  0.99924
## amh_ng_m_l1.56       3.701e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l1.58      -3.642e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l1.6       -1.868e+01  2.923e+04  -0.001  0.99949
## amh_ng_m_l1.61      -3.689e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l1.65      -3.625e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l1.67      -3.660e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l1.68      -3.901e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l1.69      -3.648e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l1.7       -3.936e+01  3.299e+04  -0.001  0.99905
## amh_ng_m_l1.8       -1.915e+01  2.923e+04  -0.001  0.99948
## amh_ng_m_l1.89      -2.515e+00  4.134e+04   0.000  0.99995
## amh_ng_m_l1.9       -3.836e+01  3.224e+04  -0.001  0.99905
## amh_ng_m_l1.92      -3.681e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l10.0      -2.140e+01  2.923e+04  -0.001  0.99942
## amh_ng_m_l10.04     -1.741e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l10.07     -1.535e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l10.32     -4.068e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l10.53      2.063e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l10.7      -3.910e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l10.8      -1.884e+01  2.923e+04  -0.001  0.99949
## amh_ng_m_l10.9      -3.853e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l11.0      -3.841e+01  3.504e+04  -0.001  0.99913
## amh_ng_m_l11.1       1.547e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l11.2      -3.724e+01  4.134e+04  -0.001  0.99928
## amh_ng_m_l11.4      -4.048e+01  4.134e+04  -0.001  0.99922
## amh_ng_m_l11.48     -5.125e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l11.6      -5.912e-02  4.134e+04   0.000  1.00000
## amh_ng_m_l11.9       1.867e+00  4.134e+04   0.000  0.99996
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## amh_ng_m_l12.0      -4.085e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l12.7       5.433e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l13.6       1.318e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l14.6      -3.656e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l14.7      -2.111e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l15.0       9.712e-01  3.507e+04   0.000  0.99998
## amh_ng_m_l15.3      -3.661e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l15.7      -2.860e+00  4.134e+04   0.000  0.99994
## amh_ng_m_l15.9       1.928e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l16.0      -3.889e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l16.6       5.181e+00  4.134e+04   0.000  0.99990
## amh_ng_m_l16.7      -4.049e+01  4.134e+04  -0.001  0.99922
## amh_ng_m_l16.8      -2.158e+01  2.923e+04  -0.001  0.99941
## amh_ng_m_l17.0      -4.047e+01  4.134e+04  -0.001  0.99922
## amh_ng_m_l17.5       3.664e+00  4.134e+04   0.000  0.99993
## amh_ng_m_l17.6       1.767e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l17.9       1.163e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l18.0      -2.000e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l18.2      -3.722e+01  4.134e+04  -0.001  0.99928
## amh_ng_m_l18.4       3.766e-02  4.134e+04   0.000  1.00000
## amh_ng_m_l18.5      -1.605e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l18.9      -3.897e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l19.0       5.881e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l19.3      -3.963e+01  4.134e+04  -0.001  0.99924
## amh_ng_m_l19.6       4.075e+00  4.134e+04   0.000  0.99992
## amh_ng_m_l19.8       2.069e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l2.0       -4.013e+01  3.541e+04  -0.001  0.99910
## amh_ng_m_l2.01      -1.711e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l2.04      -3.897e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l2.06      -3.666e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l2.07      -1.828e+01  2.923e+04  -0.001  0.99950
## amh_ng_m_l2.1       -3.923e+01  3.412e+04  -0.001  0.99908
## amh_ng_m_l2.13      -3.678e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l2.14       1.198e+00  3.429e+04   0.000  0.99997
## amh_ng_m_l2.2       -3.847e+01  3.509e+04  -0.001  0.99913
## amh_ng_m_l2.23      -4.070e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l2.25      -3.882e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l2.26      -3.639e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.28      -4.261e+01  4.134e+04  -0.001  0.99918
## amh_ng_m_l2.3       -4.318e+01  3.110e+04  -0.001  0.99889
## amh_ng_m_l2.31      -3.796e+01  3.528e+04  -0.001  0.99914
## amh_ng_m_l2.33      -3.665e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l2.333     -3.632e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.34      -3.638e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.35      -3.685e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l2.36      -3.804e+01  3.212e+04  -0.001  0.99906
## amh_ng_m_l2.38      -4.283e+01  4.134e+04  -0.001  0.99917
## amh_ng_m_l2.4       -3.764e+01  3.573e+04  -0.001  0.99916
## amh_ng_m_l2.5       -3.966e+01  3.075e+04  -0.001  0.99897
## amh_ng_m_l2.53       2.419e+00  4.134e+04   0.000  0.99995
## amh_ng_m_l2.58      -3.623e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.6       -4.101e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l2.65       5.496e-02  4.134e+04   0.000  1.00000
## amh_ng_m_l2.69      -4.057e+01  4.134e+04  -0.001  0.99922
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## amh_ng_m_l2.7       -1.568e+01  2.923e+04  -0.001  0.99957
## amh_ng_m_l2.78      -3.650e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.8       -2.228e+01  2.923e+04  -0.001  0.99939
## amh_ng_m_l2.83      -2.105e+01  2.923e+04  -0.001  0.99943
## amh_ng_m_l2.85      -3.648e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l2.9       -2.044e+01  2.923e+04  -0.001  0.99944
## amh_ng_m_l20.0      -4.925e-01  3.529e+04   0.000  0.99999
## amh_ng_m_l21.0      -2.153e+01  2.923e+04  -0.001  0.99941
## amh_ng_m_l21.8      -1.884e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l21.9      -3.584e+01  4.134e+04  -0.001  0.99931
## amh_ng_m_l22.0       1.660e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l26.4      -3.648e-01  3.561e+04   0.000  0.99999
## amh_ng_m_l26.8      -3.660e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l28.6      -1.280e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l3.0       -4.010e+01  3.515e+04  -0.001  0.99909
## amh_ng_m_l3.02      -3.944e+01  3.343e+04  -0.001  0.99906
## amh_ng_m_l3.03      -4.051e+01  4.134e+04  -0.001  0.99922
## amh_ng_m_l3.05      -3.634e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.1       -4.043e+01  3.494e+04  -0.001  0.99908
## amh_ng_m_l3.14      -3.950e+01  4.134e+04  -0.001  0.99924
## amh_ng_m_l3.17      -3.907e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l3.18      -3.647e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.2       -1.944e+01  2.923e+04  -0.001  0.99947
## amh_ng_m_l3.22      -3.651e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.29      -3.893e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l3.3       -3.741e+01  3.327e+04  -0.001  0.99910
## amh_ng_m_l3.38      -4.069e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l3.4       -3.664e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l3.49       6.975e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l3.5       -4.101e+01  3.098e+04  -0.001  0.99894
## amh_ng_m_l3.55      -1.912e+01  2.923e+04  -0.001  0.99948
## amh_ng_m_l3.56      -3.878e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l3.6       -1.935e+01  2.923e+04  -0.001  0.99947
## amh_ng_m_l3.63      -4.074e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l3.64      -3.623e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.65       5.286e+00  3.214e+04   0.000  0.99987
## amh_ng_m_l3.68      -3.640e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.7       -3.761e+01  3.224e+04  -0.001  0.99907
## amh_ng_m_l3.8       -3.801e+01  3.507e+04  -0.001  0.99914
## amh_ng_m_l3.81      -3.647e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.86      -3.828e+01  3.504e+04  -0.001  0.99913
## amh_ng_m_l3.88      -3.628e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.9       -4.297e+01  3.131e+04  -0.001  0.99890
## amh_ng_m_l3.91      -3.629e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l3.99      -3.889e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l32.0       2.704e+00  4.134e+04   0.000  0.99995
## amh_ng_m_l4.02      -3.819e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l4.07      -3.653e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l4.1       -4.479e+01  4.134e+04  -0.001  0.99914
## amh_ng_m_l4.13      -3.658e+01  3.577e+04  -0.001  0.99918
## amh_ng_m_l4.2       -2.262e+01  2.923e+04  -0.001  0.99938
## amh_ng_m_l4.27      -3.646e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l4.3       -1.855e+01  2.923e+04  -0.001  0.99949
## amh_ng_m_l4.33      -3.642e+01  4.134e+04  -0.001  0.99930
```

```
## amh_ng_m_l4.47      -3.640e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l4.5       -2.030e+01  2.923e+04  -0.001  0.99945
## amh_ng_m_l4.6       -1.968e+01  2.923e+04  -0.001  0.99946
## amh_ng_m_l4.63       3.730e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l4.66      -3.873e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l4.71      -1.879e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l4.8       -4.004e+01  3.140e+04  -0.001  0.99898
## amh_ng_m_l4.9       -3.860e+01  3.552e+04  -0.001  0.99913
## amh_ng_m_l5.0       -4.087e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l5.1       -4.201e+01  3.534e+04  -0.001  0.99905
## amh_ng_m_l5.2       -4.090e+01  3.129e+04  -0.001  0.99896
## amh_ng_m_l5.23      -3.675e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l5.25      -1.485e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l5.4       -1.796e+01  2.923e+04  -0.001  0.99951
## amh_ng_m_l5.42      -3.720e+01  4.134e+04  -0.001  0.99928
## amh_ng_m_l5.5       -1.805e+01  2.923e+04  -0.001  0.99951
## amh_ng_m_l5.6       -4.037e+01  4.134e+04  -0.001  0.99922
## amh_ng_m_l5.67       2.635e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l5.69       2.847e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l5.7       -1.921e+01  2.923e+04  -0.001  0.99948
## amh_ng_m_l5.75       2.264e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l5.76      -4.088e+01  4.134e+04  -0.001  0.99921
## amh_ng_m_l5.78      -3.920e+01  4.134e+04  -0.001  0.99924
## amh_ng_m_l5.8       -3.967e+01  3.223e+04  -0.001  0.99902
## amh_ng_m_l5.9        2.878e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l5.96      -3.703e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l6.0       -1.972e+01  2.923e+04  -0.001  0.99946
## amh_ng_m_l6.2        3.056e+00  3.544e+04   0.000  0.99993
## amh_ng_m_l6.26      -3.892e+01  4.134e+04  -0.001  0.99925
## amh_ng_m_l6.3       -3.637e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l6.33      -3.916e+01  4.134e+04  -0.001  0.99924
## amh_ng_m_l6.41      -1.866e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l6.55      -3.632e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l6.6       -1.752e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l6.8       -3.655e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l66.0       2.260e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l7.0       -3.644e+01  4.134e+04  -0.001  0.99930
## amh_ng_m_l7.2        2.001e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l7.25       1.328e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l7.3       -1.835e+01  2.923e+04  -0.001  0.99950
## amh_ng_m_l7.51       2.742e+00  4.134e+04   0.000  0.99995
## amh_ng_m_l7.6       -3.775e+01  4.134e+04  -0.001  0.99927
## amh_ng_m_l7.7       -1.909e+01  2.923e+04  -0.001  0.99948
## amh_ng_m_l7.8       -3.673e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l7.9       -3.857e+01  4.134e+04  -0.001  0.99926
## amh_ng_m_l7.94      -2.175e+00  4.134e+04   0.000  0.99996
## amh_ng_m_l8.0       -3.295e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l8.1       -3.682e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l8.46       6.405e+00  4.134e+04   0.000  0.99988
## amh_ng_m_l8.5       -3.665e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_l8.75      -4.148e+01  4.134e+04  -0.001  0.99920
## amh_ng_m_l8.8        3.186e-01  4.134e+04   0.000  0.99999
## amh_ng_m_l8.9        2.054e+00  3.510e+04   0.000  0.99995
## amh_ng_m_l9.0        2.569e+00  3.191e+04   0.000  0.99994
```

```
## amh_ng_m_l9.1       -4.127e+01  3.218e+04  -0.001  0.99898
## amh_ng_m_l9.2       -2.138e-01  4.134e+04   0.000  1.00000
## amh_ng_m_l9.7       -1.953e+01  2.923e+04  -0.001  0.99947
## amh_ng_m_l9.8        1.344e+00  4.134e+04   0.000  0.99997
## amh_ng_m_l9.9       -3.659e+01  4.134e+04  -0.001  0.99929
## amh_ng_m_la         -3.990e+01  4.134e+04  -0.001  0.99923
## weight_gain_y_n1     1.745e+00  8.464e-01   2.061  0.03928 *
## hair_growth_y_n1     2.083e+00  9.792e-01   2.127  0.03341 *
## skin_darkening_y_n1  2.125e+00  7.923e-01   2.682  0.00731 **
## hair_loss_y_n1       2.072e-01  8.679e-01   0.239  0.81126
## pimples_y_n1         2.371e+00  9.350e-01   2.536  0.01123 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 479.178  on 378  degrees of freedom
## Residual deviance:  74.445  on 133  degrees of freedom
## AIC: 566.45
##
## Number of Fisher Scoring iterations: 20
```

```
# AIC = 566.45
```

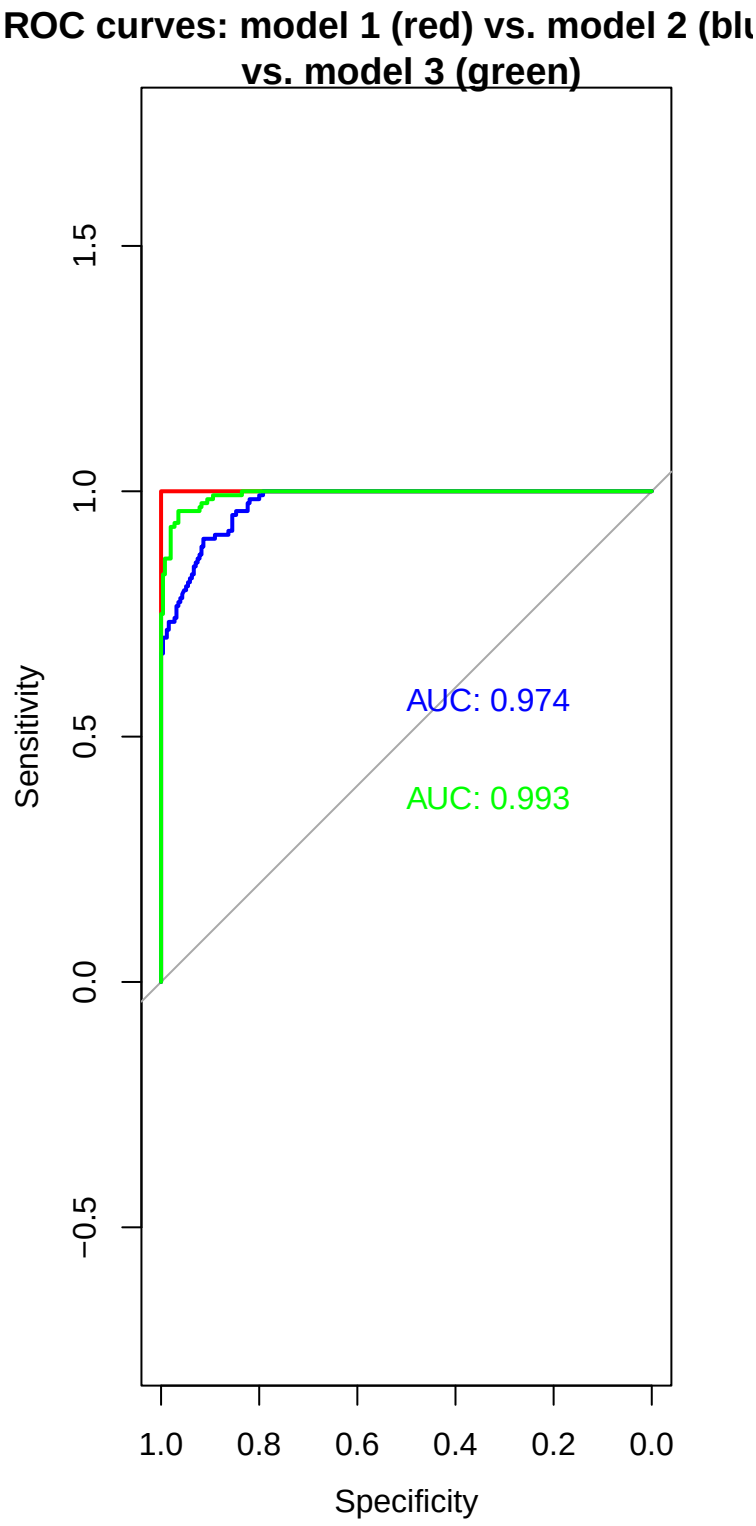
3.3 Model cross-validation (without RIDGE or LASSO) (using the caret package)

- We performed model cross-validation on our three logistic regression models and generated a summary of the cross-validation results.

```
##             Min.   1st Qu.    Median      Mean   3rd Qu.      Max. NA's
## model1 0.3289474 0.6710526 0.6710526 0.6044211 0.6710526 0.6800000    0
## model2 0.4605263 0.5000000 0.5263158 0.5383626 0.5827193 0.6266667    0
## model3 0.5000000 0.5197368 0.5657895 0.5886784 0.6093860 0.7763158    0
```

3.4 Assessing model classification performance

- Assessing model performance using ROC curves


ROC curves: model 1 (red) vs. model 2 (blu
vs. model 3 (green)
Sensitivity
1.5
1.0
0.5
0.0
−0.5
AUC: 0.974
AUC: 0.993
1.0
0.8
0.6
0.4
0.2
0.0
Specificity

Penalized logistic regression with cross-validation (RIDGE and LASSO)

Exhaustive searches (may not include?)

```
# library(bestglm)

#train.data.covariates.1 <- train.data %>%
#  select(
#     pcos_y_n,
#     i_beta_hcg_m_iu_m_l,
#     fsh_m_iu_m_l,
#     lh_m_iu_m_l,
#     tsh_m_iu_l,
#     amh_ng_m_l ,
#     weight_gain_y_n ,
#     hair_growth_y_n,
#     skin_darkening_y_n,
#     hair_loss_y_n ,
#     pimples_y_n
#   ) %>%
#   mutate_at(c("pcos_y_n",
#               "weight_gain_y_n",
#               "hair_growth_y_n",
#               "skin_darkening_y_n",
#               "hair_loss_y_n",
#               "pimples_y_n"),as.factor) %>%
#   mutate_at(c(
#     "i_beta_hcg_m_iu_m_l",
#     "fsh_m_iu_m_l" ,
#     "lh_m_iu_m_l" ,
#     "tsh_m_iu_l" ,
#     "amh_ng_m_l"), as.numeric)
#
# x_tr <- train.data.covariates.1
# # x_tr$pcos_labelled <- ifelse(x_tr$pcos_labelled=="yes",1,0)
# colnames(x_tr)[1] <- "y"
# res.bestglm <-bestglm::bestglm(Xy = x_tr,
#             family = binomial,
#             IC = "AIC",                 # Information criteria for
#             method = "exhaustive")
#
# ## Show top 5 models
# res.bestglm$BestModels
#
# summary(res.bestglm$BestModel)
```

1.4 Modelling our data using Trees and Forests

Let's select only the predictor columns we decided we wanted to include earlier. From logistic model 3, here is the list of covariates: * pcos_y_n * i_beta_hcg_m_iu_m_l * fsh_m_iu_m_l * lh_m_iu_m_l * tsh_m_iu_l * amh_ng_m_l * weight_gain_y_n * hair_growth_y_n * skin_darkening_y_n * hair_loss_y_n * pimples_y_n

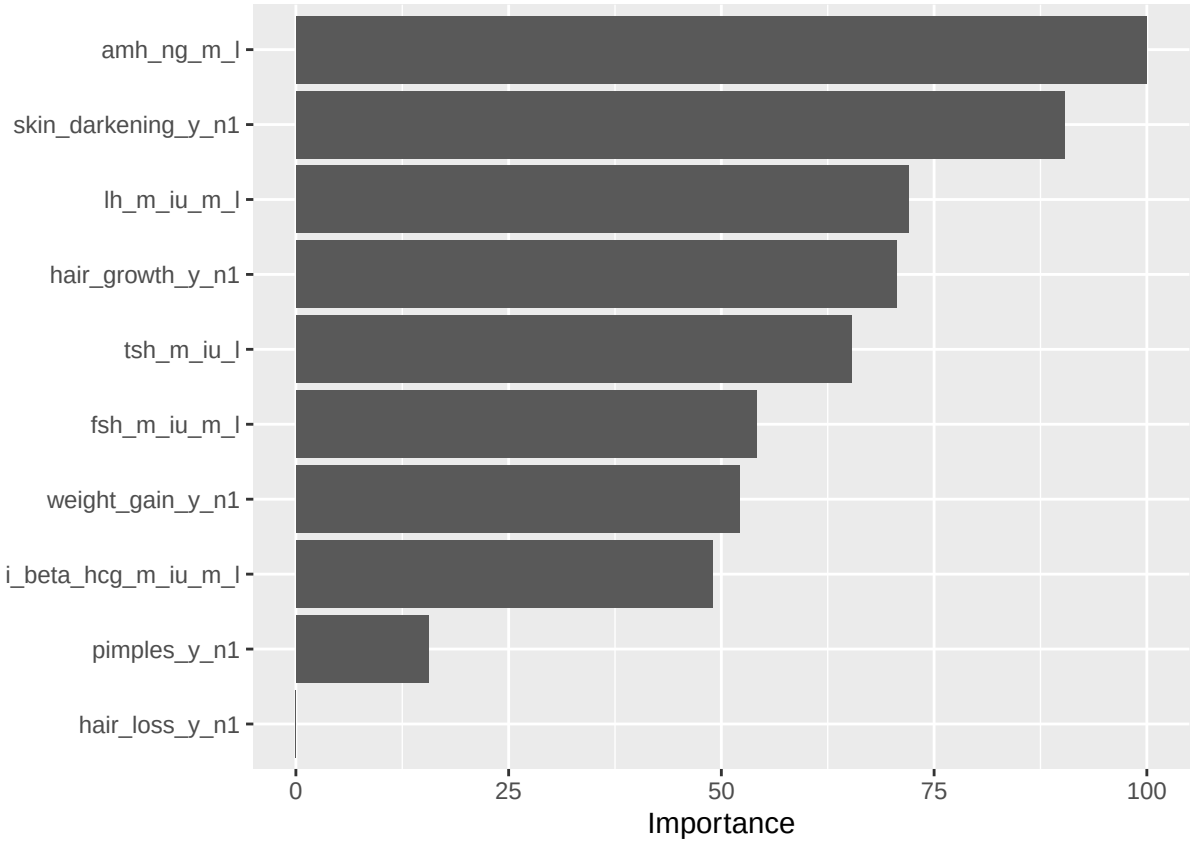
```
train.data.covariates <- train.data %>%
  select(
    pcos_y_n,
    i_beta_hcg_m_iu_m_l,
    fsh_m_iu_m_l ,
    lh_m_iu_m_l ,
    tsh_m_iu_l ,
    amh_ng_m_l ,
    weight_gain_y_n ,
    hair_growth_y_n,
    skin_darkening_y_n,
    hair_loss_y_n ,
    pimples_y_n
  ) %>% mutate(
  amh_ng_m_l = as.numeric(amh_ng_m_l),
  pcos_labelled = as.factor(ifelse(pcos_y_n==1, "yes", "no")))
```

```
## Warning in mask$eval_all_mutate(quo): NAs introduced by coercion
```

Random Forest – note that I've had to remove one missing ob from amh_ng_m_l for now.

RF Variable Importance

```
vip::vip(caret_rf)
```



XGboost

```
set.seed(123)
xgb_grid_1  <-  expand.grid(
                  nrounds = 50,
                  eta = c(0.03),
                  max_depth = 1,
                  gamma = 0,
                  colsample_bytree = 0.6,
                  min_child_weight = 1,
                  subsample = 0.5
                )

caret_xgb <- caret::train(pcos_labelled ~., data = select(train.data.covariates, -(pcos_y_n)),
                          method = "xgbTree",
                          metric = "ROC",
                          tuneGrid=xgb_grid_1,
                          na.action = na.pass,
                          trControl = trainControl(method = "cv", number = 5,classProbs = T, summaryFunc
caret_xgb
```

```
## eXtreme Gradient Boosting
##
## 379 samples
##  10 predictor
##   2 classes: 'no', 'yes'
##
## No pre-processing
## Resampling: Cross-Validated (5 fold)
## Summary of sample sizes: 303, 304, 303, 303, 303
## Resampling results:
##
##   ROC        Sens       Spec
##   0.8800556  0.9372549  0.525
##
## Tuning parameter 'nrounds' was held constant at a value of 50
## Tuning
##  held constant at a value of 1
## Tuning parameter 'subsample' was held
##  constant at a value of 0.5
```

Comparison code for later

5. Discussion and Conclusions

5.1 Discussion

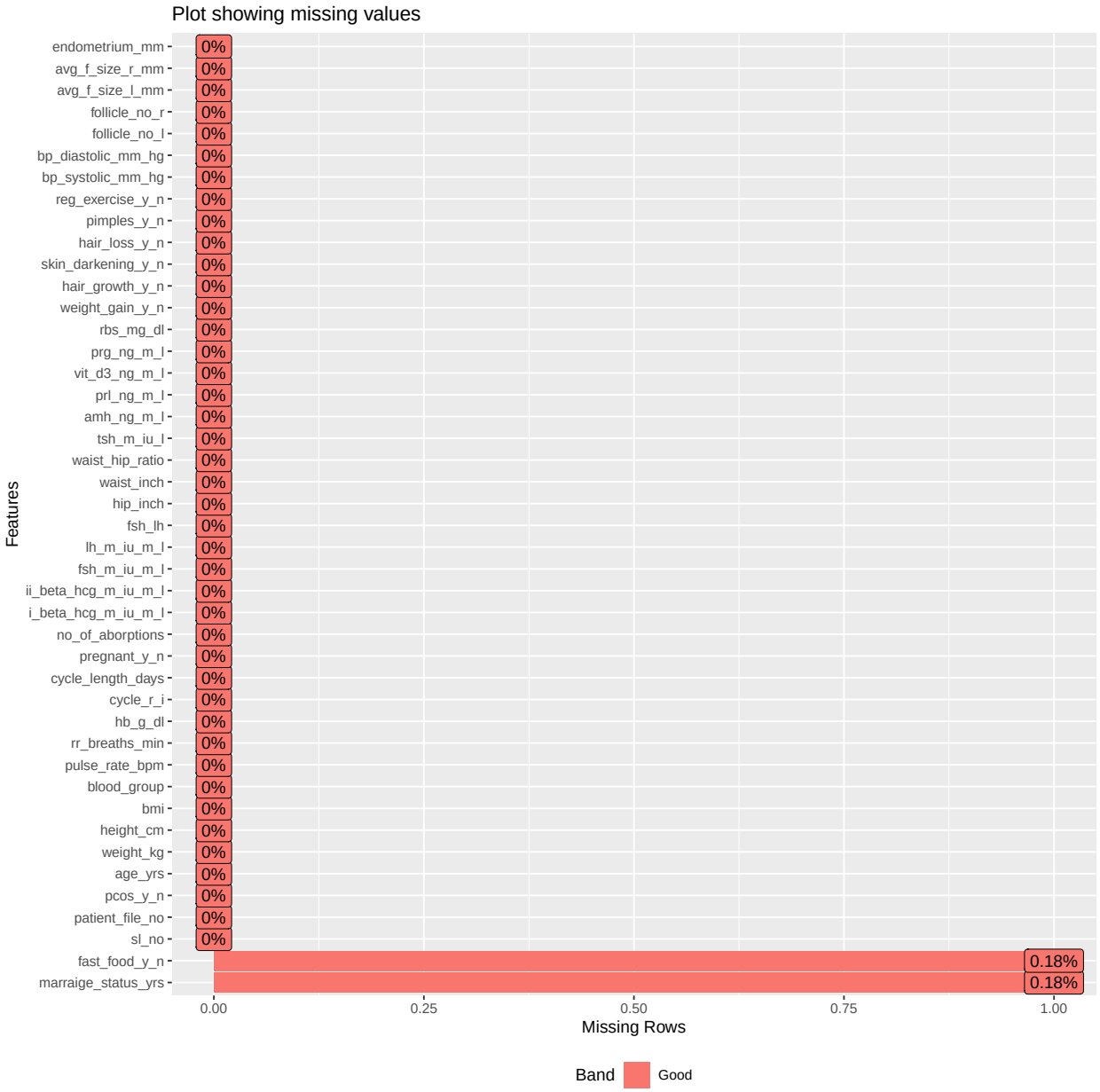
- Ethics statement

References

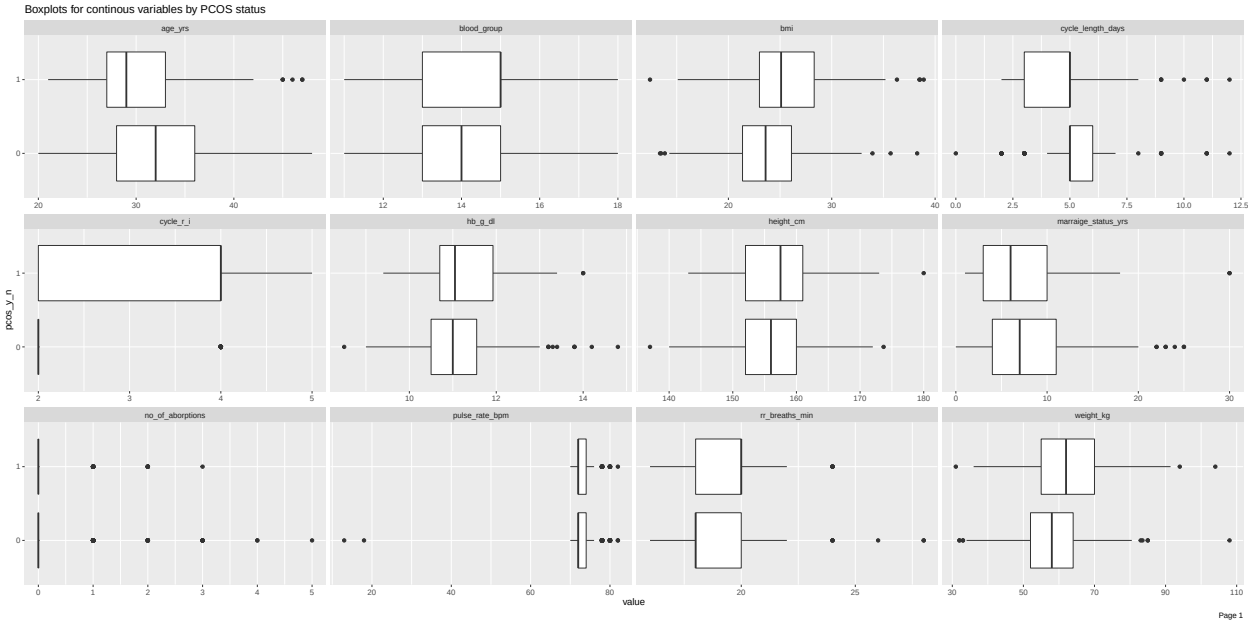
1. R for Data Science by Hadley Wickham (https://r4ds.had.co.nz)
2. Ajmal N, Khan SZ, Shaikh R. Polycystic ovary syndrome (PCOS) and genetic predisposition: A review article. Eur J Obstet Gynecol Reprod Biol X. 2019 Jun 8;3:100060. doi: 10.1016/j.eurox.2019.100060. PMID: 31403134; PMCID: PMC6687436.

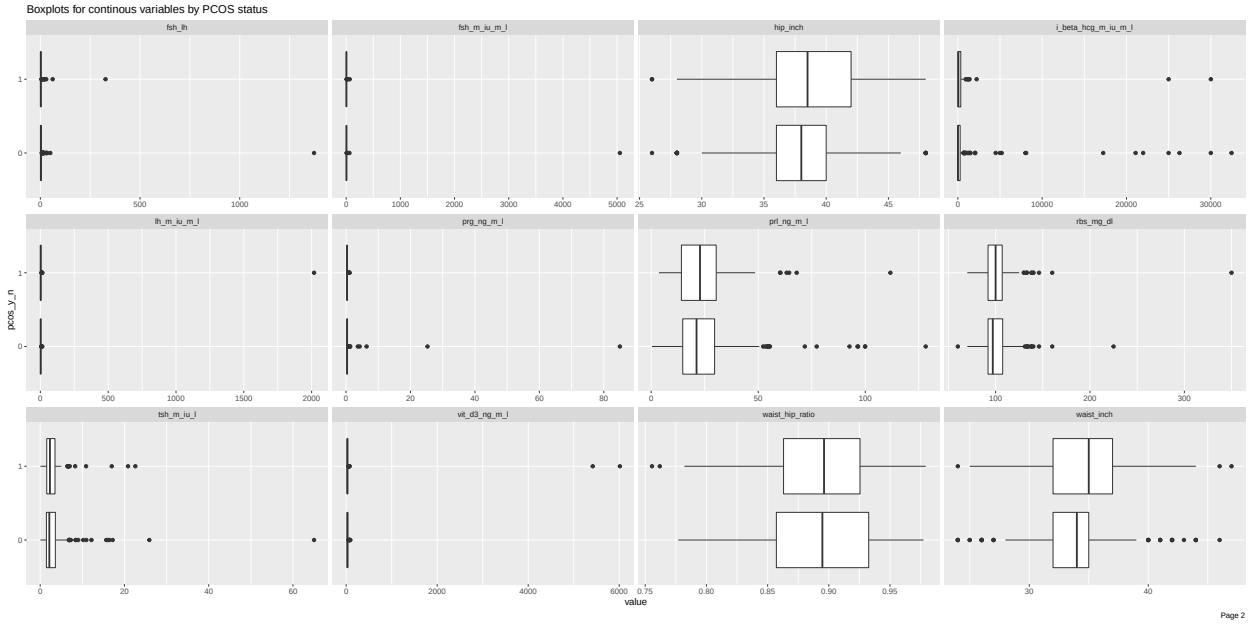
Appendix

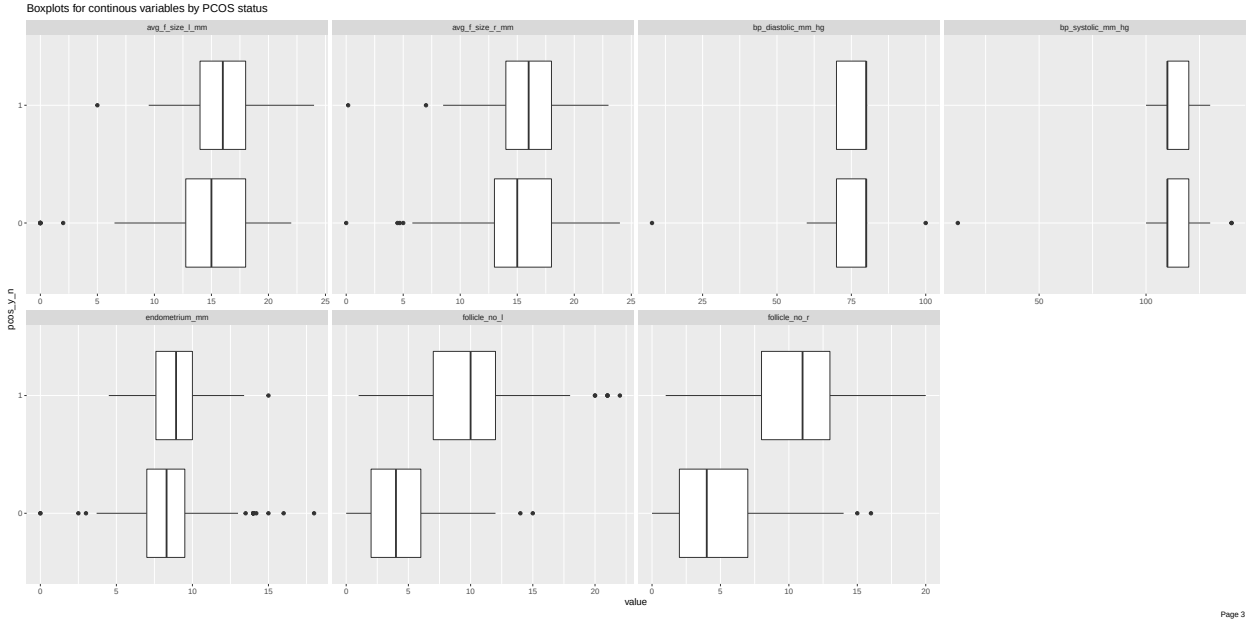
- Appendix Plot 1, as part of EDA, showing missing values in our dataset



- Appendix plot 2, as part of EDA, examining correlations between continuous features
- From this correlation plot, we find that several continuous variables do co-vary with one another.
- Specifically, as we would expect, we find a positive correlation between the variables waist and hip (in inches) with weight. We find the same positive correlation for BMI.
- Another obvious correlation we observe is that between age (in years) and marriage (in years)
-
- Appendix Plot 3 showing boxplots generated to investigate potential associations between continuous variables and PCOS status.







4a.1 Missing Values

Next in our EDA we sought to identify missing values in our dataset. Here, we see a plot showing our variables and the percentage of missing rows per variable. The plot shows the missing values in our dataset. Our EDA identified some missing values for two variables: fast food and marriage status. The analysis indicates that only 0.18% of the rows for these variables are missing. Therefore, as this is below the generally used threshold of 5 %, we will simply ignore these missing values for our subsequent analyses.

4a.2 Univariable distributions for continuous variables

To get a sense of the variation in our dataset, we plotted histograms for each continuous variable using the plot_histogram() from the DataExplorer Package.

We see that the age distribution in our dataset reveals most individuals are in the range of 20 to 40 years. No individuals in the dataset are younger than 20 or older than 50. As we would expect, the BMI values follow an approximately normal distribution. The most common blood type we observe is O+, which is consistent with the fact that O+ is the most frequent bloodtype globally. The most common cycle length is 5 days. The endometrium thickness data suggests there are two most most common thickness values (two clear peaks in the distribution).