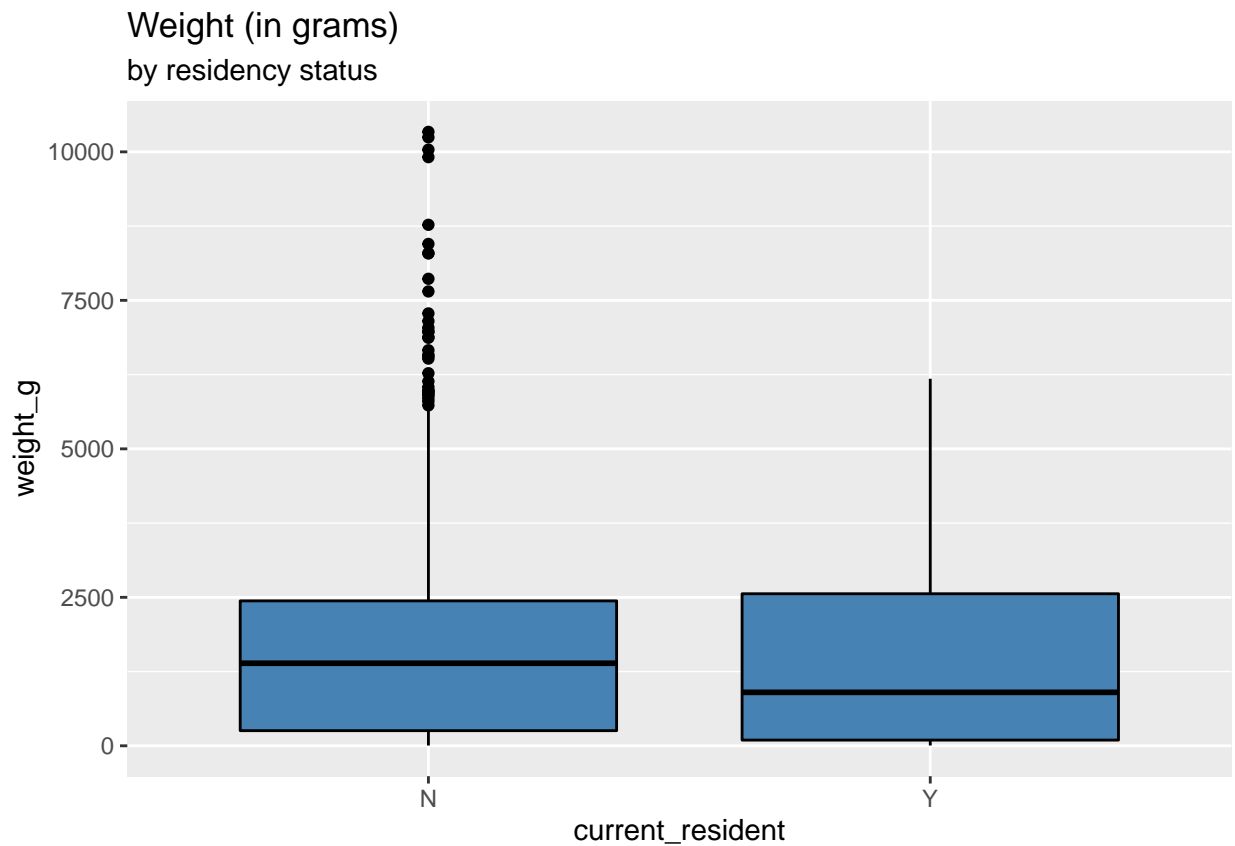


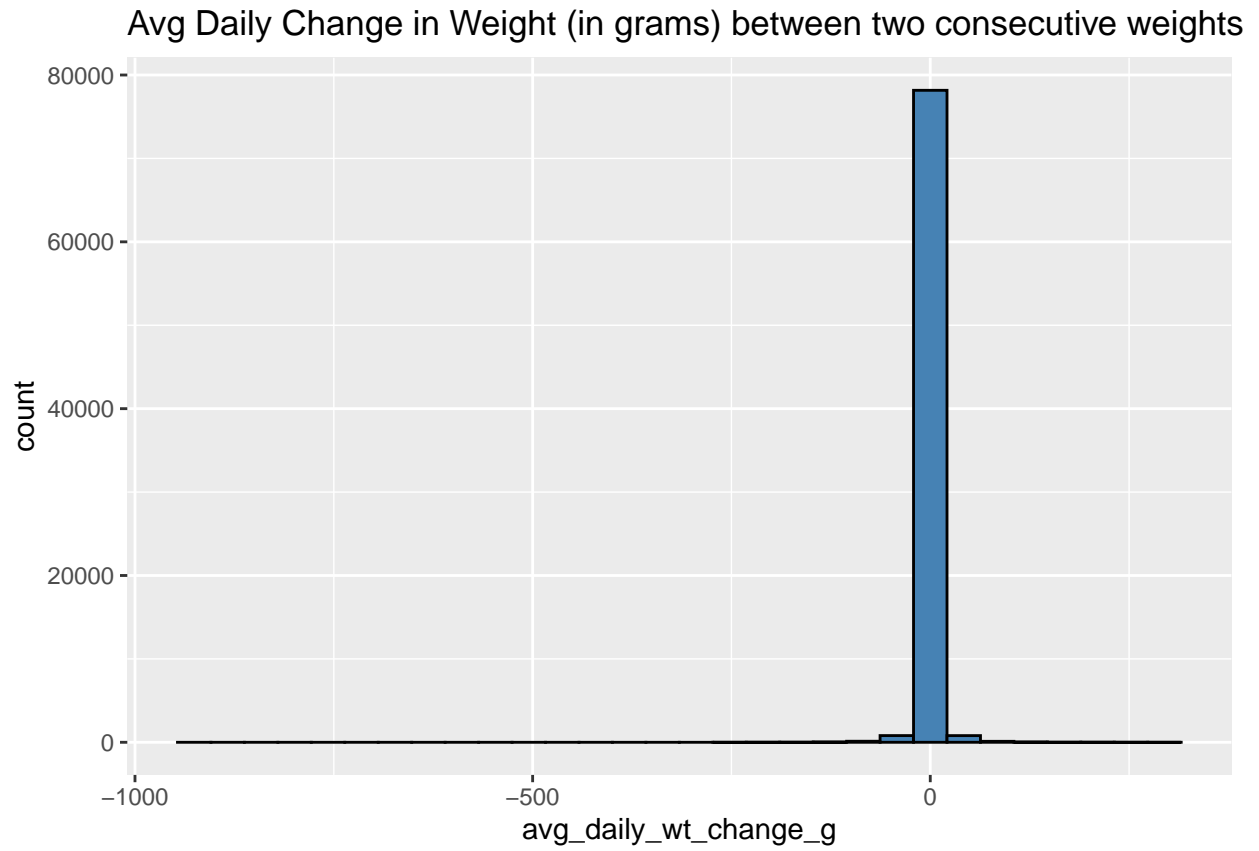
Lemurs

Nagaprasad Rudrapatna

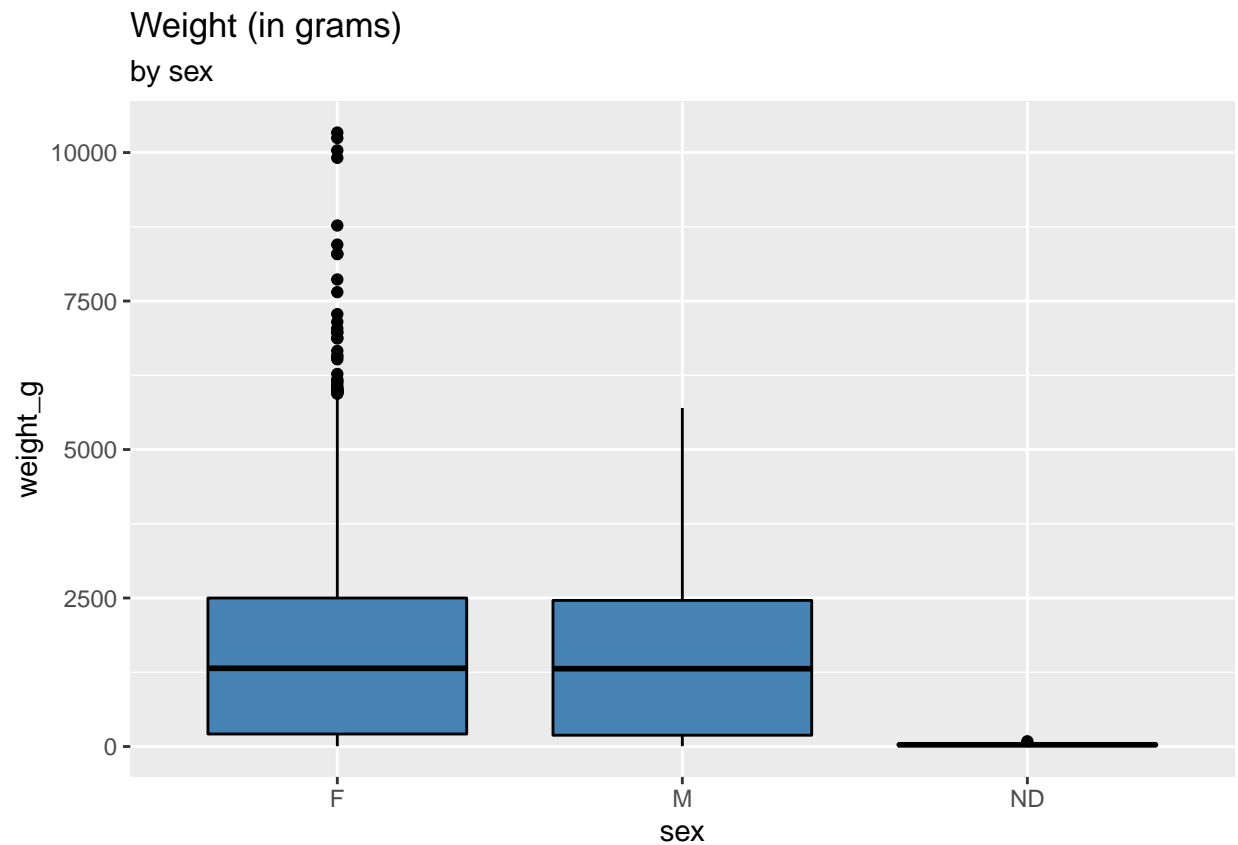


```
## # A tibble: 2 x 3
##   current_resident      n      p
##   <chr>          <int> <dbl>
## 1 N             57215 0.693
## 2 Y             25394 0.307
```

no clear relationship between `current_resident` and `weight_g`



all 323 animals in the final dataset are non-hybrids

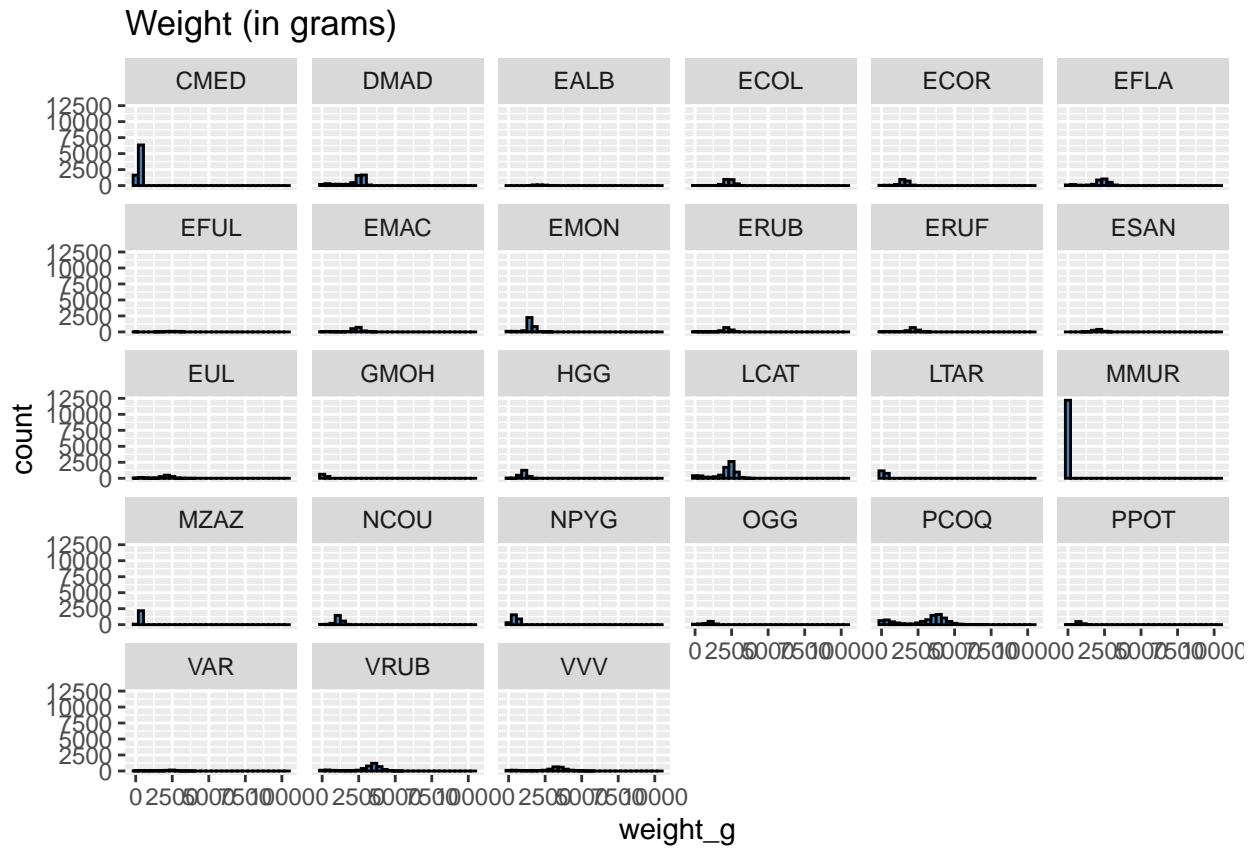


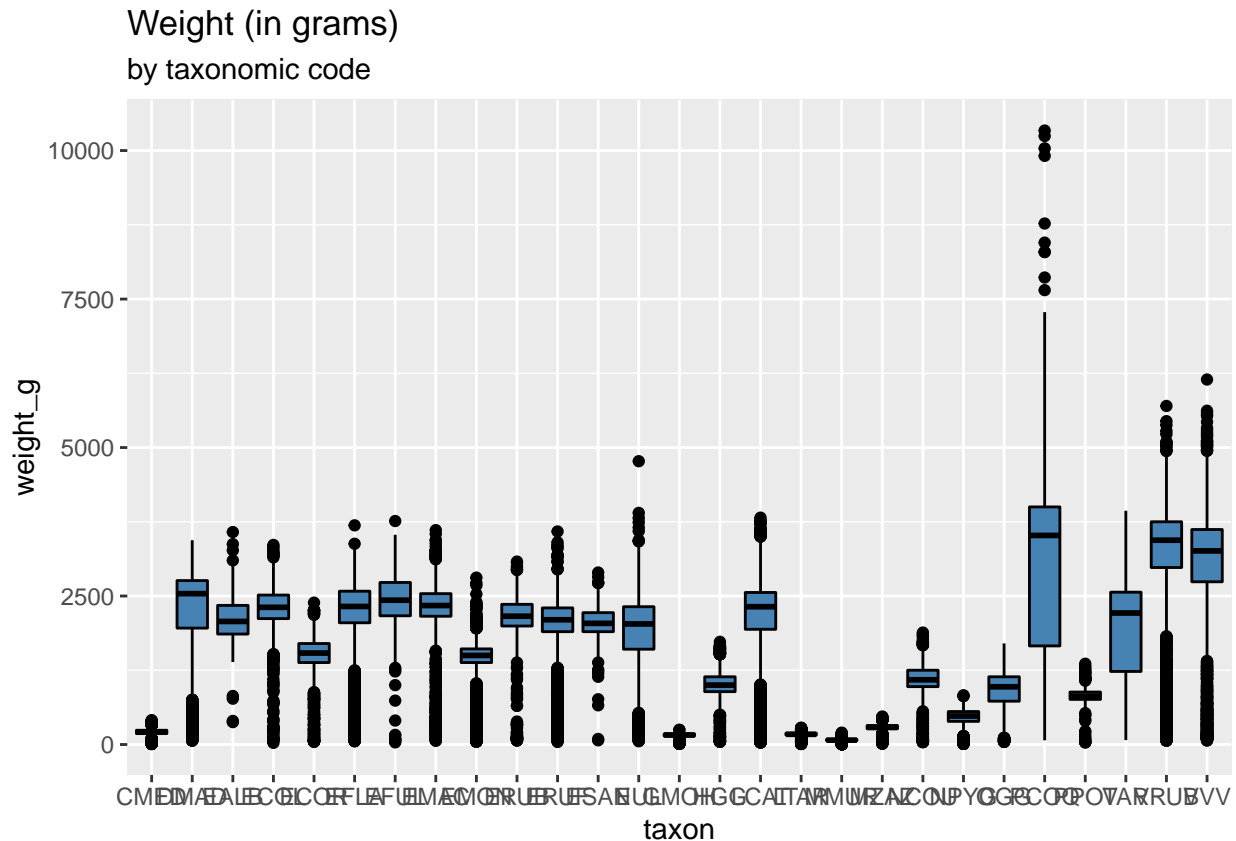
```
## # A tibble: 2 x 3
##   'sex == "ND"'      n      p
##   <lgl>          <int>  <dbl>
## 1 FALSE        82594  1.00
## 2 TRUE          15  0.000182
```

- not determined sex: less than 0.018% of animals
- remove them

```
## [1] 598
```

- 598 animals whose weight was measured only once or twice
- remove these





highest median weight - Coquerel's sifaka (PCOQ) lowest median weight - Gray mouse lemur (MMUR)

small lemurs cause issues with the distribution of response; also taxon has too many levels to be included as is in the model as fixed effect

```
## # A tibble: 10 x 15
##   taxon sex   name   dob      birth_type birth_institution dod
##   <chr> <chr> <chr> <date>    <chr>        <chr>          <date>
## 1 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 2 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 3 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 4 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 5 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 6 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 7 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 8 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 9 PCOQ  F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## 10 PCOQ F     SABINA 1986-07-07 CB          Duke Lemur Center 1993-06-04
## # ... with 8 more variables: n_known_offspring <dbl>, weight_g <dbl>,
## #   weight_date <date>, age_at_wt_d <dbl>, age_at_wt_y <dbl>,
## #   age_category <chr>, preg_status <chr>, infant_lit_sz_if_preg <dbl>

## # A tibble: 27 x 4
##   taxon median mean    n
##   <chr>   <dbl> <dbl> <int>
## 1 VRUB   3440  3133.  4139
```

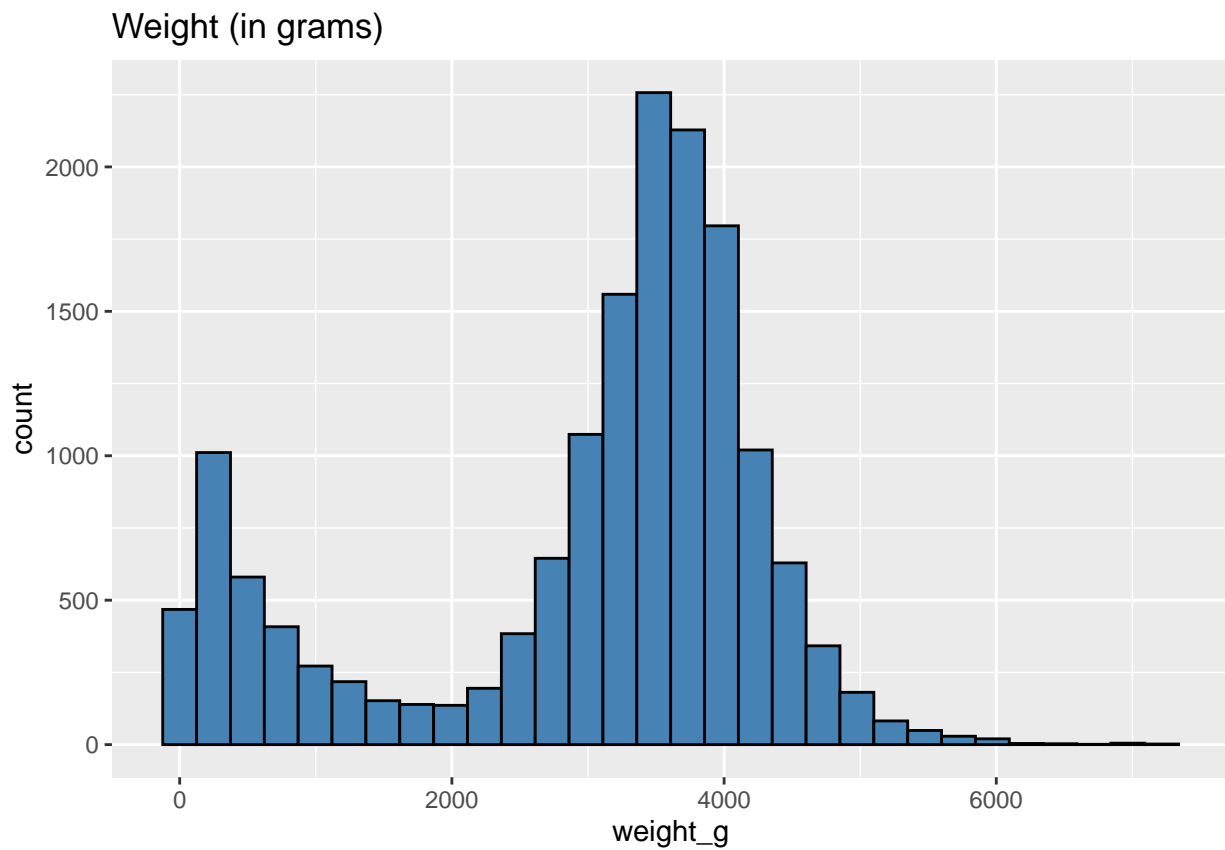
```
## 2 VVV      3260  2954.  2681
## 3 PCOQ      3520  2935.  8969
## 4 EFUL      2430  2387.   300
## 5 ECOL      2310  2298.  2456
## 6 EMAC      2340  2230.  1696
## 7 DMAD      2540  2187.  5074
## 8 EFLA      2324.  2146.  3200
## 9 ERUB      2160  2123.  1352
## 10 EALB     2072.  2094.   312
## # ... with 17 more rows
```

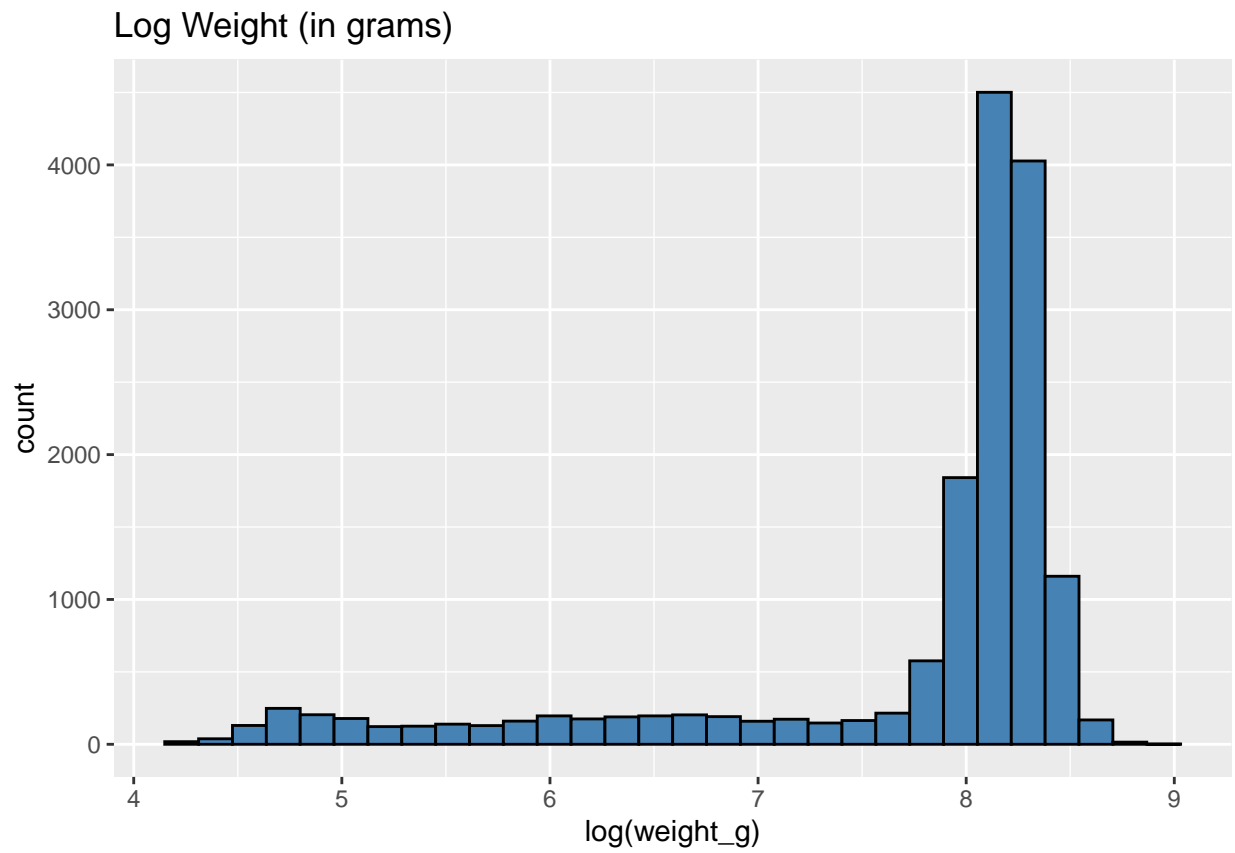
limit it to the 3 heaviest lemur taxons on average - PCOQ, VRUB, and VVV

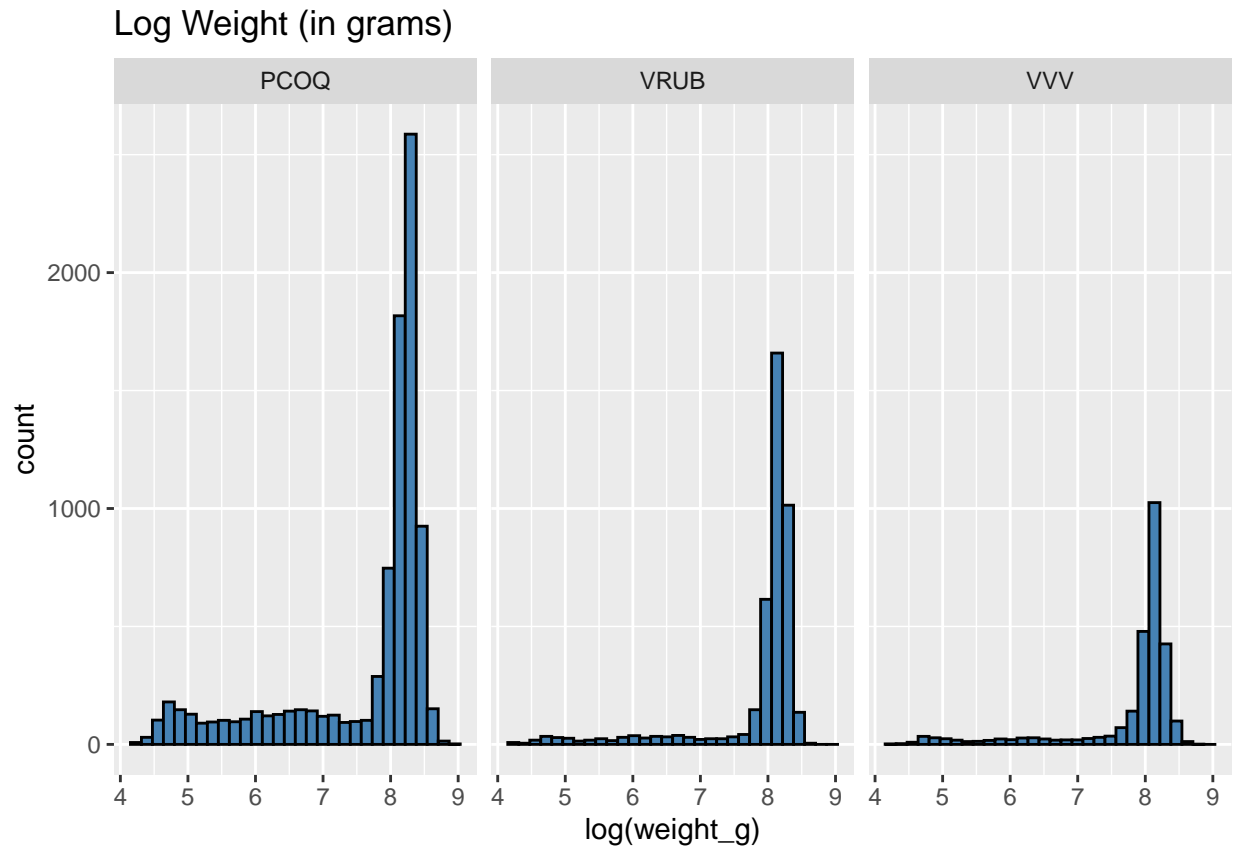
```
## # A tibble: 2 x 3
##   sex      n      p
##   <chr> <int> <dbl>
## 1 F      7707 0.488
## 2 M      8082 0.512
```

- dataset has roughly equal proportions of males and females

** Analysis applies to heavy lemurs





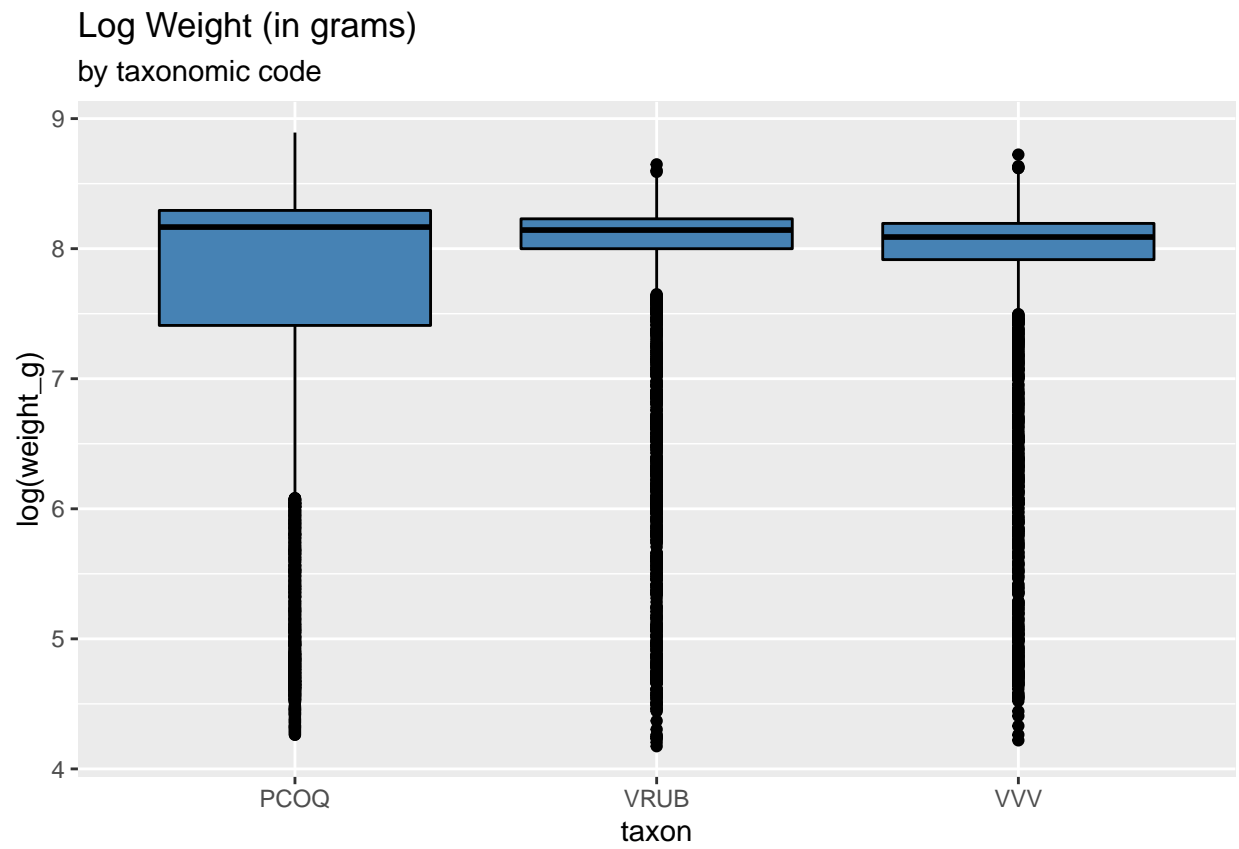


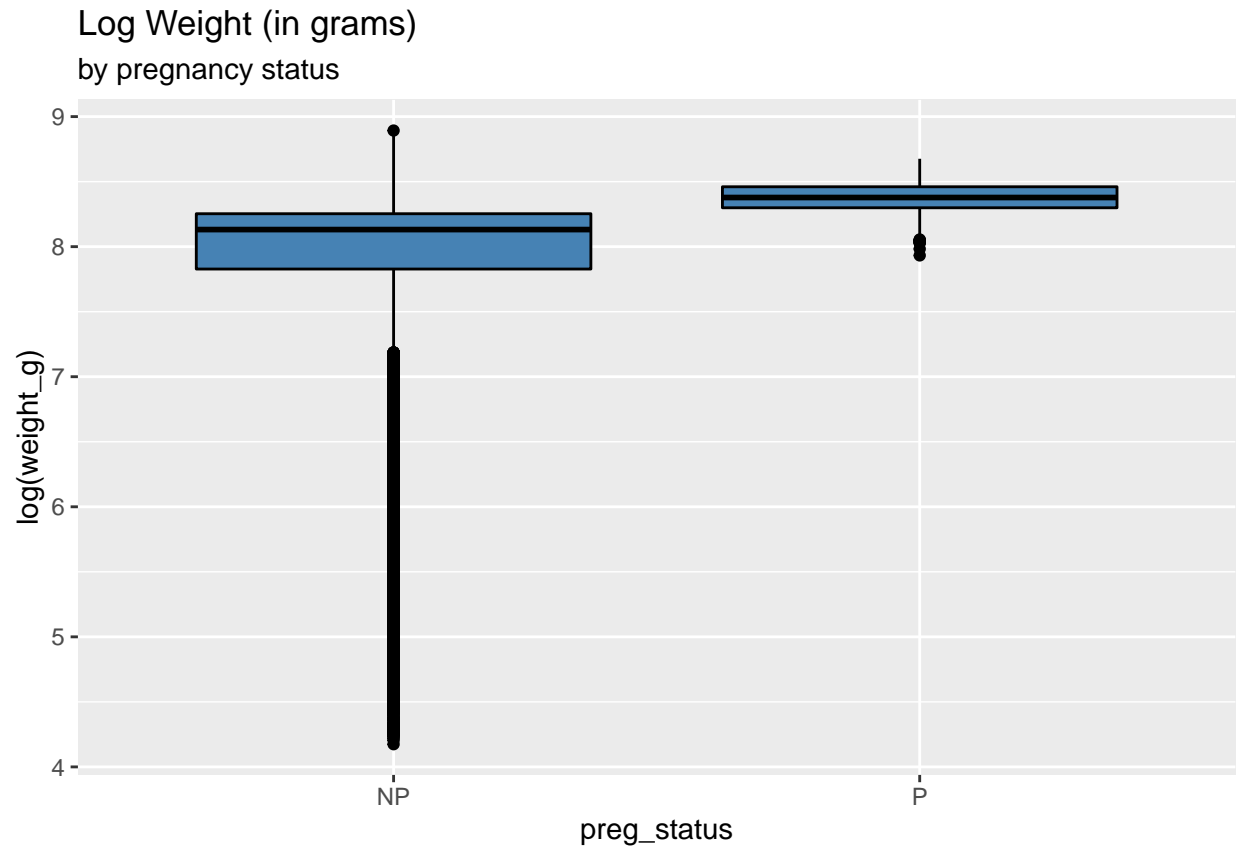
spike at low weights (IJ) right-skewed unimodal

log-transform response: left-skewed, unimodal

```
## # A tibble: 9 x 3
## # Groups:   taxon [3]
##   taxon age_category     n
##   <chr> <chr>         <int>
## 1 PCOQ  adult           3707
## 2 PCOQ  IJ              3818
## 3 PCOQ  young_adult     1444
## 4 VRUB  adult           2744
## 5 VRUB  IJ              944
## 6 VRUB  young_adult      451
## 7 VVV   adult           1700
## 8 VVV   IJ              722
## 9 VVV   young_adult      259
```

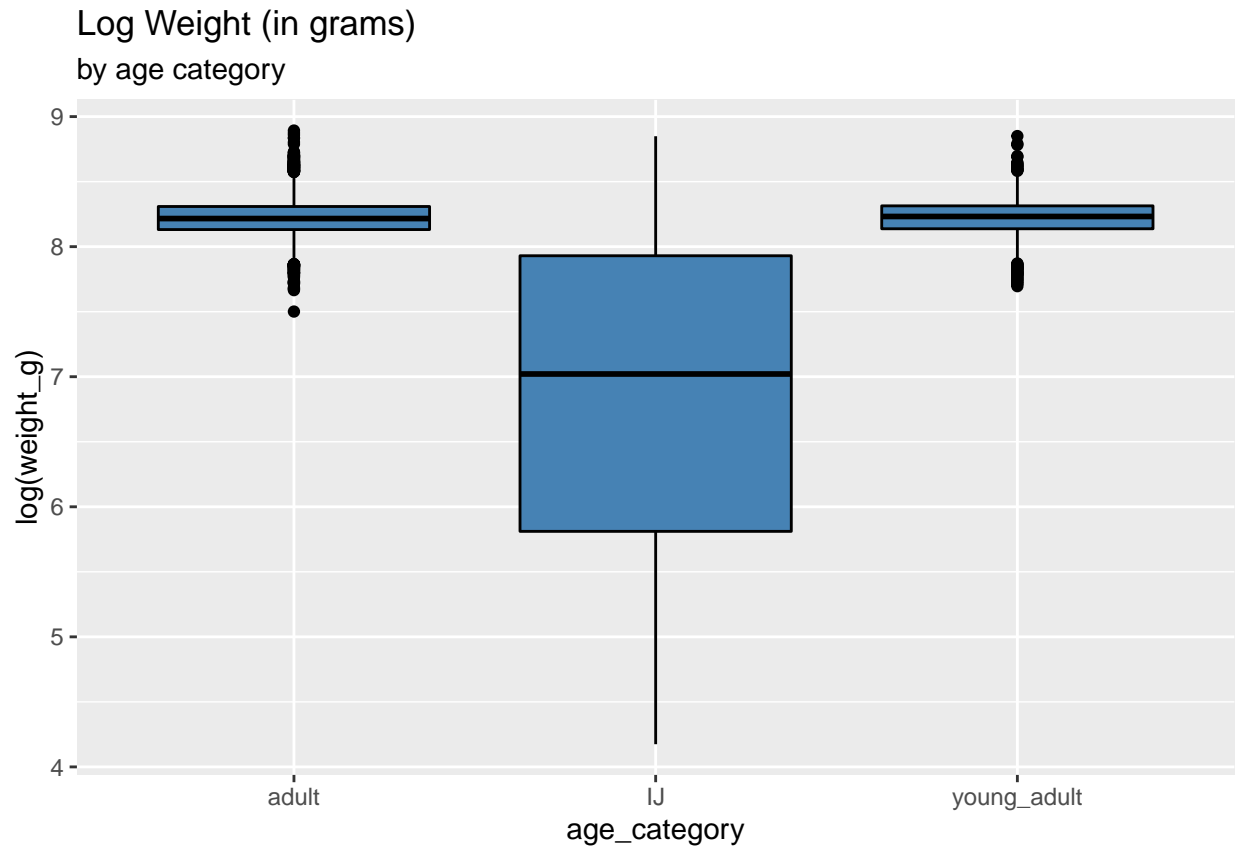
most IJ are of PCOQ taxon





```
## # A tibble: 2 x 3
##   preg_status     n     p
##   <chr>         <int> <dbl>
## 1 NP           7098 0.921
## 2 P             609 0.0790
```

- roughly 7.9% of females were pregnant during a weight check
- pregnant animals have higher median weight



```
## # A tibble: 3 x 3
##   age_category      n      p
##   <chr>      <int> <dbl>
## 1 adult      8151 0.516
## 2 IJ         5484 0.347
## 3 young_adult 2154 0.136
```

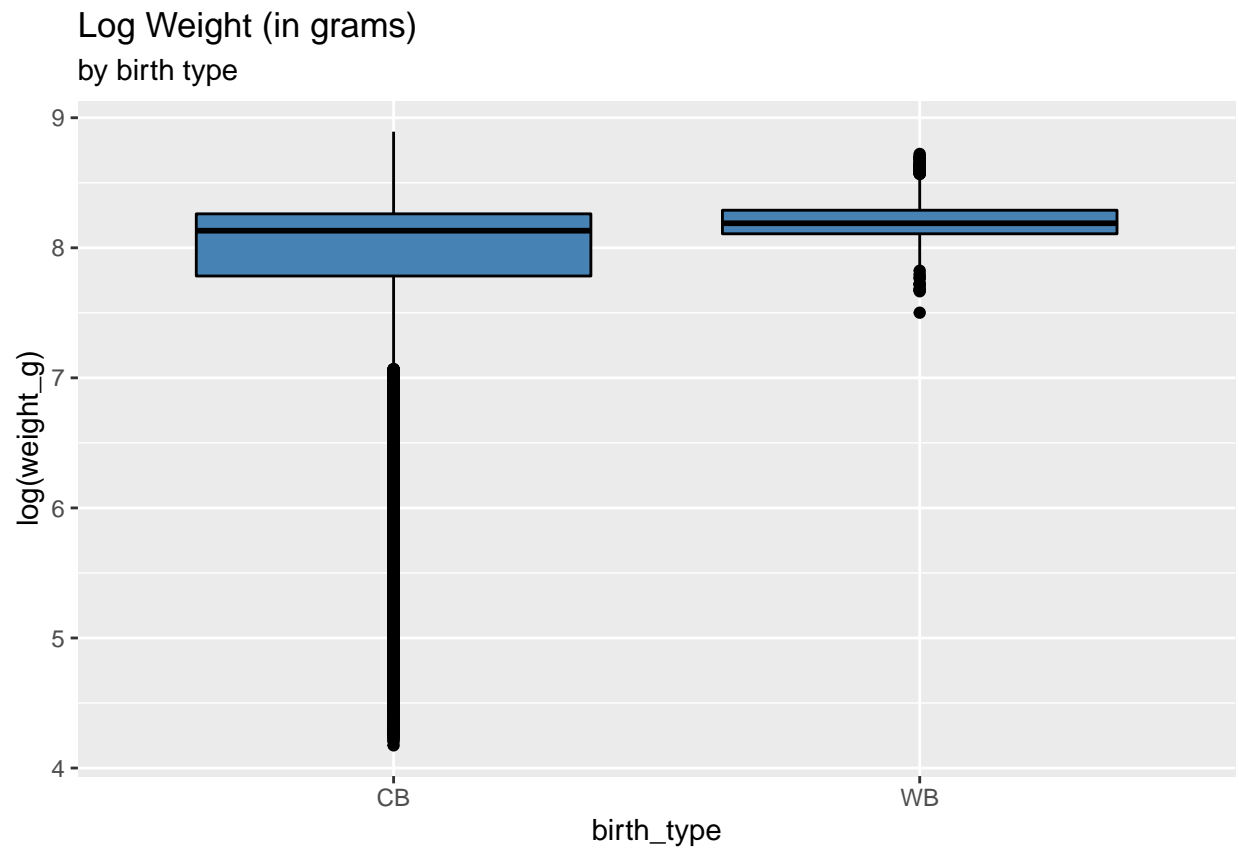
```
## # A tibble: 6 x 4
## # Groups:   sex [2]
##   sex age_category      n      p
##   <chr> <chr>      <int> <dbl>
## 1 F adult      3997 0.519
## 2 F IJ         2623 0.340
## 3 F young_adult 1087 0.141
## 4 M adult      4154 0.514
## 5 M IJ         2861 0.354
## 6 M young_adult 1067 0.132
```

- roughly equal proportions of males and females in each age category

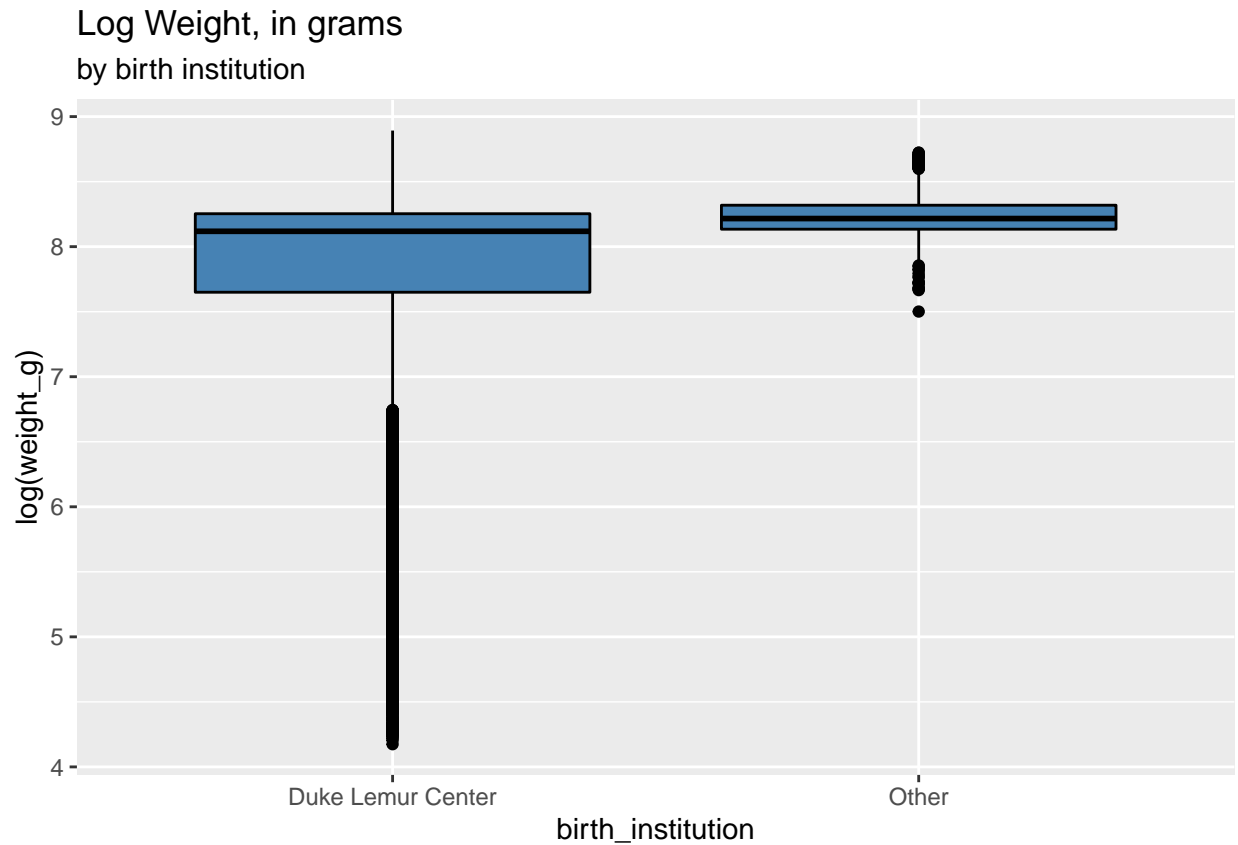
~ **52% adult** 35% IJ
13% young adult

- young adults have similar median weight to adults, IJ have lowest median weight

```
## # A tibble: 3 x 3
##   birth_type median    n
##   <fct>      <dbl> <int>
## 1 CB          3400 14454
## 2 Unk          3866.    6
## 3 WB          3600 1329
```



wild birth has slightly higher median log-weight

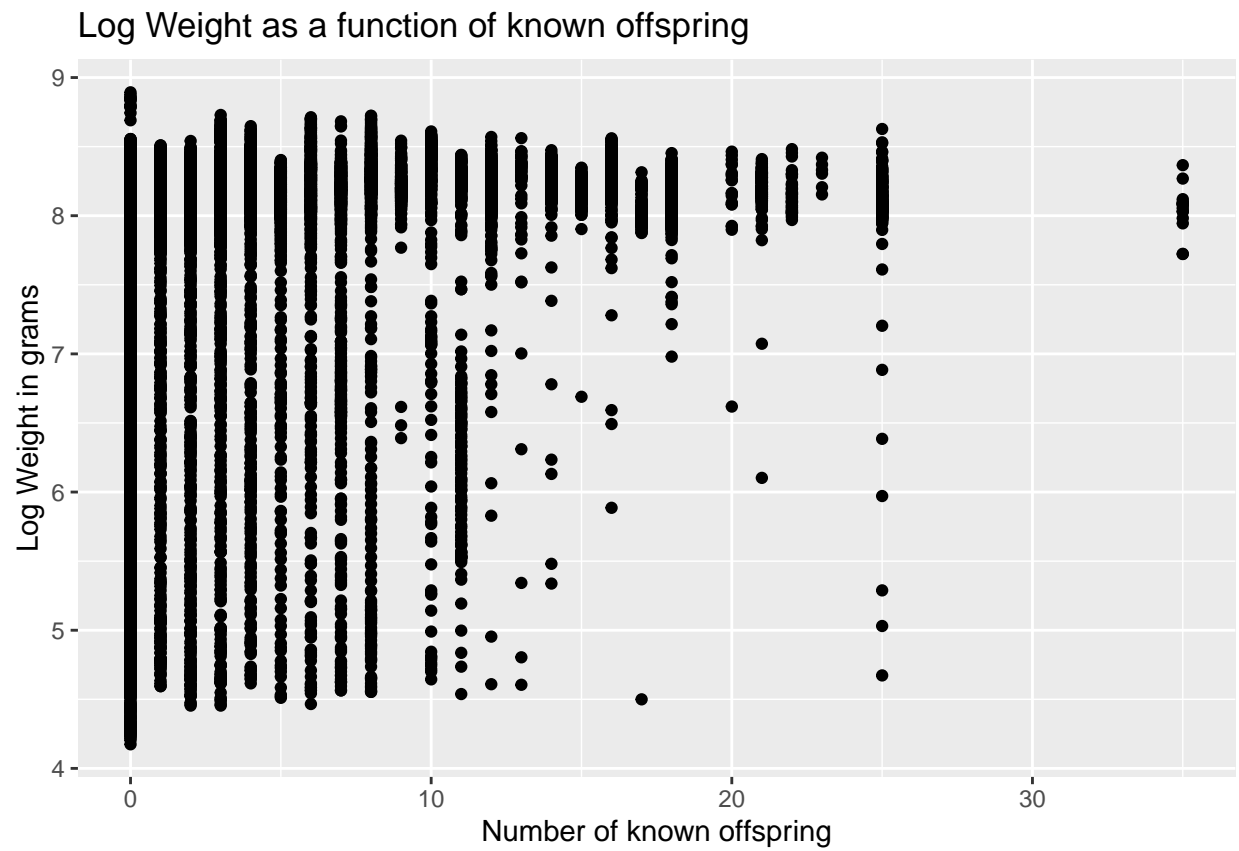


```
## # A tibble: 2 x 2
## # Groups:   birth_institution [2]
##   birth_institution     n
##   <fct>             <int>
## 1 Duke Lemur Center 13507
## 2 Other              2276
```

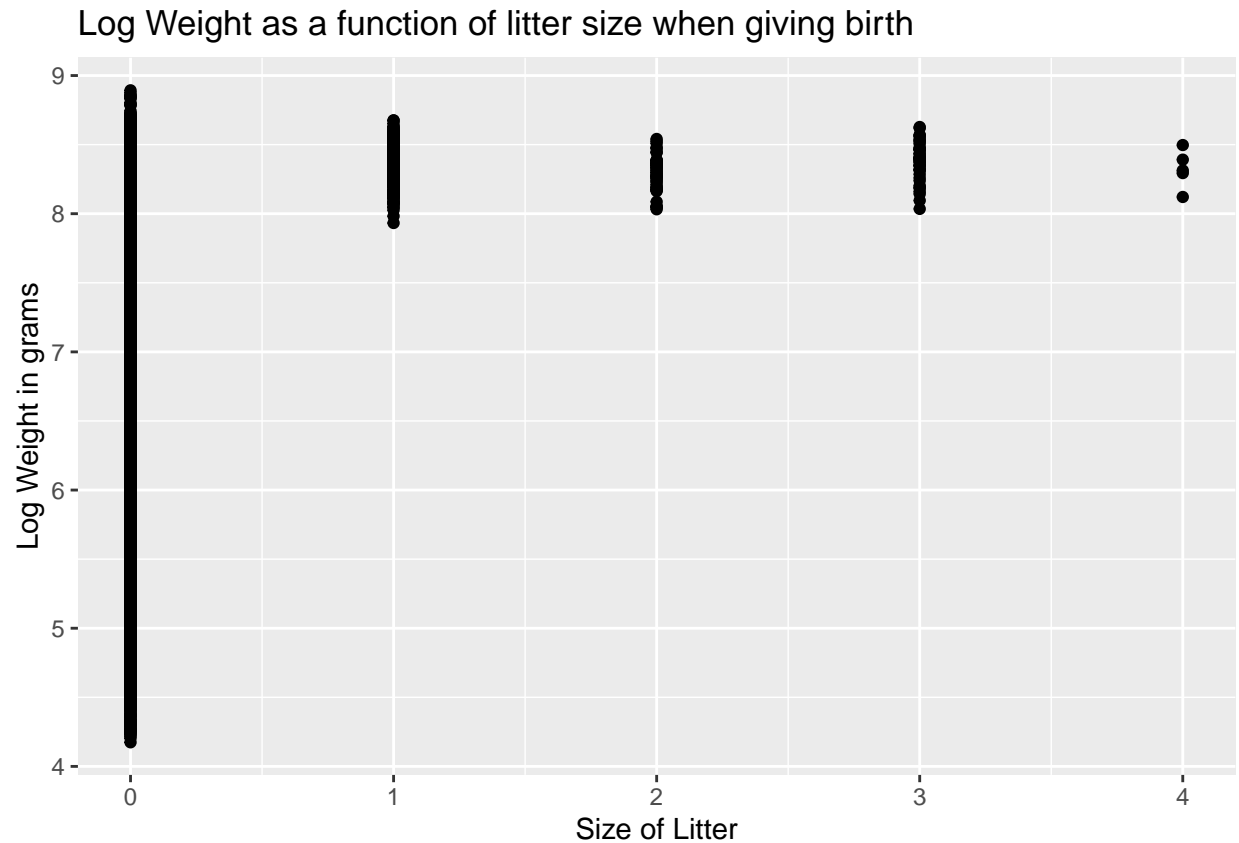
```
## # A tibble: 2 x 2
##   birth_institution median
##   <fct>             <dbl>
## 1 Duke Lemur Center  3355
## 2 Other              3700
```

since the overwhelming majority (about 85.5%) of lemurs were born at DLC, we can simply consider DLC or not

lemurs not born at the DLC has higher median weight



no clear relationship with `n_known_offspring`

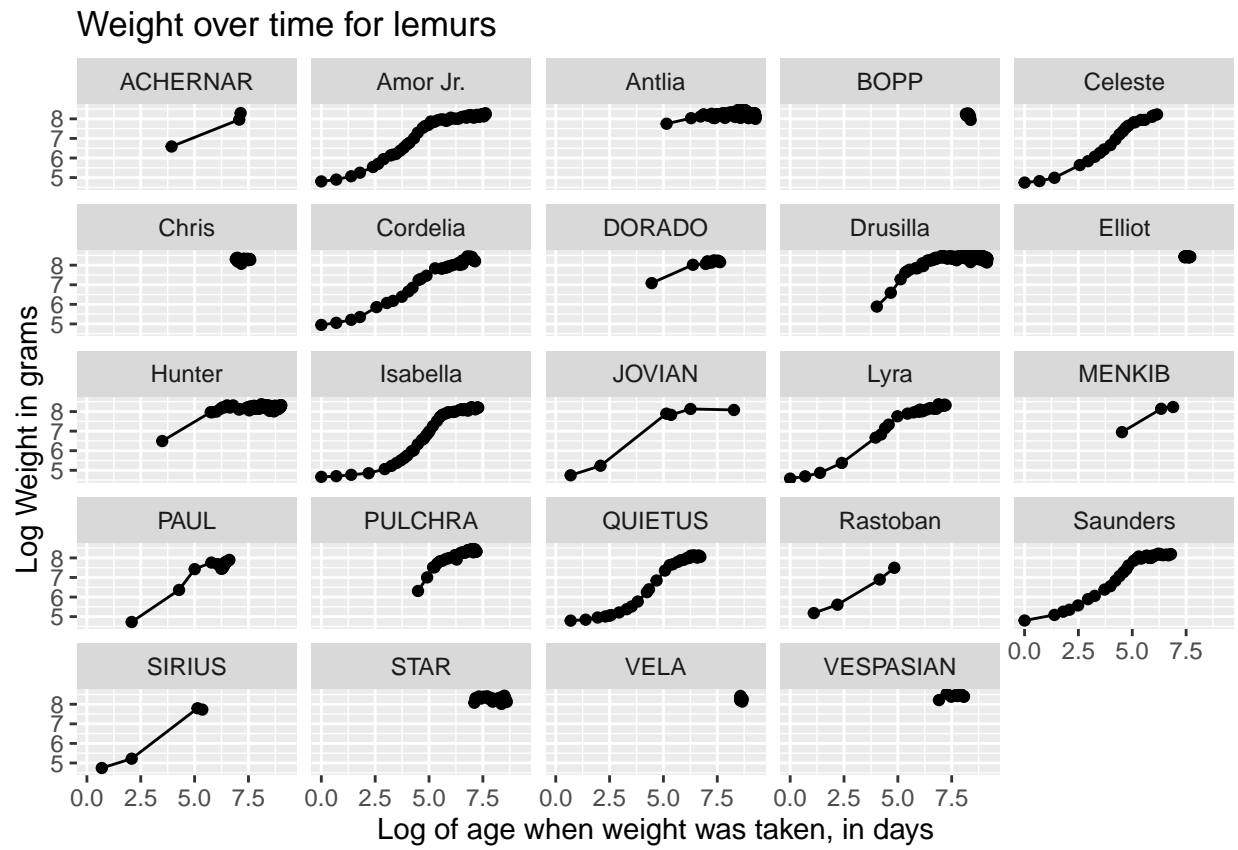


no relationship with litter size

```
## # A tibble: 15 x 3
##   skim_variable    n_missing complete_rate
##   <chr>            <int>         <dbl>
## 1 taxon              0             1
## 2 sex                0             1
## 3 name               0             1
## 4 age_category       0             1
## 5 preg_status       0             1
## 6 dob               0             1
## 7 dod              7550         0.522
## 8 weight_date       0             1
## 9 birth_type        0             1
## 10 birth_institution 0             1
## 11 n_known_offspring 0             1
## 12 weight_g         0             1
## 13 age_at_wt_d       0             1
## 14 age_at_wt_y       0             1
## 15 infant_lit_sz_if_preg 0             1
```

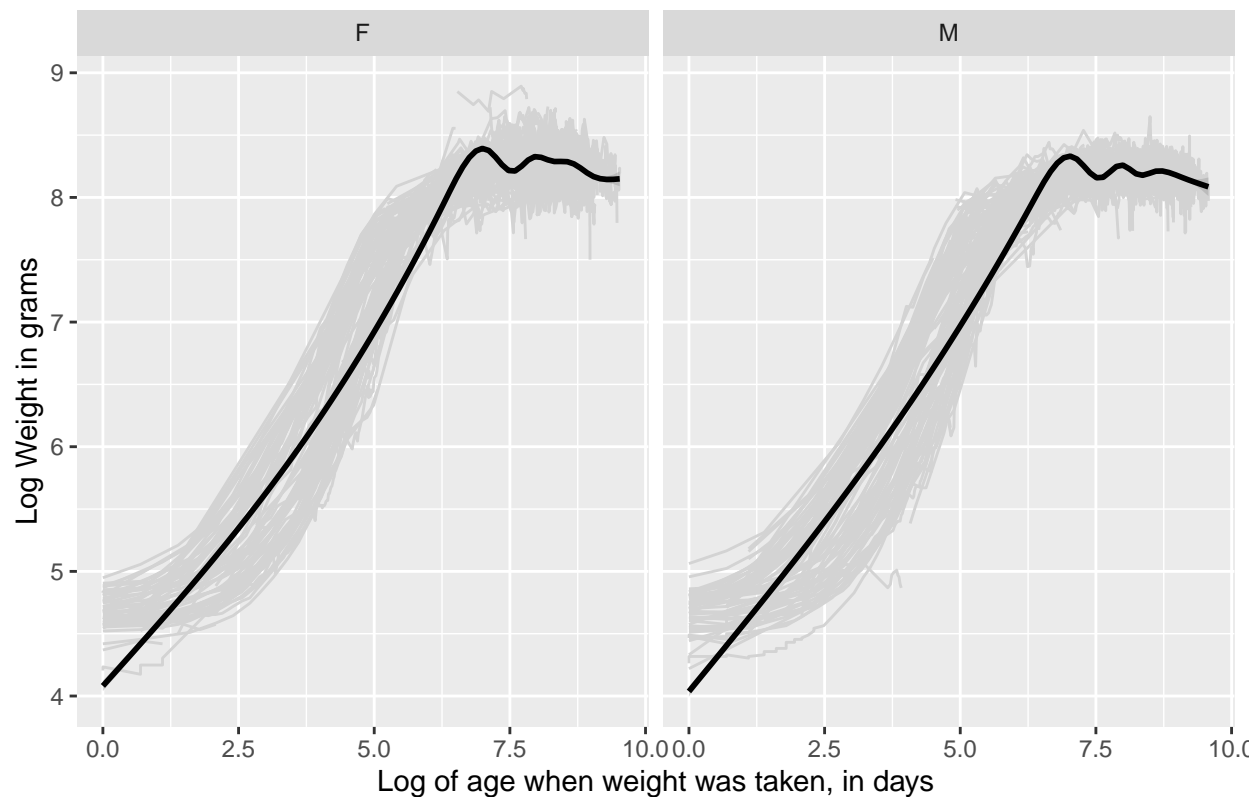
```
## # A tibble: 1 x 1
##       n
##   <int>
## 1   323
```

323 unique animals





Weight over time for lemurs



Unconditional means model

```
## # A tibble: 3 x 6
##   effect  group    term          estimate std.error statistic
##   <chr>   <chr>   <chr>          <dbl>     <dbl>     <dbl>
## 1 fixed  <NA>    (Intercept)    7.58      0.0416     182.
## 2 ran_pars name    sd__(Intercept)  0.715      NA         NA
## 3 ran_pars Residual sd__Observation  0.780      NA         NA

## [1] 0.4562919
```

p-hat = 0.456 45.6% of the variability in log-weight measurements can be attributed to differences between lemurs (lemur-to-lemur variability). The average correlation between any two log-weight measurements for the same animal is about 0.456.

About 54.4% of the variability in log-weight measurements can be attributed to changes over time

Unconditional growth model

```
## # A tibble: 6 x 6
##   effect  group    term          estimate std.error statistic
##   <chr>   <chr>   <chr>          <dbl>     <dbl>     <dbl>
## 1 fixed  <NA>    (Intercept)    5.29      0.101     52.4
```

## 2 fixed	<NA>	log_age_at_wt_d	0.410	0.0149	27.5
## 3 ran_pars	name	sd__(Intercept)	1.68	NA	NA
## 4 ran_pars	name	cor__(Intercept).log_age_at_wt~	-0.986	NA	NA
## 5 ran_pars	name	sd__log_age_at_wt_d	0.249	NA	NA
## 6 ran_pars	Residual	sd__Observation	0.242	NA	NA

Calculate the $PseudoR^2$ to estimate the change of within-animal variance between the unconditional means and unconditional growth models.

```
## [1] 0.9036657
```

~ 90.4% decrease in the residual variance due to inclusion of log_age_at_wt_d (age at time of weight check)

Adding Level One variables

##	effect	group	term	estimate	std.error	statistic
##	<chr>	<chr>	<chr>	<dbl>	<dbl>	<dbl>
## 1 fixed	<NA>		(Intercept)	4.16	0.0927	44.8
## 2 fixed	<NA>		log_age_at_wt_d	0.525	0.0126	41.5
## 3 fixed	<NA>		age_categoryIJ	0.605	0.00939	64.4
## 4 fixed	<NA>		age_categoryyoung_adult	0.384	0.00732	52.4
## 5 ran_pars	name		sd__(Intercept)	1.51	NA	NA
## 6 ran_pars	name		cor__(Intercept).log_age_at_wt~	-0.986	NA	NA
## 7 ran_pars	name		sd__log_age_at_wt_d	0.207	NA	NA
## 8 ran_pars	Residual		sd__Observation	0.214	NA	NA

```
## Data: lemurs3
```

```
## Models:
```

```
## model2: log_weight ~ log_age_at_wt_d + (log_age_at_wt_d | name)
```

```
## model3: log_weight ~ log_age_at_wt_d + age_category + (log_age_at_wt_d | name)
```

```
##      npar      AIC      BIC  logLik deviance  Chisq Df Pr(>Chisq)
```

```
## model2      6 2239.3 2285.3 -1113.67 2227.3
```

```
## model3      8 -1641.3 -1580.0 828.64 -1657.3 3884.6 2 < 2.2e-16 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: < 2.2e-16 model 3 > model 2 (include age_category)

also, model 3 has lower AIC/BIC

##	effect	group	term	estimate	std.error	statistic
##	<chr>	<chr>	<chr>	<dbl>	<dbl>	<dbl>
## 1 fixed	<NA>		(Intercept)	4.15	0.0922	45.0
## 2 fixed	<NA>		log_age_at_wt_d	0.526	0.0126	41.8
## 3 fixed	<NA>		age_categoryIJ	0.610	0.00939	64.9
## 4 fixed	<NA>		age_categoryyoung_adult	0.387	0.00732	52.8
## 5 fixed	<NA>		preg_statusP	0.0760	0.00996	7.64
## 6 ran_pars	name		sd__(Intercept)	1.50	NA	NA
## 7 ran_pars	name		cor__(Intercept).log_age_at_wt~	-0.986	NA	NA
## 8 ran_pars	name		sd__log_age_at_wt_d	0.206	NA	NA
## 9 ran_pars	Residual		sd__Observation	0.214	NA	NA

```
## Data: lemurs3
## Models:
## model3: log_weight ~ log_age_at_wt_d + age_category + (log_age_at_wt_d | name)
## model4: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d | name)
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
## model3      8 -1641.3 -1580.0 828.64 -1657.3
## model4      9 -1697.5 -1628.5 857.73 -1715.5 58.189 1 2.381e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 2.381e-14 model 4 > model 3 (include age_category, preg_status)

model 4 has lower AIC/BIC

Level One covariates: log_age_at_wt_d, age_category, and preg_status

Adding Random Effects

```
## # A tibble: 16 x 6
##   effect   group   term                estimate std.error statistic
##   <chr>    <chr>   <chr>                <dbl>     <dbl>     <dbl>
## 1 fixed   <NA>    (Intercept)          4.50      0.134      33.5
## 2 fixed   <NA>    log_age_at_wt_d       0.480     0.0174     27.6
## 3 fixed   <NA>    age_categoryIJ        0.411     0.0378     10.9
## 4 fixed   <NA>    age_categoryyoung_adult 0.333     0.0184     18.1
## 5 fixed   <NA>    preg_statusP          0.0828    0.00953     8.69
## 6 ran_pars name    sd_(Intercept)        2.19      NA         NA
## 7 ran_pars name    cor_(Intercept).log_age_at_w~ -0.995    NA         NA
## 8 ran_pars name    cor_(Intercept).age_category~ -0.891    NA         NA
## 9 ran_pars name    cor_(Intercept).age_category~ -0.802    NA         NA
## 10 ran_pars name   sd_log_age_at_wt_d     0.285     NA         NA
## 11 ran_pars name   cor_log_age_at_wt_d.age_cate~ 0.894     NA         NA
## 12 ran_pars name   cor_log_age_at_wt_d.age_cate~ 0.757     NA         NA
## 13 ran_pars name   sd_age_categoryIJ      0.575     NA         NA
## 14 ran_pars name   cor_age_categoryIJ.age_categ~ 0.848     NA         NA
## 15 ran_pars name   sd_age_categoryyoung_adult 0.241     NA         NA
## 16 ran_pars Residual sd_Observation         0.200     NA         NA
```

```
## Data: lemurs3
## Models:
## model4: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d | name)
## model5: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_category | name)
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
## model4      9 -1697.5 -1628.5 857.73 -1715.5
## model5     16 -3322.9 -3200.4 1677.46 -3354.9 1639.5 7 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

parametric bootstrap takes too long but p-value from LRT is already very small p-value: < 2.2e-16 model 5 > model 4 model 5 has lower AIC/BIC

```
## # A tibble: 21 x 6
##   effect   group term                estimate std.error statistic
```

```
##      <chr>      <chr> <chr>                                <dbl>      <dbl>      <dbl>
## 1 fixed      <NA> (Intercept)                            4.49       0.134      33.6
## 2 fixed      <NA> log_age_at_wt_d                        0.481      0.0173     27.8
## 3 fixed      <NA> age_categoryIJ                         0.415      0.0375     11.1
## 4 fixed      <NA> age_categoryyoung_adult                0.335      0.0184     18.2
## 5 fixed      <NA> preg_statusP                           0.0859     0.0170      5.06
## 6 ran_pars name sd__(Intercept)                          2.18       NA         NA
## 7 ran_pars name cor__(Intercept).log_age_at_wt_d        -0.995     NA         NA
## 8 ran_pars name cor__(Intercept).age_categoryIJ         -0.890     NA         NA
## 9 ran_pars name cor__(Intercept).age_categoryyou~       -0.800     NA         NA
## 10 ran_pars name cor__(Intercept).preg_statusP          0.257     NA         NA
## # ... with 11 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model5: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_category
```

```
## model6: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_category
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model5    16 -3322.9 -3200.4 1677.5 -3354.9
```

```
## model6    21 -3373.1 -3212.3 1707.6 -3415.1 60.205  5  1.103e-11 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

model 6 has lower AIC/BIC but the difference is very small (AIC diff: 50.2; BIC diff: 11.9)

does not justify the 5 additional variance components, so despite the LRT result, stick with model 5

```
## # A tibble: 15 x 6
```

```
##      effect group term                                estimate std.error statistic
##      <chr>      <chr> <chr>                                <dbl>      <dbl>      <dbl>
## 1 fixed      <NA> (Intercept)                            4.50       0.121      37.2
## 2 fixed      <NA> log_age_at_wt_d                        0.485      0.0162     29.9
## 3 fixed      <NA> age_categoryIJ                         0.476      0.0350     13.6
## 4 fixed      <NA> age_categoryyoung_adult                0.311      0.0185     16.9
## 5 fixed      <NA> preg_statusP                           0.0838     0.00954      8.79
## 6 ran_pars name sd__(Intercept)                          1.94       NA         NA
## 7 ran_pars name cor__(Intercept).log_age_at_w~        -0.999     NA         NA
## 8 ran_pars name sd__log_age_at_wt_d                    0.267     NA         NA
## 9 ran_pars name.1 sd__(Intercept)                       0.223     NA         NA
## 10 ran_pars name.1 cor__(Intercept).age_category~      -0.348     NA         NA
## 11 ran_pars name.1 cor__(Intercept).age_category~      -0.811     NA         NA
## 12 ran_pars name.1 sd__age_categoryIJ                   0.496     NA         NA
## 13 ran_pars name.1 cor__age_categoryIJ.age_categ~       0.794     NA         NA
## 14 ran_pars name.1 sd__age_categoryyoung_adult          0.221     NA         NA
## 15 ran_pars Residual sd__Observation                    0.200     NA         NA
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model7: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d | name) + (age_
```

```
## model5: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_category
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model7    15 -3062.6 -2947.7 1546.3 -3092.6
```

```
## model5    16 -3322.9 -3200.4 1677.5 -3354.9 262.3  1 < 2.2e-16 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

stick with model 5 since it has lower AIC/BIC

```
## # A tibble: 16 x 6
##   effect      group      term      estimate std.error statistic
##   <chr>    <chr>    <chr>    <dbl>    <dbl>    <dbl>
## 1 fixed    <NA>    (Intercept)      4.50      0.134      33.5
## 2 fixed    <NA>    log_age_at_wt_d    0.480      0.0174     27.6
## 3 fixed    <NA>    age_categoryIJ     0.411      0.0378     10.9
## 4 fixed    <NA>    age_categoryyoung_adult 0.333      0.0184     18.1
## 5 fixed    <NA>    preg_statusP      0.0828     0.00953      8.69
## 6 ran_pars name    sd__(Intercept)    2.19      NA         NA
## 7 ran_pars name    cor__(Intercept).log_age_at_w~ -0.995      NA         NA
## 8 ran_pars name    cor__(Intercept).age_category~ -0.891      NA         NA
## 9 ran_pars name    cor__(Intercept).age_category~ -0.802      NA         NA
## 10 ran_pars name   sd_log_age_at_wt_d    0.285      NA         NA
## 11 ran_pars name   cor__log_age_at_wt_d.age_cate~ 0.894      NA         NA
## 12 ran_pars name   cor__log_age_at_wt_d.age_cate~ 0.757      NA         NA
## 13 ran_pars name   sd_age_categoryIJ     0.575      NA         NA
## 14 ran_pars name   cor__age_categoryIJ.age_categ~ 0.848      NA         NA
## 15 ran_pars name   sd_age_categoryyoung_adult 0.241      NA         NA
## 16 ran_pars Residual sd__Observation      0.200      NA         NA
```

Adding Level Two (lemur-specific) covariates

Level One:

$$\log(Y_{ij}) = a_i + b_i \log(\text{age})_{ij} + c_i \text{ageCategoryIJ}_{ij} + d_i \text{ageCategoryYoungAdult}_{ij} + e_i \text{pregStatusP}_{ij} + \epsilon_{ij}$$

—— u_i - intercept v_i - log(age) y_i - age_categoryIJ z_i - age_categoryYoungAdult

Level 2 potential covariates: sex, taxon, birth_institution, birth_type, n_known_offspring, infant_lit_sz_if_preg

only want categorical-quantitative interactions

Level Two:

intercept: taxon, sex, birth_type, infant_lit_sz_if_preg

log-age: taxon, birth_type

age_categoryIJ: infant_lit_sz_if_preg

age_categoryYoungAdult: birth_type, infant_lit_sz_if_preg

preg_status: none

$$a_i = \alpha_0 + \alpha_1 \text{taxonVRUB}_i + \alpha_2 \text{taxonVVV}_i + \alpha_3 \text{sexM}_i + \alpha_4 \text{birthTypeWB}_i + \alpha_5 \text{infantLitterSize}_i + u_i$$

$$b_i = \beta_0 + \beta_1 \text{taxonVRUB}_i + \beta_2 \text{taxonVVV}_i + \beta_3 \text{birthTypeWB}_i + v_i$$

$$c_i = \gamma_0 + \gamma_1 \text{infantLitterSize}_i + y_i$$

$$d_i = \psi_0 + \psi_1 \text{birthTypeWB}_i + \psi_2 \text{infantLitterSize}_i + z_i$$

$$e_i = \eta_0$$

Composite:

$$\begin{aligned}
\log(Y_{ij}) = & \alpha_0 + \alpha_1 \text{taxonVRUB}_i + \alpha_2 \text{taxonVVV}_i + \alpha_3 \text{sexM}_i + \alpha_4 \text{birthTypeWB}_i + \alpha_5 \text{infantLitterSize}_i \\
& + [\beta_0 + \beta_1 \text{taxonVRUB}_i + \beta_2 \text{taxonVVV}_i + \beta_3 \text{birthTypeWB}_i] \times \log(\text{age})_{ij} \\
& + [\gamma_0 + \gamma_1 \text{infantLitterSize}_i] \times \text{ageCategoryIJ}_{ij} \\
& + [\psi_0 + \psi_1 \text{birthTypeWB}_i + \psi_2 \text{infantLitterSize}_i] \times \text{ageCategoryYoungAdult}_{ij} \\
& + \eta_0 \text{pregStatusP}_{ij} \\
& + u_i + v_i \log(\text{age})_{ij} + y_i \text{ageCategoryIJ}_{ij} + z_i \text{ageCategoryYoungAdult}_{ij} + \epsilon_{ij}
\end{aligned}$$

Intercept

```
## # A tibble: 18 x 6
##   effect   group   term                estimate std.error statistic
##   <chr>   <chr>   <chr>                <dbl>    <dbl>    <dbl>
## 1 fixed   <NA>   (Intercept)          4.42     0.134     33.0
## 2 fixed   <NA>   taxonVRUB             0.0884   0.0211     4.20
## 3 fixed   <NA>   taxonVVV              0.0736   0.0244     3.01
## 4 fixed   <NA>   log_age_at_wt_d       0.483    0.0173    27.9
## 5 fixed   <NA>   age_categoryIJ        0.417    0.0375    11.1
## 6 fixed   <NA>   age_categoryyoung_adult 0.343    0.0186    18.4
## 7 fixed   <NA>   preg_statusP          0.0836   0.00953    8.78
## 8 ran_pars name    sd__(Intercept)       2.17     NA        NA
## 9 ran_pars name    cor__(Intercept).log_age_at_w~ -0.995   NA        NA
## 10 ran_pars name   cor__(Intercept).age_category~ -0.896   NA        NA
## 11 ran_pars name   cor__(Intercept).age_category~ -0.798   NA        NA
## 12 ran_pars name   sd__log_age_at_wt_d      0.283    NA        NA
## 13 ran_pars name   cor__log_age_at_wt_d.age_cate~ 0.897    NA        NA
## 14 ran_pars name   cor__log_age_at_wt_d.age_cate~ 0.750    NA        NA
## 15 ran_pars name   sd__age_categoryIJ       0.568    NA        NA
## 16 ran_pars name   cor__age_categoryIJ.age_categ~ 0.835    NA        NA
## 17 ran_pars name   sd__age_categoryyoung_adult 0.240    NA        NA
## 18 ran_pars Residual sd__Observation        0.200    NA        NA

## Data: lemurs3
## Models:
## model5: log_weight ~ log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_category
## model8: log_weight ~ taxon + log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_c
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
## model5    16 -3322.9 -3200.4 1677.5  -3354.9
## model8    18 -3335.5 -3197.6 1685.8  -3371.5 16.615  2  0.0002466 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 0.0002466 model8 > model5 (include taxon) model8 has lower AIC/BIC

```
## # A tibble: 19 x 6
##   effect   group   term                estimate std.error statistic
##   <chr>   <chr>   <chr>                <dbl>    <dbl>    <dbl>
## 1 fixed   <NA>   (Intercept)          4.45     0.135     33.1
## 2 fixed   <NA>   taxonVRUB             0.0856   0.0206     4.16
## 3 fixed   <NA>   taxonVVV              0.0815   0.0243     3.36
```

##	4	fixed	<NA>	sexM	-0.0498	0.0181	-2.75
##	5	fixed	<NA>	log_age_at_wt_d	0.483	0.0173	27.9
##	6	fixed	<NA>	age_categoryIJ	0.416	0.0375	11.1
##	7	fixed	<NA>	age_categoryyoung_adult	0.343	0.0186	18.4
##	8	fixed	<NA>	preg_statusP	0.0823	0.00953	8.64
##	9	ran_pars	name	sd__(Intercept)	2.17	NA	NA
##	10	ran_pars	name	cor__(Intercept).log_age_at_w~	-0.995	NA	NA
##	11	ran_pars	name	cor__(Intercept).age_category~	-0.897	NA	NA
##	12	ran_pars	name	cor__(Intercept).age_category~	-0.797	NA	NA
##	13	ran_pars	name	sd__log_age_at_wt_d	0.284	NA	NA
##	14	ran_pars	name	cor__log_age_at_wt_d.age_cate~	0.897	NA	NA
##	15	ran_pars	name	cor__log_age_at_wt_d.age_cate~	0.749	NA	NA
##	16	ran_pars	name	sd__age_categoryIJ	0.569	NA	NA
##	17	ran_pars	name	cor__age_categoryIJ.age_categ~	0.837	NA	NA
##	18	ran_pars	name	sd__age_categoryyoung_adult	0.240	NA	NA
##	19	ran_pars	Residual	sd__Observation	0.200	NA	NA

Data: lemurs3

Models:

model8: log_weight ~ taxon + log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d + age_c

model9: log_weight ~ taxon + sex + log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d +

	npar	AIC	BIC	logLik	deviance	Chisq	Df	Pr(>Chisq)
--	------	-----	-----	--------	----------	-------	----	------------

## model8	18	-3335.5	-3197.6	1685.8	-3371.5			
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## model9	19	-3340.7	-3195.2	1689.4	-3378.7	7.2201	1	0.007209 **
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Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

p-value: 0.007209 model9 > model8 (include taxon, sex) model9 has lower AIC/BIC

A tibble: 20 x 6

##	effect	group	term	estimate	std.error	statistic	
##	<chr>	<chr>	<chr>	<dbl>	<dbl>	<dbl>	
##	1	fixed	<NA>	(Intercept)	4.45	0.135	33.0
##	2	fixed	<NA>	taxonVRUB	0.0912	0.0208	4.39
##	3	fixed	<NA>	taxonVVV	0.0841	0.0242	3.48
##	4	fixed	<NA>	sexM	-0.0485	0.0181	-2.68
##	5	fixed	<NA>	birth_institutionOther	0.0237	0.0300	0.790
##	6	fixed	<NA>	log_age_at_wt_d	0.481	0.0175	27.6
##	7	fixed	<NA>	age_categoryIJ	0.415	0.0377	11.0
##	8	fixed	<NA>	age_categoryyoung_adult	0.343	0.0188	18.3
##	9	fixed	<NA>	preg_statusP	0.0823	0.00953	8.64
##	10	ran_pars	name	sd__(Intercept)	2.17	NA	NA
##	11	ran_pars	name	cor__(Intercept).log_age_at_w~	-0.995	NA	NA
##	12	ran_pars	name	cor__(Intercept).age_category~	-0.897	NA	NA
##	13	ran_pars	name	cor__(Intercept).age_category~	-0.797	NA	NA
##	14	ran_pars	name	sd__log_age_at_wt_d	0.285	NA	NA
##	15	ran_pars	name	cor__log_age_at_wt_d.age_cate~	0.898	NA	NA
##	16	ran_pars	name	cor__log_age_at_wt_d.age_cate~	0.748	NA	NA
##	17	ran_pars	name	sd__age_categoryIJ	0.571	NA	NA
##	18	ran_pars	name	cor__age_categoryIJ.age_categ~	0.836	NA	NA
##	19	ran_pars	name	sd__age_categoryyoung_adult	0.241	NA	NA
##	20	ran_pars	Residual	sd__Observation	0.200	NA	NA

Data: lemurs3


```
## Models:
## model9: log_weight ~ taxon + sex + log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d +
## model10: log_weight ~ taxon + sex + birth_institution + log_age_at_wt_d + age_category + preg_status
##      npar      AIC      BIC logLik deviance  Chisq Df Pr(>Chisq)
## model9      19 -3340.7 -3195.2 1689.4  -3378.7
## model10     20 -3339.1 -3185.9 1689.6  -3379.1 0.3897  1      0.5324
```

p-value: 0.5324 model9 > model10 (include taxon, sex) model9 has lower AIC/BIC

```
## # A tibble: 20 x 6
##   effect group term estimate std.error statistic
##   <chr> <chr> <chr>      <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept) 4.45      0.135      33.0
## 2 fixed <NA> taxonVRUB 0.103     0.0205     5.05
## 3 fixed <NA> taxonVVV 0.0982    0.0241     4.08
## 4 fixed <NA> sexM -0.0474   0.0179    -2.64
## 5 fixed <NA> birth_typeWB 0.128     0.0431     2.98
## 6 fixed <NA> log_age_at_wt_d 0.479     0.0176    27.3
## 7 fixed <NA> age_categoryIJ 0.408     0.0380    10.7
## 8 fixed <NA> age_categoryyoung_adult 0.342     0.0187    18.3
## 9 fixed <NA> preg_statusP 0.0825    0.00953    8.66
## 10 ran_pars name sd__(Intercept) 2.18      NA        NA
## 11 ran_pars name cor__(Intercept).log_age_at_w~ -0.995     NA        NA
## 12 ran_pars name cor__(Intercept).age_category~ -0.901     NA        NA
## 13 ran_pars name cor__(Intercept).age_category~ -0.797     NA        NA
## 14 ran_pars name sd__log_age_at_wt_d 0.288     NA        NA
## 15 ran_pars name cor__log_age_at_wt_d.age_cate~ 0.901     NA        NA
## 16 ran_pars name cor__log_age_at_wt_d.age_cate~ 0.747     NA        NA
## 17 ran_pars name sd__age_categoryIJ 0.576     NA        NA
## 18 ran_pars name cor__age_categoryIJ.age_categ~ 0.831     NA        NA
## 19 ran_pars name sd__age_categoryyoung_adult 0.241     NA        NA
## 20 ran_pars Residual sd__Observation 0.200     NA        NA
```

Data: lemurs3

```
## Models:
## model9: log_weight ~ taxon + sex + log_age_at_wt_d + age_category + preg_status + (log_age_at_wt_d +
## model11: log_weight ~ taxon + sex + birth_type + log_age_at_wt_d + age_category + preg_status + (log
##      npar      AIC      BIC logLik deviance  Chisq Df Pr(>Chisq)
## model9      19 -3340.7 -3195.2 1689.4  -3378.7
## model11     20 -3344.8 -3191.6 1692.4  -3384.8 6.0116  1      0.01421 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 0.0142 model11 > model9 (include taxon, sex, birth_type) model11 has lower AIC/BIC

```
## # A tibble: 21 x 6
##   effect group term estimate std.error statistic
##   <chr> <chr> <chr>      <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept) 4.44      0.135      32.9
## 2 fixed <NA> taxonVRUB 0.111     0.0206     5.40
## 3 fixed <NA> taxonVVV 0.106     0.0242     4.38
## 4 fixed <NA> sexM -0.0469   0.0179    -2.62
## 5 fixed <NA> birth_typeWB 0.133     0.0446     2.97
```

```
## 6 fixed <NA> n_known_offspring      0.00286    0.00183      1.56
## 7 fixed <NA> log_age_at_wt_d         0.479      0.0176     27.2
## 8 fixed <NA> age_categoryIJ          0.409      0.0379     10.8
## 9 fixed <NA> age_categoryyoung_adult 0.341      0.0188     18.2
## 10 fixed <NA> preg_statusP           0.0819     0.00953      8.59
## # ... with 11 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model11: log_weight ~ taxon + sex + birth_type + log_age_at_wt_d + age_category + preg_status + (log
```

```
## model12: log_weight ~ taxon + sex + birth_type + n_known_offspring + log_age_at_wt_d + age_category +
```

```
##          npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model11    20 -3344.8 -3191.6 1692.4 -3384.8
```

```
## model12    21 -3344.6 -3183.7 1693.3 -3386.6 1.8044 1 0.1792
```

p-value: 0.1792 model11 > model12 (include taxon, sex, birth_type) model11 has lower AIC/BIC

```
## # A tibble: 21 x 6
```

```
##   effect group term                estimate std.error statistic
##   <chr> <chr> <chr>                <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept)          4.44        0.134       33.0
## 2 fixed <NA> taxonVRUB             0.100       0.0206        4.86
## 3 fixed <NA> taxonVVV              0.0943      0.0242        3.90
## 4 fixed <NA> sexM                  -0.0462     0.0180       -2.57
## 5 fixed <NA> birth_typeWB           0.124       0.0432        2.86
## 6 fixed <NA> infant_lit_sz_if_preg  0.0825     0.0149        5.52
## 7 fixed <NA> log_age_at_wt_d        0.481      0.0175       27.5
## 8 fixed <NA> age_categoryIJ         0.412      0.0378       10.9
## 9 fixed <NA> age_categoryyoung_adult 0.344      0.0187       18.4
## 10 fixed <NA> preg_statusP          -0.0200     0.0209       -0.956
## # ... with 11 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model11: log_weight ~ taxon + sex + birth_type + log_age_at_wt_d + age_category + preg_status + (log
```

```
## model13: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##          npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model11    20 -3344.8 -3191.6 1692.4 -3384.8
```

```
## model13    21 -3373.1 -3212.3 1707.6 -3415.1 30.382 1 3.548e-08 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 0.007209 model13 > model11 (include taxon, sex, birth_type, infant_lit_sz_if_preg) model13 has lower AIC/BIC

Log-Age

```
## # A tibble: 23 x 6
```

```
##   effect group term                estimate std.error statistic
##   <chr> <chr> <chr>                <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept)          3.69        0.144       25.6
```

```
## 2 fixed <NA> taxonVRUB          1.24      0.124      10.0
## 3 fixed <NA> taxonVVV           1.27      0.143       8.87
## 4 fixed <NA> sexM              -0.0480     0.0178     -2.70
## 5 fixed <NA> birth_typeWB       0.155     0.0424       3.66
## 6 fixed <NA> infant_lit_sz_if_preg 0.0852     0.0150       5.70
## 7 fixed <NA> log_age_at_wt_d     0.584     0.0191      30.6
## 8 fixed <NA> age_categoryIJ      0.409     0.0394      10.4
## 9 fixed <NA> age_categoryyoung_adult 0.344     0.0188      18.3
## 10 fixed <NA> preg_statusP      -0.0240     0.0209     -1.15
## # ... with 13 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model13: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model14: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model13    21 -3373.1 -3212.3 1707.6 -3415.1
```

```
## model14    23 -3452.2 -3276.0 1749.1 -3498.2 83.05  2 < 2.2e-16 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: < 2.2e-16 model14 > model13 (include taxon) model14 has lower AIC/BIC

```
## # A tibble: 24 x 6
```

```
##   effect group term          estimate std.error statistic
##   <chr>  <chr> <chr>          <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept)      3.65      0.152      23.9
## 2 fixed <NA> taxonVRUB         1.24      0.123      10.1
## 3 fixed <NA> taxonVVV          1.25      0.143       8.73
## 4 fixed <NA> sexM              0.0398     0.109       0.365
## 5 fixed <NA> birth_typeWB       0.155     0.0425       3.65
## 6 fixed <NA> infant_lit_sz_if_preg 0.0852     0.0150       5.70
## 7 fixed <NA> log_age_at_wt_d     0.589     0.0203      29.1
## 8 fixed <NA> age_categoryIJ      0.409     0.0393      10.4
## 9 fixed <NA> age_categoryyoung_adult 0.344     0.0188      18.3
## 10 fixed <NA> preg_statusP      -0.0241     0.0209     -1.16
## # ... with 14 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model14: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model15: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model14    23 -3452.2 -3276 1749.1 -3498.2
```

```
## model15    24 -3450.8 -3267 1749.4 -3498.8 0.6544  1    0.4186
```

p-value: 0.4186 model14 > model15 (include taxon) model14 has lower AIC/BIC

```
## # A tibble: 24 x 6
```

```
##   effect group term          estimate std.error statistic
##   <chr>  <chr> <chr>          <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept)      3.37      0.127      26.5
```

```
## 2 fixed <NA> taxonVRUB          1.33      0.115      11.6
## 3 fixed <NA> taxonVVV           1.30      0.131       9.95
## 4 fixed <NA> sexM              -0.0507     0.0175     -2.89
## 5 fixed <NA> birth_typeWB       4.09      0.345      11.8
## 6 fixed <NA> infant_lit_sz_if_preg 0.0853     0.0149      5.70
## 7 fixed <NA> log_age_at_wt_d     0.628     0.0168     37.3
## 8 fixed <NA> age_categoryIJ      0.464     0.0372     12.5
## 9 fixed <NA> age_categoryyoung_adult 0.346     0.0197     17.6
## 10 fixed <NA> preg_statusP      -0.0222     0.0209     -1.07
## # ... with 14 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model14: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model16: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##          npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model14    23 -3452.2 -3276.0 1749.1 -3498.2
```

```
## model16    24 -3556.6 -3372.8 1802.3 -3604.6 106.41  1 < 2.2e-16 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: < 2.2e-16 model16 > model14 (include taxon, birth_type) model16 has lower AIC/BIC

Age_category

```
## # A tibble: 28 x 6
```

```
##   effect group term          estimate std.error statistic
##   <chr>  <chr> <chr>          <dbl>      <dbl>      <dbl>
## 1 fixed <NA> (Intercept)      3.43      0.173      19.8
## 2 fixed <NA> taxonVRUB         1.35      0.254       5.32
## 3 fixed <NA> taxonVVV          1.04      0.277       3.77
## 4 fixed <NA> sexM             -0.0494     0.0176     -2.81
## 5 fixed <NA> birth_typeWB       4.01      0.345      11.6
## 6 fixed <NA> infant_lit_sz_if_preg 0.0856     0.0149      5.72
## 7 fixed <NA> log_age_at_wt_d     0.617     0.0226     27.3
## 8 fixed <NA> age_categoryIJ      0.452     0.0579      7.81
## 9 fixed <NA> age_categoryyoung_adult 0.358     0.0309     11.6
## 10 fixed <NA> preg_statusP      -0.0225     0.0209     -1.08
## # ... with 18 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model16: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model17: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##          npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model16    24 -3556.6 -3372.8 1802.3 -3604.6
```

```
## model17    28 -3551.9 -3337.5 1804.0 -3607.9 3.3342  4    0.5035
```

p-value: 0.5035 model16 > model17 model16 has lower AIC/BIC

```
## # A tibble: 26 x 6
```

```
##      effect group term                estimate std.error statistic
##      <chr>  <chr> <chr>                <dbl>    <dbl>    <dbl>
##  1 fixed  <NA> (Intercept)                3.37      0.127      26.4
##  2 fixed  <NA> taxonVRUB                    1.32      0.114      11.6
##  3 fixed  <NA> taxonVVV                     1.28      0.131       9.78
##  4 fixed  <NA> sexM                       -0.0468     0.0311     -1.51
##  5 fixed  <NA> birth_typeWB                 4.09      0.345      11.8
##  6 fixed  <NA> infant_lit_sz_if_preg        0.0853     0.0149       5.71
##  7 fixed  <NA> log_age_at_wt_d              0.627     0.0168      37.3
##  8 fixed  <NA> age_categoryIJ              0.447     0.0423      10.6
##  9 fixed  <NA> age_categoryyoung_adult      0.345     0.0256      13.5
## 10 fixed  <NA> preg_statusP                -0.0226     0.0209     -1.08
## # ... with 16 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model16: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model18: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model16    24 -3556.6 -3372.8 1802.3 -3604.6
```

```
## model18    26 -3554.5 -3355.3 1803.2 -3606.5 1.8624  2    0.3941
```

p-value: 0.3941 model16 > model18 model16 has lower AIC/BIC

```
## # A tibble: 25 x 6
```

```
##      effect group term                estimate std.error statistic
##      <chr>  <chr> <chr>                <dbl>    <dbl>    <dbl>
##  1 fixed  <NA> (Intercept)                3.31      0.126      26.2
##  2 fixed  <NA> taxonVRUB                    1.28      0.114      11.2
##  3 fixed  <NA> taxonVVV                     1.27      0.131       9.69
##  4 fixed  <NA> sexM                       -0.0496     0.0174     -2.85
##  5 fixed  <NA> birth_typeWB                 5.35      0.463      11.6
##  6 fixed  <NA> infant_lit_sz_if_preg        0.0851     0.0149       5.70
##  7 fixed  <NA> log_age_at_wt_d              0.634     0.0167      38.0
##  8 fixed  <NA> age_categoryIJ              0.498     0.0368      13.5
##  9 fixed  <NA> age_categoryyoung_adult      0.367     0.0193      19.0
## 10 fixed  <NA> preg_statusP                -0.0226     0.0209     -1.08
## # ... with 15 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model16: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
## model19: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model16    24 -3556.6 -3372.8 1802.3 -3604.6
```

```
## model19    25 -3571.7 -3380.2 1810.8 -3621.7 17.079  1 3.585e-05 ***
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 3.585e-05 model19 > model16 (include birth_type) model19 has lower AIC/BIC

```
## # A tibble: 27 x 6
```

```
##      effect group term                estimate std.error statistic
##      <chr>  <chr> <chr>                <dbl>    <dbl>    <dbl>
##  1 fixed  <NA> (Intercept)              3.31      0.126     26.3
##  2 fixed  <NA> taxonVRUB                  1.28      0.114     11.2
##  3 fixed  <NA> taxonVVV                   1.27      0.131      9.72
##  4 fixed  <NA> sexM                      -0.0534    0.0175    -3.06
##  5 fixed  <NA> birth_typeWB              5.36      0.463     11.6
##  6 fixed  <NA> infant_lit_sz_if_preg     0.0865    0.0150      5.78
##  7 fixed  <NA> log_age_at_wt_d           0.634     0.0166    38.1
##  8 fixed  <NA> age_categoryIJ            0.500     0.0367    13.6
##  9 fixed  <NA> age_categoryyoung_adult   0.371     0.0193    19.2
## 10 fixed  <NA> preg_statusP             -0.0154    0.0210    -0.733
## # ... with 17 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model19: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_category
```

```
## model20: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_category
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model19    25 -3571.7 -3380.2 1810.8 -3621.7
```

```
## model20    27 -3574.0 -3367.2 1814.0 -3628.0 6.3307  2    0.0422 *
```

```
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

p-value: 0.0422 model20 > model19 (include birth_type, infant_lit_sz_if_preg) model20 has lower AIC/BIC

Preg_status

```
## # A tibble: 29 x 6
```

```
##      effect group term                estimate std.error statistic
##      <chr>  <chr> <chr>                <dbl>    <dbl>    <dbl>
##  1 fixed  <NA> (Intercept)              3.31      0.126     26.2
##  2 fixed  <NA> taxonVRUB                  1.28      0.114     11.2
##  3 fixed  <NA> taxonVVV                   1.27      0.131      9.72
##  4 fixed  <NA> sexM                      -0.0530    0.0175    -3.03
##  5 fixed  <NA> birth_typeWB              5.35      0.463     11.6
##  6 fixed  <NA> infant_lit_sz_if_preg     0.0667    0.0205      3.25
##  7 fixed  <NA> log_age_at_wt_d           0.635     0.0166    38.1
##  8 fixed  <NA> age_categoryIJ            0.500     0.0367    13.6
##  9 fixed  <NA> age_categoryyoung_adult   0.370     0.0193    19.2
## 10 fixed  <NA> preg_statusP             -0.000998  0.0234    -0.0427
## # ... with 19 more rows
```

```
## Data: lemurs3
```

```
## Models:
```

```
## model20: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_category
```

```
## model21: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_category
```

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model20    27 -3574.0 -3367.2 1814 -3628.0
```

```
## model21    29 -3572.1 -3349.9 1815 -3630.1 2.0653  2    0.3561
```

p-value: 0.3561 model20 > model21 model20 has lower AIC/BIC

```
## # A tibble: 28 x 6
##   effect group term                estimate std.error statistic
##   <chr>   <chr> <chr>                <dbl>     <dbl>     <dbl>
## 1 fixed  <NA> (Intercept)          3.31      0.126      26.3
## 2 fixed  <NA> taxonVRUB          1.28      0.114      11.2
## 3 fixed  <NA> taxonVVV          1.27      0.131      9.72
## 4 fixed  <NA> sexM            -0.0535    0.0175     -3.06
## 5 fixed  <NA> birth_typeWB       5.36      0.463      11.6
## 6 fixed  <NA> infant_lit_sz_if_preg 0.0859    0.0150      5.73
## 7 fixed  <NA> log_age_at_wt_d       0.634     0.0166     38.2
## 8 fixed  <NA> age_categoryIJ        0.501     0.0367     13.6
## 9 fixed  <NA> age_categoryyoung_adult 0.371     0.0193     19.2
## 10 fixed <NA> preg_statusP        -0.0111    0.0219     -0.508
## # ... with 18 more rows
```

Data: lemurs3

Models:

model20: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ

model22: log_weight ~ taxon + sex + birth_type + infant_lit_sz_if_preg + log_age_at_wt_d + age_categ

```
##      npar      AIC      BIC logLik deviance Chisq Df Pr(>Chisq)
```

```
## model20    27 -3574.0 -3367.2 1814.0  -3628.0
```

```
## model22    28 -3572.5 -3358.0 1814.3  -3628.5 0.5091  1    0.4755
```

p-value: 0.4755 model20 > model22 model20 has lower AIC/BIC