Case study:
Brown Fat

STAC51 Final Project
Group 1

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INTRODUCTION

Brown fat, also known as the brown adipose tissues (BAT) is an unfamiliar term for humans but it is widely existing in animals of all kinds.

Unlike regular fat which functions as energy storage, brown fat mainly contributes to the thermogenesis process to help animals resist extremely cold weather without any external help.

– The Revenant

INTRODUCTION

Brown fat, also known as the brown adipose tissues (BAT) is an unfamiliar term for humans but it is widely existing in animals of all kinds.
Unlike regular fat which functions as energy storage, brown fat mainly contributes to the thermogenesis process to help animals resist extremely cold weather without any external help.

The functional importance of Brown fat in newborn humans and small rodents have long been appreciated, but the existence of brown fat in human adults seems redundant and unnecessary .

However, growing evidence advocated a potential role for brown adipose tissue in cancer growth and progression .

STUDY OBJECTIVES

relationship between each of the covariates and the presence and volume of brown fat

Gender

Age

Body temperature, external temperature, body size, body mass index

Cancer status. Glycemia, lean body weight

METHODOLOGY

Data Overview

The data is provided by Molecular Imaging Center at The University of Sherbrooke and it has a very large sample size of 4843 for the analysis of 10 factors that will potentially impact the existence and volume of the brown fat

The average age of the subjects in this data set is 62.17, most of them are seniors. Also, the data are consist of a large cohort of cancer patients.

Better choice?

METHODOLOGY

Data Overview

Since we are investigating the existence and volume of brown fat in normal human, so a better choice of data would be those instances that are not restrict to cancer status.

RESULTS ANALYSIS R

```
#
##        Female Male
##   No     2125 2389
##   Yes     245   83
```

This table is the relationship between sex and the presence of brown fat. From the table the observed odds ratio of brown fat(No, Yes) and sex(Female, Male) is 0.30, The observed probability of presence of brown fat among males is 0.30 times of the observed probability of presence of brown fat among females

```
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table.sex
## X-squared = 92.243, df = 1, p-value < 2.2e-16
```

From the Pearson Chi-squared test of independent of the presence of Brown Fat and sex, the p-value is 2.2x10-16, so we reject the null hypothesis. Which implies that the presence of brown fat is dependent on sex..

RESULTS ANALYSIS R

```
##
##      Diabetes_No Diabetes_Yes
##  No         3991          523
##  Yes         322            6
```

The observed odds ratio of presence of brown fat(No, Yes) and Diabetes(No, Yes) from this table is 0.14, which implies that the presence of brown fat can restrain the presence of diabetes.

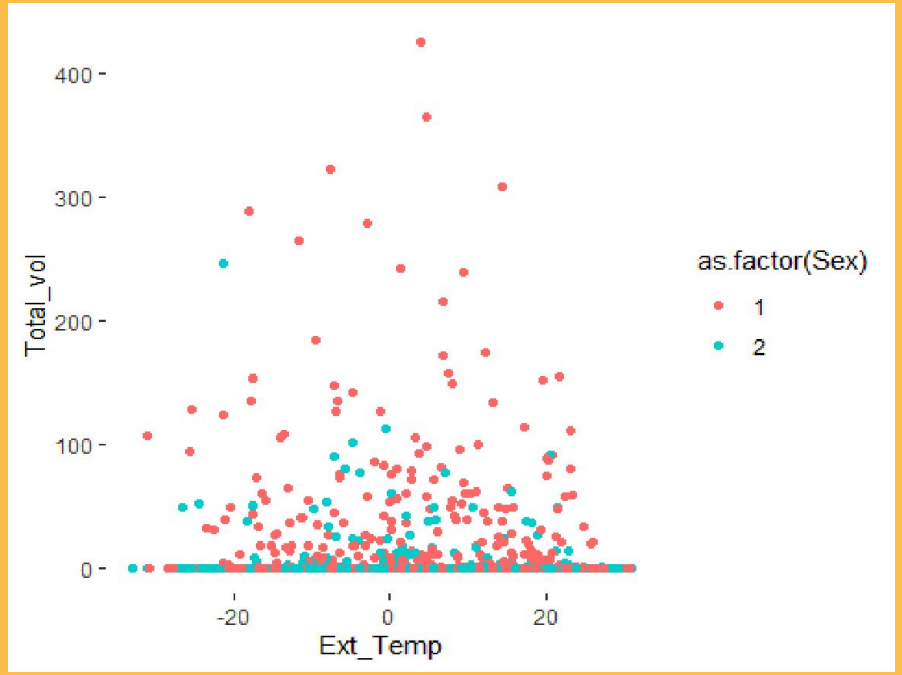
RESULTS ANALYSIS R

```
##
##       Cancer_NO Cancer_YES
##   No       1804       2473
##   Yes       143        172

##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  table.cancer_status
## X-squared = 1.1156, df = 1, p-value = 0.2909
```

This is a Pearson Chi-squared test of independent on presence of brown fat and presence of cancer. From the test we got an p-value of 0.2909, thus we cannot reject the null hypothesis, so there is no significant evidence that the presence of brown fat is dependent to cancer status...

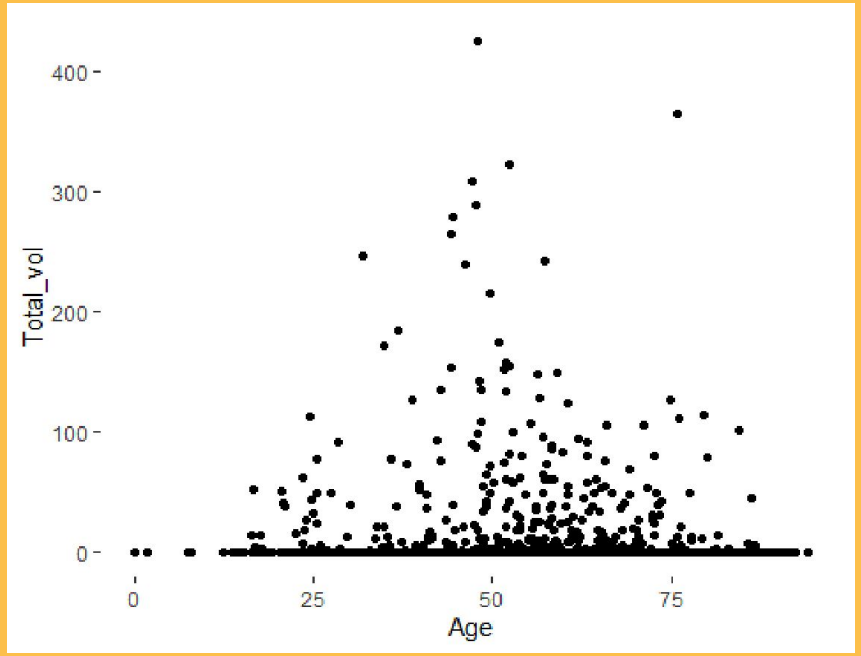
RESULTS ANALYSIS PLOTS



Red: Female
Blue: Male

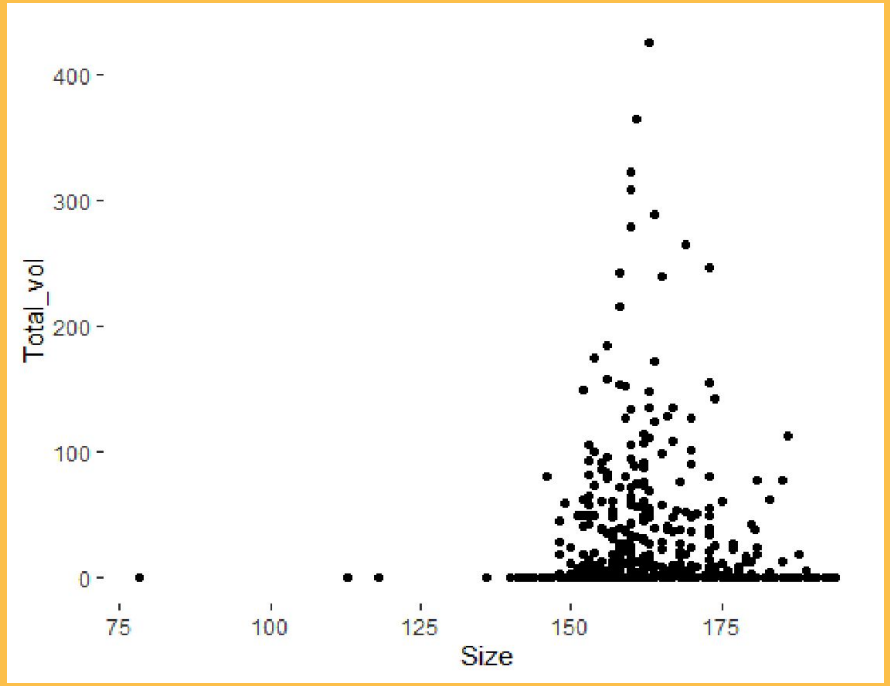
From the plot, females generally have a higher total volume of brown fat compare to males. In addition, regardless of sex, individuals tend to have higher volume of brown fat if the external temperature is close to 0.

RESULTS ANALYSIS PLOTS



From the plot, individuals tend to have higher total volume of brown fat if age is close to 50.

RESULTS ANALYSIS PLOTS



From the plot, we can see that the presence of brown fat in size group 75-137.5 (cm) is 0, the reason for this could be the size is related to the age, and from the plot of the age, if the age is relatively small, the chance of having brown fat is very low..

Model Selection

```
step(bfat.presence, direction = "backward", test="Chisq")
```

We did a model selection using the backward selection process. The model selected with the backward elimination is a model with Sex, Diabetes, Age, Ext_Temp, 2D_temp, 3D_temp, 1M_temp, Season, Duration_Sunshine, Weight and LBW.

```
# this is the selected model by backward elimination.
bfat.presence.selected = glm(formula = BrownFat ~ Sex + Diabetes + Age +
Ext_Temp + bfat$"2D_Temp" +
    bfat$"3D_Temp" + bfat$"1M_Temp" + Season + Duration_Sunshine +
    Weigth + LBW, family = binomial, data = bfat)
summary(bfat.presence.selected)

##
## Call:
## glm(formula = BrownFat ~ Sex + Diabetes + Age + Ext_Temp + bfat
$"2D_Temp" +
##     bfat$"3D_Temp" + bfat$"1M_Temp" + Season + Duration_Sunshine +
##     Weigth + LBW, family = binomial, data = bfat)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.4163  -0.4055  -0.2732  -0.1852   3.0654
##
## Coefficients:
##                      Estimate Std. Error z value Pr(>|z|)
## (Intercept)         3.4493108  0.8626662   3.998 6.38e-05 ***
## Sex                -1.3622380  0.2271493  -5.997 2.01e-09 ***
## Diabetes           -1.4754791  0.4204392  -3.509 0.000449 ***
## Age                -0.0368583  0.0040038  -9.206  < 2e-16 ***
## Ext_Temp           -0.0544046  0.0140153  -3.882 0.000104 ***
## bfat$"2D_Temp"      0.1344775  0.0421971   3.187 0.001438 **
## bfat$"3D_Temp"     -0.1218486  0.0409110  -2.978 0.002898 **
## bfat$"1M_Temp"      0.0281003  0.0166283   1.690 0.091046 .
## Season             -0.1792388  0.0848203  -2.113 0.034587 *
## Duration_Sunshine -0.0013346  0.0008498  -1.570 0.116316
## Weigth             -0.0377656  0.0087227  -4.330 1.49e-05 ***
## LBW                 0.0448701  0.0192479   2.331 0.019744 *
## ---
```

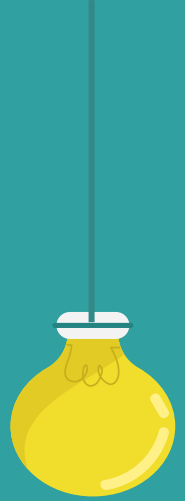
CONCLUSIONS

In conclusion, the covariates that significantly affect the presence of brown fat is Diabetes, Age, Ext_Temp, 2D_Temp, 3D_Temp, 1M_Temp, Season, Duration_Sunshine, Weight, and LBW.

The model that we should use to estimate the probability of having brown fat should include the following covariates: Diabetes, Age, Ext_Temp, 2D_Temp, 3D_Temp, 1M_Temp, Season, Duration_Sunshine, Weight, and LBW.

In addition, differences in sex, external temperature, age, and size have an impact on the total volume of brown fat.

BIBLIOGRAPHY



- **Bakhshayeshkaram, M., Aghahosseini, F., Dehghani, Z., Doroudinia, A., Hassanzad, M., Ansari, M., & Jamaati, H. R. (2018).** *Brown adipose tissue at F-18 FDG PET/CT: Correlation of metabolic parameter with demographics and cancer-related characteristics in cancer patients.* Iranian Journal of Radiology, 15(3) doi:http://dx.doi.org/10.5812/iranjradiol.56074.

THANKS

Does anyone have any questions?