Data Science Project Examining Identity Theft with the 2016 Identity Theft Supplement of the National Crime Victimization Survey

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Executive Summary

Data analysis was conducted to see if certain predictor variables were associated with past year identity theft. The data used in this analysis came from the 2016 Identity Theft Supplement (ITS) to the National Crime Victimization Survey (NCVS). The results of this analysis found that identity theft was dependent on the majority of the predictors used (age, race/Hispanic origin, annual household income, being a victim of identity theft prior to the past year, having personal information exposed due to a data breach, and using preventative behaviors). Gender was found to be independent of past year identity theft.A logistic regression model predicting past year identity theft was trained on the data. All predictors were used, except for sex.

```
#adding libraries
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(ggplot2)
library(ggthemes)
library(caret)
```

```
## Loading required package: lattice
```

```
library(car)
```

```
## Loading required package: carData
```

```
##
## Attaching package: 'car'

## The following object is masked from 'package:dplyr':
##
##     recode
```

Loading Data

Data were downloaded from the 2016 ITS study page from the National Archives of Criminal Justice Data to a subfolder entitled "data" in the project on R-Studio, unzipped, loaded into R-Studio and renamed with a shorter name. Due to the size of the datafile, the memory limit had to be increased prior to loading the data in R-Studio.

```
## [1] 20000
```

Data Wrangling

There were 125,165 total persons in the 2016 ITS. Only completed telephone and personal interviews were used in the analysis which left 96,130 interviews or observations in the dataset.

```
##                          Number
## (1) Personal interview    57119
## (2) Telephone interview   39011
## (5) ITS Noninterview      29035
## Total                    125165
```

```
##                          Number
## (1) Personal interview    57119
## (2) Telephone interview   39011
## (5) ITS Noninterview          0
## Total                     96130
```

Created variables that would be used in analysis from the larger ITS dataset.

Individual variables creatd in the previous step were combined into a smaller dataset and larger dataset was removed.

Summary of the created dataset.

```
## 'data.frame':    96130 obs. of  22 variables:
##  $ sex                 : Factor w/ 3 levels "(1) Male","(2) Female",..: 2 1 1 1 1 2 1 1 2 2 ...
##  $ race                : Factor w/ 21 levels "(01) White only",..: 1 2 6 1 1 1 1 1 1 1 ...
##  $ hispanic            : Factor w/ 3 levels "(1) Yes","(2) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ income              : Factor w/ 14 levels "(01) Less than $5,000",..: 14 14 14 14 4 13 13 13 13 1
##  $ age                 : num  46 50 22 78 50 30 29 62 60 74 ...
##  $ pastyearbankacct    : Factor w/ 5 levels "(01) Yes","(02) No",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ existing_bank       : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ currentccacct       : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 1 1 1 1 2 1 1 ...
##  $ pastyearccacct      : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 NA NA NA NA 2 NA NA ...
##  $ existing_credit_card: Factor w/ 5 levels "(01) Yes","(02) No",..: NA NA NA 2 2 2 2 NA 2 2 ...
```

```
##  $ other_existing_accts: Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ open_new_acct       : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ personal_info       : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ OUTSIDE_PAST_YEAR   : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 1 2 2 1 2 2 2 2 ...
##  $ CHCKD_CR_PAST_YR    : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 1 2 2 1 1 2 2 1 ...
##  $ CHNG_PASSWORDS      : Factor w/ 5 levels "(01) Yes","(02) No",..: 1 1 2 2 2 1 1 2 2 2 ...
##  $ PURCHASE_IDTHFT_INS : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ SHRED_DOCS          : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 1 1 1 1 1 1 1 2 ...
##  $ VERIFY_CHARGES      : Factor w/ 5 levels "(01) Yes","(02) No",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ PROTECT_COMPUTER    : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ PURCHASE_IDTHFT_PROT: Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ notify_breach       : Factor w/ 5 levels "(01) Yes","(02) No",..: 2 2 2 2 2 2 2 2 2 2 ...

##           sex                                  race              hispanic
##  (1) Male   :44908   (01) White only           :79770   (1) Yes    :12131
##  (2) Female :51222   (02) Black only           :10051   (2) No     :83999
##  (8) Residue:    0   (04) Asian only           : 4160   (8) Residue:    0
##                      (03) Am Ind/AK native only:  656
##                      (07) White-Amer Ind       :  530
##                      (06) White-Black          :  304
##                      (Other)                   :  659
##                      income           age              pastyearbankacct
##  (14) $75,000 and over  :33662   Min.   :16.00   (01) Yes       :85793
##  (13) $50,000 to $74,999:17342   1st Qu.:34.00   (02) No        :10337
##  (12) $40,000 to $49,999: 9330   Median :50.00   (08) Residue   :    0
##  (10) $30,000 to $34,999: 5811   Mean   :49.26   (98) Refused   :    0
##  (11) $35,000 to $39,999: 5316   3rd Qu.:63.00   (99) Don't know:    0
##  (08) $20,000 to $24,999: 5137   Max.   :90.00
##  (Other)                :19532
##          existing_bank           currentccacct           pastyearccacct
##  (01) Yes       : 4665   (01) Yes       :69446   (01) Yes       : 1003
##  (02) No        :81128   (02) No        :26670   (02) No        :25681
##  (08) Residue   :    0   (08) Residue   :    0   (08) Residue   :    0
##  (98) Refused   :    0   (98) Refused   :   10   (98) Refused   :    0
##  (99) Don't know:    0   (99) Don't know:    4   (99) Don't know:    0
##  NA's           :10337                           NA's           :69446
##
##       existing_credit_card      other_existing_accts         open_new_acct
##  (01) Yes       : 5460     (01) Yes       :  815     (01) Yes       :  589
##  (02) No        :64989     (02) No        :95315     (02) No        :95541
##  (08) Residue   :    0     (08) Residue   :    0     (08) Residue   :    0
##  (98) Refused   :    0     (98) Refused   :    0     (98) Refused   :    0
##  (99) Don't know:    0     (99) Don't know:    0     (99) Don't know:    0
##  NA's           :25681
##
##          personal_info         OUTSIDE_PAST_YEAR        CHCKD_CR_PAST_YR
##  (01) Yes       :  473   (01) Yes       :12267   (01) Yes       :44385
##  (02) No        :95657   (02) No        :83692   (02) No        :51344
##  (08) Residue   :    0   (08) Residue   :   48   (08) Residue   :   80
##  (98) Refused   :    0   (98) Refused   :   39   (98) Refused   :  158
##  (99) Don't know:    0   (99) Don't know:   84   (99) Don't know:  163
##
##
##          CHNG_PASSWORDS       PURCHASE_IDTHFT_INS           SHRED_DOCS
```

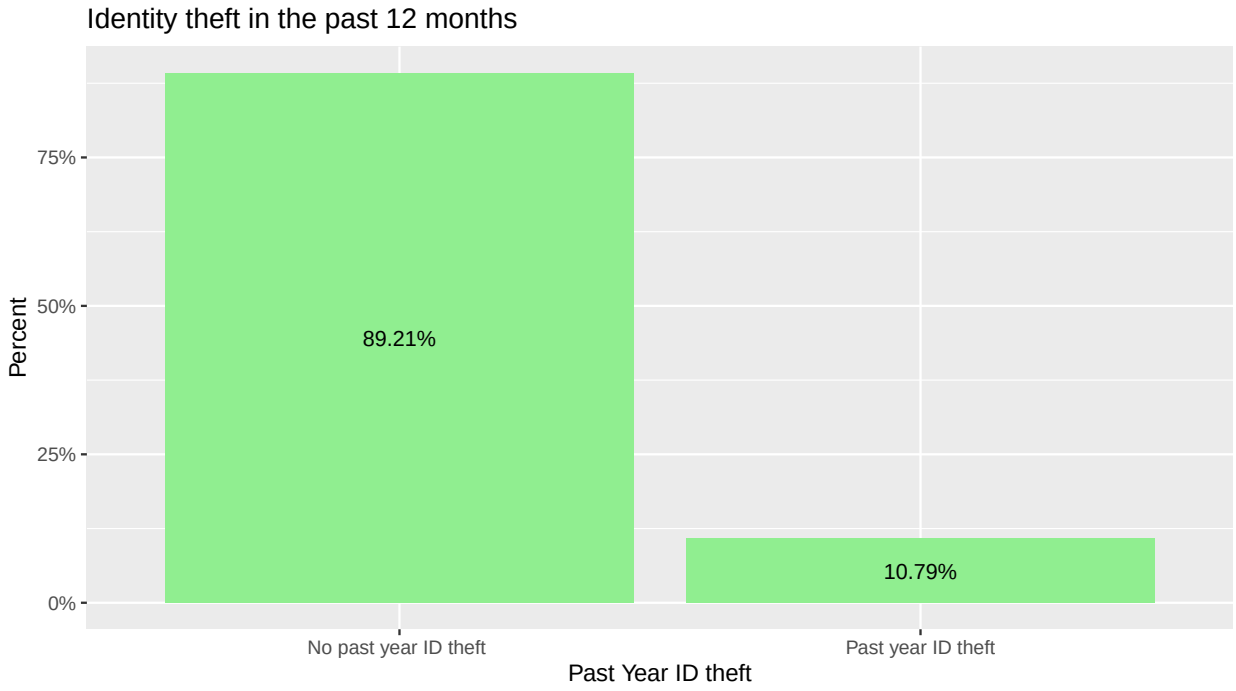
```
##  (01) Yes       :36861   (01) Yes       :12149    (01) Yes       :67772
##  (02) No        :58670   (02) No        :83440    (02) No        :27942
##  (08) Residue   :   88   (08) Residue   :   88    (08) Residue   :   92
##  (98) Refused   :  250   (98) Refused   :  193    (98) Refused   :  196
##  (99) Don't know:  261   (99) Don't know:  260    (99) Don't know:  128
##
##
##          VERIFY_CHARGES         PROTECT_COMPUTER      PURCHASE_IDTHFT_PROT
##  (01) Yes       :75419   (01) Yes       :16447   (01) Yes       : 4881
##  (02) No        :20344   (02) No        :79001   (02) No        :90756
##  (08) Residue   :   94   (08) Residue   :  100   (08) Residue   :  100
##  (98) Refused   :  180   (98) Refused   :  209   (98) Refused   :  217
##  (99) Don't know:   93   (99) Don't know:  373   (99) Don't know:  176
##
##
##          notify_breach
##  (01) Yes       :11037
##  (02) No        :84652
##  (08) Residue   :  102
##  (98) Refused   :  179
##  (99) Don't know:  160
##
##
```

Recoded variables, collapsing categories and computing necessary categories and variables for analysis.

Exploratory analysis

Past year identity theft

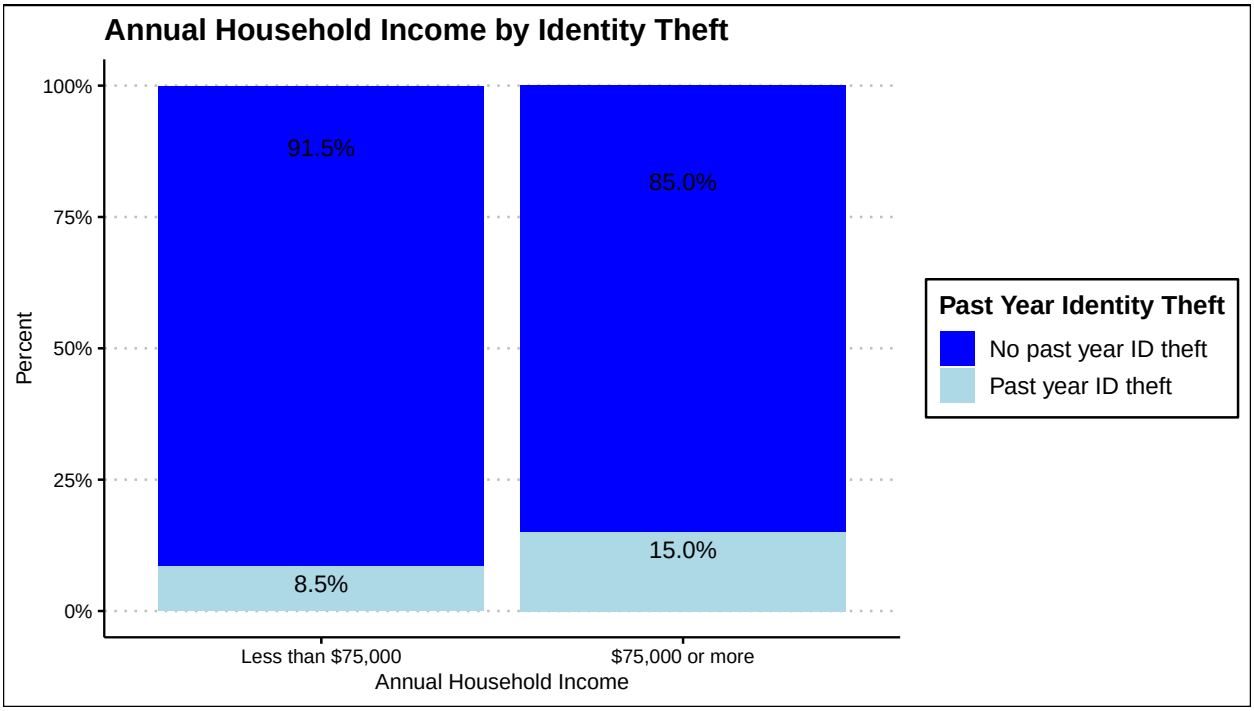
About 11% of the sample reported at least one type of identity theft (misuse of an existing account, misuse of personal information to open new account, or misuse of personal information for other fraudulent purposes) in the past year while 89% of the sample reported no identity theft.



Annual household income

About two thirds of the sample were in households with annual incomes of less than $75,000 (65%) while the remainder (35%) were in households with annual incomes of at least $75,000. Within each income category the majority of respondents did not report experiencing identity theft in the past year. However, 15% of persons in households with incomes of $75,000 or more reported past year identity theft, compared to 9% of those in other households.

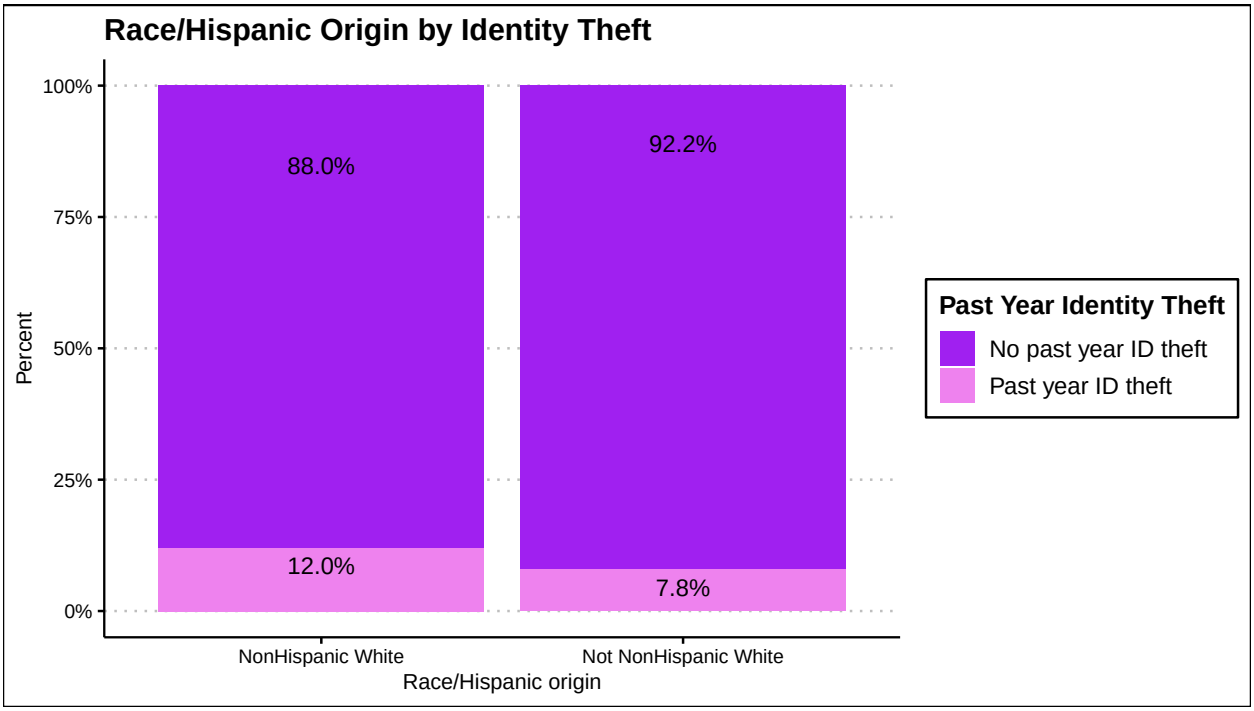
```
##                    Count Percentage
## Total              96130        100
## Less than $75,000 62468         65
## $75,000 or more   33662         35
```



Race/Hispanic origin

Seventy one percent of respondents were NonHispanic White while 29% were belonged to other race/Hispanic origin groups. Twelve percent of nonHispanic Whites reported past year identity theft compared to 8% of other persons reported identity theft in the past year.

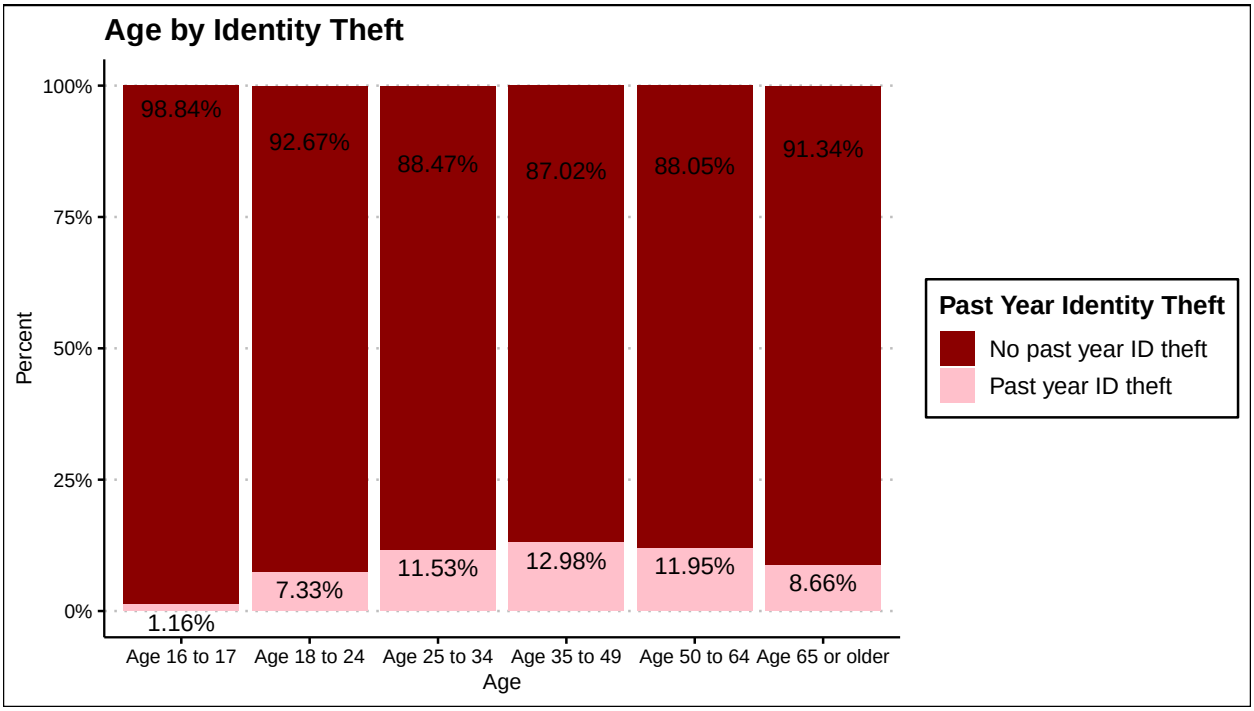
```
##                       Count Percentage
## Total                 96130        100
## NonHispanic White     68265         71
## Not NonHispanic White 27865         29
```



Age

Twenty eight percent of the sample was age 50 to 64 while nearly one in four (24%) were age 35 to 49. 23% of the sample was age 65 or older. The remainder of the sample was under the age of 35. Thirteen percent of persons age 35 to 49 reported experiencing past year identity theft, compared to 7% of persons age 18 to 34 and 9% of persons age 65 or older.

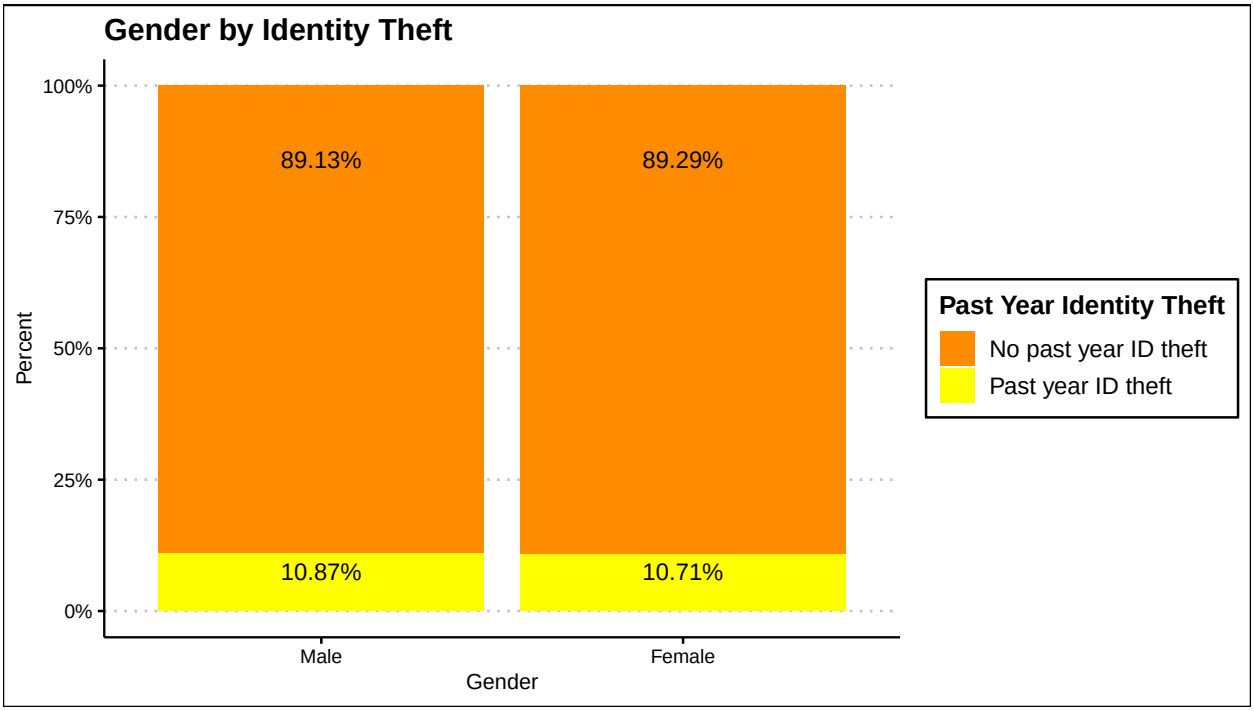
```
##                 Count Percentage
## Total           96130        100
## Age 16 to 17     1986          2
## Age 18 to 24     7826          8
## Age 25 to 34    14740         15
## Age 35 to 49    23147         24
## Age 50 to 64    26621         28
## Age 65 or older 21810         23
```



Gender

More than half of the sample (53%) was female while the remainder (47%) was male. Past year identity theft was experienced by 11% of males and a similar percentage of females.

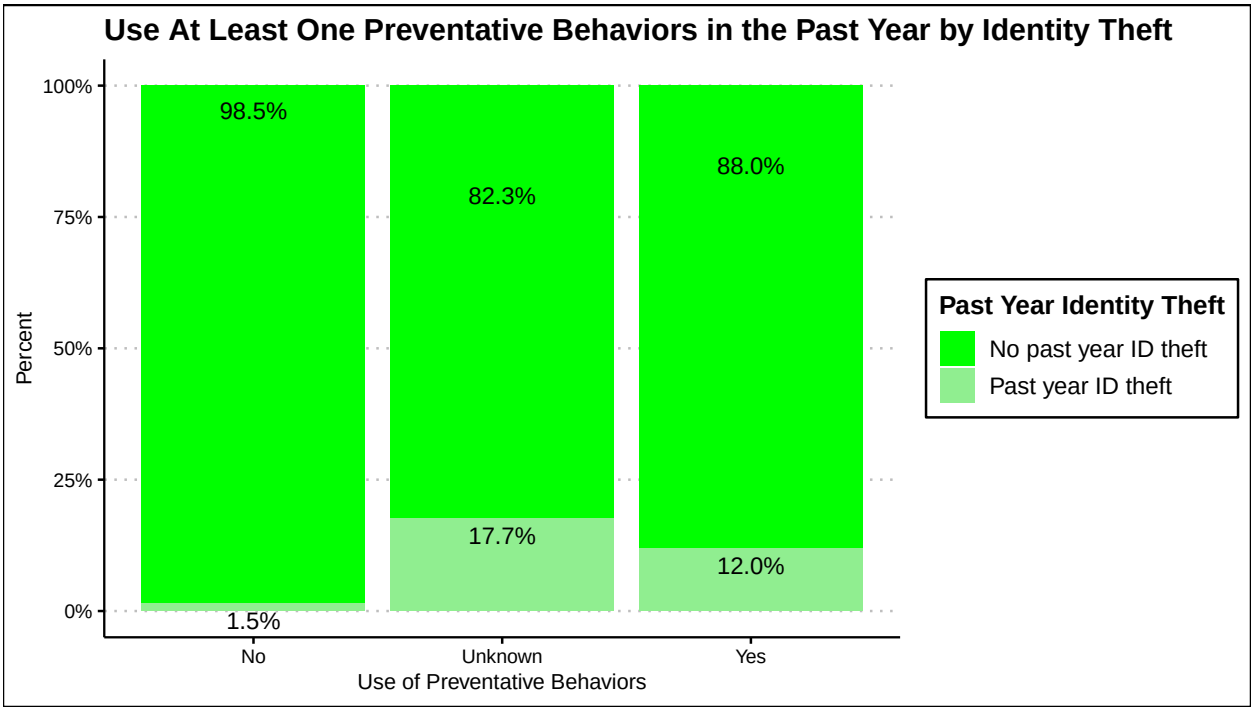
```
##         Count Percentage
## Total   96130        100
## Male    44908         47
## Female  51222         53
## Unknown     0          0
```



Preventative behaviors

Nearly nine out of ten persons in the sample (88%) used at least one of the preventative behaviors measured (checked credit report, changed password on financial accounts, had credit monitoring services or identity theft insurance, shredded or destroyed documents containing personal information, checked bank or credit card statements for unfamiliar charges, purchased identity theft protection) in the past 12 months. Eighteen percent of respondents who did not know if they had used a preventative behavior in the past 12 months reported past year identity theft compared to 12% of those who had used at least 1 preventative behavior in the past 12 months. Surprisingly, only 2% of those who did not participate in any prventative behaviors in the past 12 months reported past year identity theft.

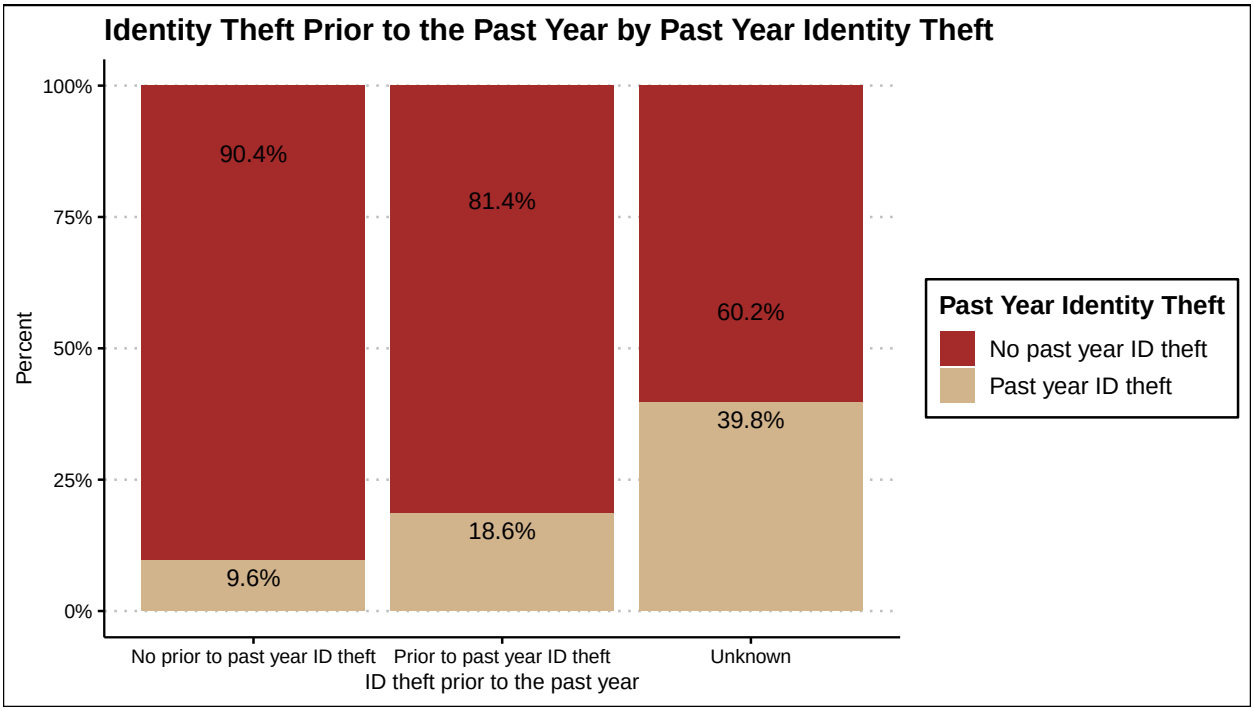
```
##         Count Percentage
## Total   96130        100
## No      11066         12
## Unknown   368          0
## Yes     84696         88
```



Identity theft prior to the past year

Thirteen percent of the sample experienced identity theft (misuse of an existing account, misuse of personal information to create new account or misuse of personal information for other fraudulent purposes) prior to 12 months prior to their ITS interview. The majority of the sample did not experience it. About 40% of respondents who did not know if they were a victim of identity theft prior to the past year experienced identity theft in the past 12 months. This is compared to 10% of those who had no identity theft prior to the past year and 19% of those who had identity theft prior to the past year.

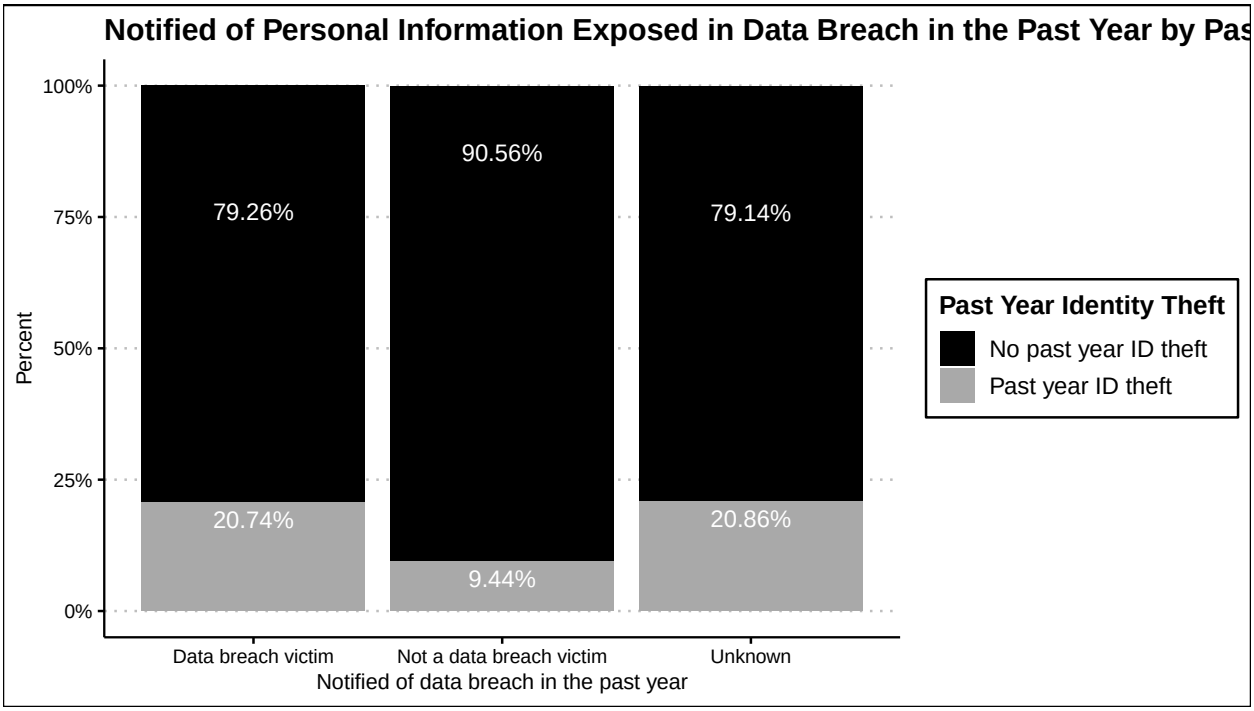
```
##                                Count Percentage
## Total                          96130        100
## No prior to past year ID theft 83692         87
## Prior to past year ID theft    12267         13
## Unknown                          171          0
```



Notified of exposure due to data breach

Twelve percent of the sample reported that they were notified that their personal information was exposed during a data breach. The majority of the sample (88%) reported that they were not notified that their personal information was exposed during a data breach.Of those who were notified that their information was exposed during a data breach, one in five (21%) reported being victims of identity theft in the past year. This is compared to 9% of those who were not notified that their personal information was exposed in a data breach being victims of past year identity theft.

```
##                           Count Percentage
## Total                     96130        100
## Data breach victim        11037         11
## Not a data breach victim  84652         88
## Unknown                     441          0
```



Data analysis

More data wrangling

Make copies of each variable used in analysis. Unknown level on each individual variable was changed to NA. Individual variables were combined into a single dataset and deleted individual variables. The individual variables were combined into a dataset (its1). The number of complete (cases with no NA values on any variable) and incomplete cases (cases with at least one variable with a value of NA) was summed from the dataset. There were 614 cases with a value of NA on atleast one variable with the remaining cases being complete cases

```
## 'data.frame':    96130 obs. of  8 variables:
##  $ idtheft           : Factor w/ 2 levels "No past year ID theft ",..: 1 1 1 1 1 1 1 1 1 1 ...
##  $ incomer           : Factor w/ 2 levels "Less than $75,000",..: 2 2 2 2 1 1 1 1 1 1 ...
##  $ ager              : Factor w/ 6 levels "Age 16 to 17",..: 4 5 2 6 5 3 3 5 5 6 ...
##  $ ethnicr           : Factor w/ 2 levels "NonHispanic White",..: 1 2 2 1 1 1 1 1 1 1 ...
##  $ prevent_total     : Factor w/ 2 levels "No","Yes": 2 2 2 2 2 2 2 2 2 2 ...
##  $ OUTSIDE_PAST_YEARR: Factor w/ 2 levels "No prior to past year ID theft",..: 1 1 2 1 1 2 1 1 1 1 .
##  $ notify_breachr    : Factor w/ 2 levels "Data breach victim",..: 2 2 2 2 2 2 2 2 2 2 ...
##  $ sexr              : Factor w/ 2 levels "Male","Female": 2 1 1 1 1 2 1 1 2 2 ...
```

```
##                   Number Percent
## Total              96130     100
## Cases with NAs       614       1
## Cases without NAs  95516      99
```

Data analysis

Chi-Square-Multiple chi-square analyses were run on the dataset with only completed cases. They show that between past year identity theft was dependent on most of the predictors ($p < 0.05$) with the exception of sex ($p > 0.05$).

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$incomer
## X-squared = 972.79, df = 1, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test
##
## data:  its1$idtheft and its1$ager
## X-squared = 552.16, df = 5, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$sexr
## X-squared = 0.59442, df = 1, p-value = 0.4407
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$ethnicr
## X-squared = 356.47, df = 1, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$prevent_total
## X-squared = 1120.4, df = 1, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$OUTSIDE_PAST_YEARR
## X-squared = 915.56, df = 1, p-value < 2.2e-16
```

```
##
##  Pearson's Chi-squared test with Yates' continuity correction
##
## data:  its1$idtheft and its1$notify_breachr
## X-squared = 1300.4, df = 1, p-value < 2.2e-16
```

Machine Learning-The dataset, its1, was split into training and testing data sets to in an attempt to train a logistics regression model predicting past year identity theft. Sixty percent of its1 was assigned to the training data while the remainind 40% went to the test dataset. The training dataset was examined for variables with near zero or zero variability. ITs whoed that no variables had zero or near zero variability.

```
inTrain<-createDataPartition(its1$idtheft,p=.6, list=FALSE)
training <- its1[inTrain,]
testing <- its1[-inTrain,]
nzv<-nearZeroVar(training, saveMetrics = TRUE)
nzv
```

```
##                     freqRatio percentUnique zeroVar   nzv
## idtheft              8.271661   0.003467466   FALSE FALSE
## incomer              1.843992   0.003467466   FALSE FALSE
## ager                 1.150310   0.010402399   FALSE FALSE
## ethnicr              2.472756   0.003467466   FALSE FALSE
## prevent_total        7.656420   0.003467466   FALSE FALSE
## OUTSIDE_PAST_YEARR   6.779054   0.003467466   FALSE FALSE
## notify_breachr       7.660078   0.003467466   FALSE FALSE
## sexr                 1.128848   0.003467466   FALSE FALSE
```

A logistic regression model predicting past year identity theft was ran over the training data. All of the predictors with the exception of sex was included in the model. Sex was excluded due to the chi-square analysis showing that sex was independent of past year identity theft. The results of the model showed that

```
modFit <- glm(idtheft ~incomer+ager+ethnicr+prevent_total+
                OUTSIDE_PAST_YEARR+notify_breachr,data=training,family="binomial")
#get model estimates
summary(modFit)
```

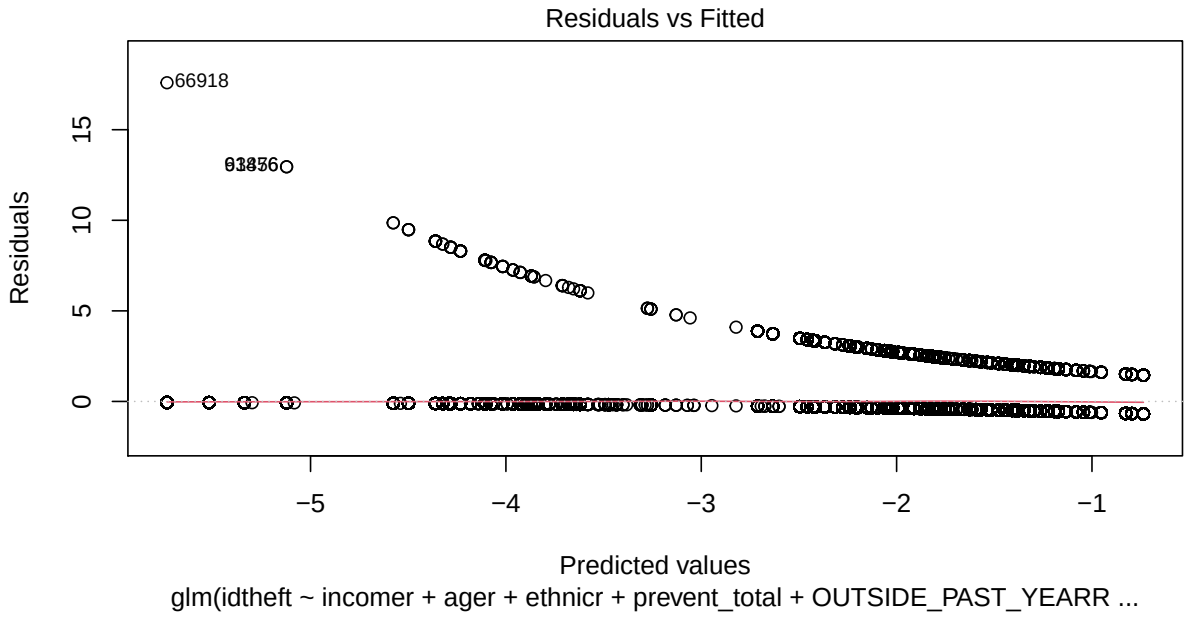
```
##
## Call:
## glm(formula = idtheft ~ incomer + ager + ethnicr + prevent_total +
##     OUTSIDE_PAST_YEARR + notify_breachr, family = "binomial",
##     data = training)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8845  -0.5248  -0.4493  -0.3725   3.3877
##
## Coefficients:
##                                          Estimate Std. Error z value
## (Intercept)                              -4.93616    0.27039 -18.256
## incomer$75,000 or more                    0.39616    0.02843  13.936
## agerAge 18 to 24                          1.23639    0.26026   4.751
## agerAge 25 to 34                          1.44326    0.25651   5.627
## agerAge 35 to 49                          1.50242    0.25555   5.879
## agerAge 50 to 64                          1.41136    0.25547   5.524
```

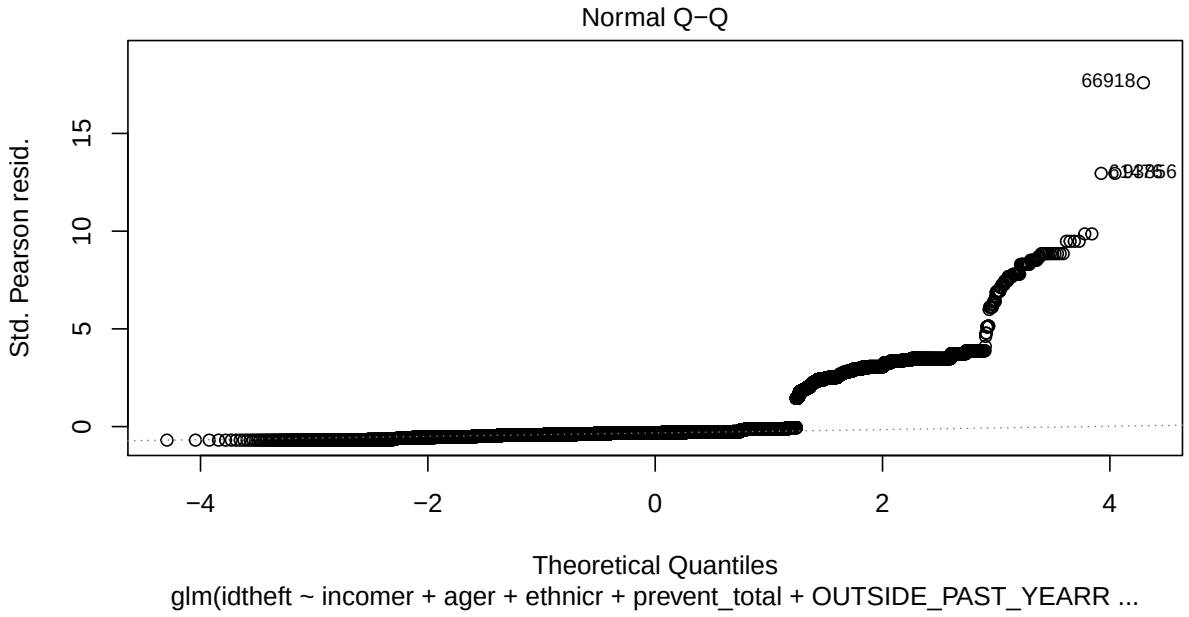
```
## agerAge 65 or older                               1.15824    0.25622   4.521
## ethnicrNot NonHispanic White                     -0.21608    0.03396  -6.362
## prevent_totalYes                                  1.86505    0.10647  17.517
## OUTSIDE_PAST_YEARRPrior to past year ID theft     0.43590    0.03504  12.440
## notify_breachrNot a data breach victim           -0.58271    0.03537 -16.474
##                                                  Pr(>|z|)
## (Intercept)                                       < 2e-16 ***
## incomer$75,000 or more                            < 2e-16 ***
## agerAge 18 to 24                                 2.03e-06 ***
## agerAge 25 to 34                                 1.84e-08 ***
## agerAge 35 to 49                                 4.13e-09 ***
## agerAge 50 to 64                                 3.30e-08 ***
## agerAge 65 or older                              6.17e-06 ***
## ethnicrNot NonHispanic White                     1.99e-10 ***
## prevent_totalYes                                  < 2e-16 ***
## OUTSIDE_PAST_YEARRPrior to past year ID theft     < 2e-16 ***
## notify_breachrNot a data breach victim            < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 39056  on 57288  degrees of freedom
## Residual deviance: 36962  on 57278  degrees of freedom
##   (390 observations deleted due to missingness)
## AIC: 36984
##
## Number of Fisher Scoring iterations: 7
```

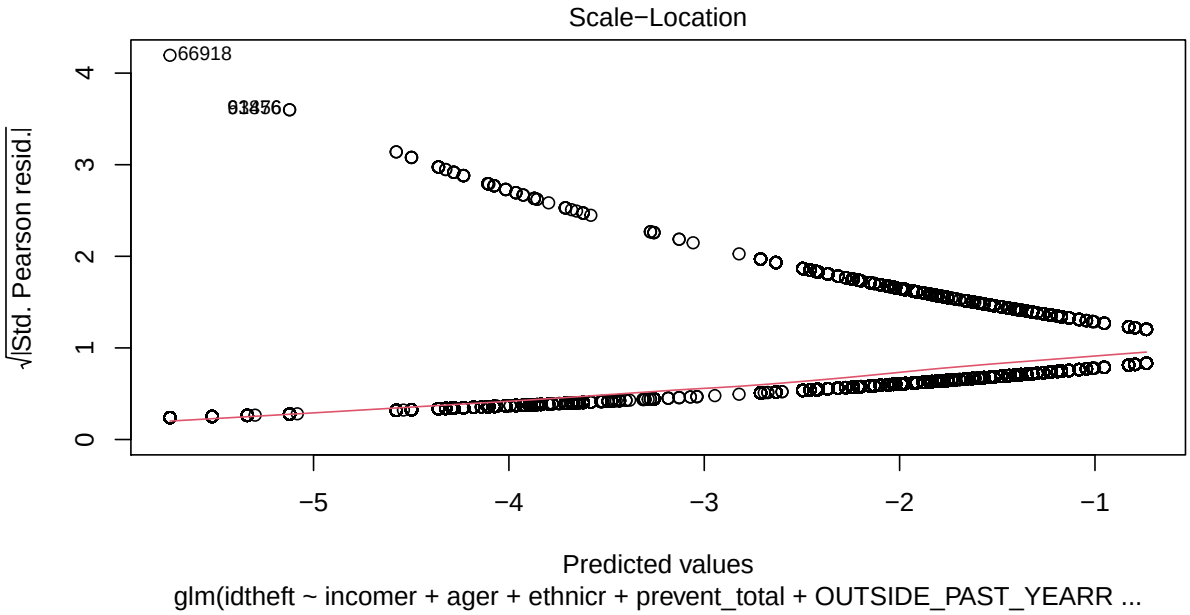
```
#Odds ratio
exp(modFit$coeff)
```

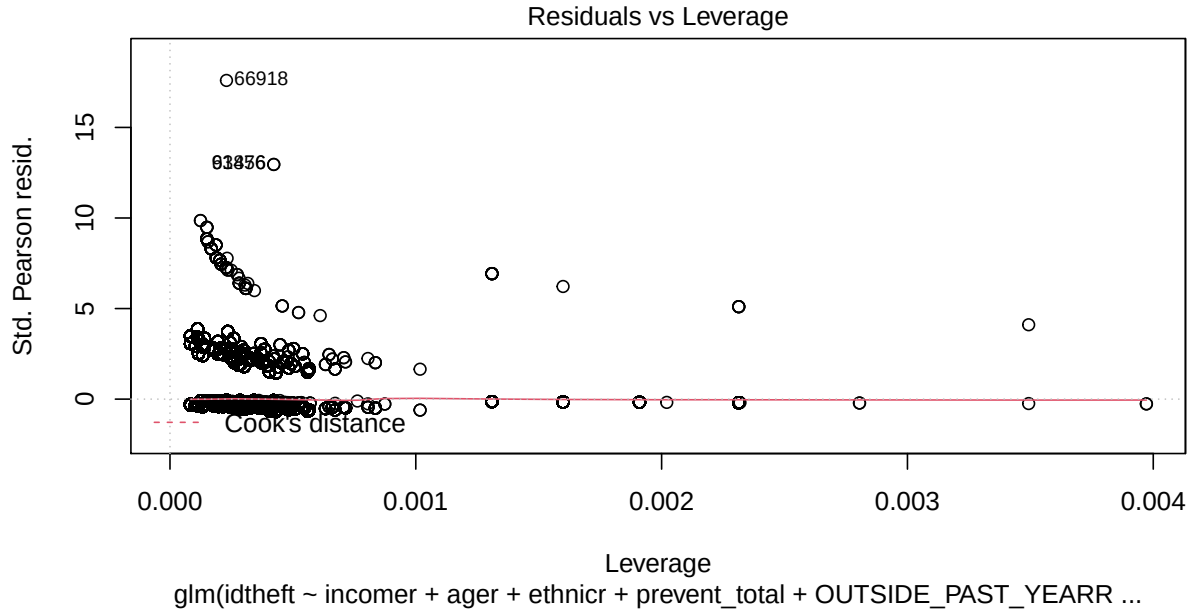
```
##                                   (Intercept)
##                                   0.007182143
##                          incomer$75,000 or more
##                                   1.486114369
##                                agerAge 18 to 24
##                                   3.443166674
##                                agerAge 25 to 34
##                                   4.234459730
##                                agerAge 35 to 49
##                                   4.492553701
##                                agerAge 50 to 64
##                                   4.101511149
##                              agerAge 65 or older
##                                   3.184317903
##                     ethnicrNot NonHispanic White
##                                   0.805673503
##                                prevent_totalYes
##                                   6.456258312
## OUTSIDE_PAST_YEARRPrior to past year ID theft
##                                   1.546348688
##        notify_breachrNot a data breach victim
##                                   0.558383343
```

```r
#graph of model residuals
plot(modFit)
```










```
#get variance inflation factors
vif(modFit)
```

```
##                       GVIF Df GVIF^(1/(2*Df))
## incomer           1.065216  1        1.032093
## ager              1.074241  5        1.007187
## ethnicr           1.050404  1        1.024892
## prevent_total     1.019303  1        1.009605
## OUTSIDE_PAST_YEARR 1.049612  1        1.024506
```

```
## notify_breachr     1.061054  1        1.030075
```

```
#confidence intervals
exp(confint(modFit))
```

```
## Waiting for profiling to be done...
```

```
##                                                      2.5 %     97.5 %
## (Intercept)                                     0.004067536 0.01181313
## incomer$75,000 or more                          1.405546569 1.57123615
## agerAge 18 to 24                                2.138254573 5.97126906
## agerAge 25 to 34                                2.652210182 7.29795427
## agerAge 35 to 49                                2.819971797 7.73047838
## agerAge 50 to 64                                2.574990392 7.05664297
## agerAge 65 or older                             1.995778289 5.48541927
## ethnicrNot NonHispanic White                    0.753569987 0.86088191
## prevent_totalYes                                5.273466116 8.00856667
## OUTSIDE_PAST_YEARRPrior to past year ID theft 1.443313762 1.65584224
## notify_breachrNot a data breach victim          0.521113897 0.59862095
```

```
#anova- used for putting factors in and out of model
anova(modFit, test = "Chisq")
```

```
## Analysis of Deviance Table
##
## Model: binomial, link: logit
##
## Response: idtheft
##
## Terms added sequentially (first to last)
##
##
##                    Df Deviance Resid. Df Resid. Dev  Pr(>Chi)
## NULL                                57288      39056
## incomer             1   527.46     57287      38528 < 2.2e-16 ***
## ager                5   308.34     57282      38220 < 2.2e-16 ***
## ethnicr             1   132.12     57281      38088 < 2.2e-16 ***
## prevent_total       1   659.06     57280      37429 < 2.2e-16 ***
## OUTSIDE_PAST_YEARR  1   212.72     57279      37216 < 2.2e-16 ***
## notify_breachr      1   253.88     57278      36962 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```