```r
#Jaini Shah
#QBS 103 Final Project
#Summer 2024

#Submission #1
```

```r
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
```

```r
library(tidyr)
# set the working directory to where my csv file is located
getwd()
```

```
## [1] "/Users/jainishah/Documents/GitHub/QBS103"
```

```r
setwd("/Users/jainishah/Desktop/final_project_data")

#reading gene expression data and metadata files
gene_expression <- read.csv("genes.csv")
metadata <- read.csv("metadata.csv")

head(gene_expression)
```

```
##         X COVID_01_39y_male_NonICU COVID_02_63y_male_NonICU
## 1    A1BG                     0.49                     0.29
## 2    A1CF                     0.00                     0.00
## 3     A2M                     0.21                     0.14
## 4   A2ML1                     0.04                     0.00
## 5 A3GALT2                     0.07                     0.00
## 6  A4GALT                     0.00                     0.00
##   COVID_03_33y_male_NonICU COVID_04_49y_male_NonICU COVID_05_49y_male_NonICU
## 1                     0.26                     0.45                     0.17
## 2                     0.00                     0.01                     0.00
## 3                     0.03                     0.09                     0.00
## 4                     0.02                     0.07                     0.05
## 5                     0.00                     0.00                     0.07
## 6                     0.00                     0.00                     0.00
##   COVID_06_.y_male_NonICU COVID_07_38y_female_NonICU COVID_08_78y_male_ICU
## 1                    0.21                       0.49                  0.12
## 2                    0.00                       0.01                  0.00
## 3                    0.08                       0.23                  0.08
## 4                    0.04                       0.03                  0.01
## 5                    0.00                       0.07                  0.00
## 6                    0.00                       0.00                  0.00
##   COVID_09_64y_female_ICU COVID_10_62y_male_ICU COVID_11_52y_female_NonICU
## 1                    0.51                  0.10                       0.38
## 2                    0.01                  0.00                       0.02
## 3                    0.88                  0.13                       0.47
## 4                    0.02                  0.01                       0.03
## 5                    0.79                  0.15                       0.08
## 6                    0.00                  0.00                       0.00
##   COVID_12_50y_male_ICU COVID_13_37y_male_NonICU COVID_14_55y_male_ICU
## 1                  0.45                     0.18                  0.23
## 2                  0.00                     0.00                  0.00
## 3                  0.16                     0.07                  0.22
## 4                  0.00                     0.01                  0.04
## 5                  1.75                     0.00                  0.93
## 6                  0.00                     0.00                  0.00
##   COVID_15_68y_male_ICU COVID_16_48y_male_NonICU COVID_17_54y_male_NonICU
## 1                  0.42                     0.41                     0.63
## 2                  0.00                     0.01                     0.02
## 3                  0.07                     0.58                     0.15
## 4                  0.00                     0.00                     0.02
## 5                  0.15                     0.19                     0.00
## 6                  0.03                     0.00                     0.00
##   COVID_18_70y_female_NonICU COVID_19_51y_male_NonICU COVID_20_62y_male_ICU
## 1                       0.47                     0.33                  0.32
## 2                       0.00                     0.02                  0.00
## 3                       0.30                     0.11                  0.07
## 4                       0.02                     0.02                  0.00
## 5                       0.06                     0.00                  0.22
## 6                       0.03                     0.00                  0.00
##   COVID_21_66y_male_ICU COVID_22_43y_male_ICU COVID_23_76y_male_ICU
## 1                  0.18                  0.09                  0.18
## 2                  0.00                  0.00                  0.01
## 3                  0.00                  0.06                  0.03
## 4                  0.00                  0.00                  0.00
## 5                  0.37                  0.06                  0.07
## 6                  0.03                  0.00                  0.03
##   COVID_24_55y_male_ICU COVID_25_55y_male_ICU COVID_26_41y_female_ICU
## 1                  0.22                  0.29                    0.42
## 2                  0.01                  0.00                    0.00
## 3                  0.11                  0.09                    0.18
## 4                  0.02                  0.03                    0.00
## 5                  0.15                  0.00                    0.87
## 6                  0.00                  0.00                    0.00
##   COVID_27_71y_female_ICU COVID_28_63y_male_ICU COVID_29_63y_female_ICU
## 1                    0.16                  0.18                    0.35
## 2                    0.01                  0.00                    0.00
## 3                    0.23                  0.18                    0.03
## 4                    0.01                  0.05                    0.03
## 5                    0.18                  0.45                    0.15
## 6                    0.00                  0.00                    0.03
##   COVID_30_54y_male_ICU COVID_31_50y_male_ICU COVID_32_72y_male_ICU
## 1                  0.23                  0.15                  0.34
## 2                  0.00                  0.00                  0.01
## 3                  0.11                  0.47                  0.04
## 4                  0.01                  0.00                  0.00
## 5                  0.00                  0.00                  0.29
## 6                  0.00                  0.03                  0.00
##   COVID_33_81y_male_NonICU COVID_34_64y_female_NonICU
## 1                     0.35                       0.36
## 2                     0.00                       0.00
## 3                     0.30                       0.11
## 4                     0.06                       0.00
## 5                     0.26                       0.12
## 6                     0.00                       0.00
##   COVID_35_58y_female_NonICU COVID_36_68y_male_NonICU COVID_37_87y_male_NonICU
## 1                       0.26                     0.18                     0.20
## 2                       0.00                     0.01                     0.00
## 3                       0.51                     0.09                     0.09
## 4                       0.02                     0.00                     0.07
## 5                       0.16                     0.08                     0.31
## 6                       0.00                     0.00                     0.00
##   COVID_38_68y_male_ICU COVID_39_80y_female_ICU COVID_40_66y_male_ICU
## 1                  0.29                    0.19                  0.22
## 2                  0.00                    0.00                  0.00
## 3                  0.10                    0.27                  0.17
## 4                  0.02                    0.00                  0.00
## 5                  0.35                    0.00                  0.08
## 6                  0.00                    0.07                  0.00
##   COVID_41_74y_male_ICU COVID_42_21y_female_ICU COVID_43_83y_female_ICU
## 1                  0.19                    0.24                    0.29
## 2                  0.00                    0.01                    0.00
## 3                  0.14                    0.33                    0.00
## 4                  0.00                    0.01                    0.00
## 5                  0.19                    0.39                    0.11
## 6                  0.00                    0.00                    0.00
##   COVID_44_46y_male_ICU COVID_45_62y_female_ICU COVID_46_62y_male_ICU
## 1                  0.22                    0.14                  0.53
## 2                  0.00                    0.00                  0.01
## 3                  0.14                    0.15                  0.10
## 4                  0.00                    0.03                  0.00
## 5                  0.00                    0.19                  0.06
## 6                  0.04                    0.00                  0.00
##   COVID_47_78y_male_ICU COVID_48_72y_female_ICU COVID_49_73y_male_ICU
## 1                  0.08                    0.19                  0.48
## 2                  0.01                    0.00                  0.00
## 3                  0.04                    0.06                  0.09
## 4                  0.03                    0.01                  0.03
## 5                  0.60                    0.23                  0.00
## 6                  0.00                    0.06                  0.00
##   COVID_50_37y_male_ICU COVID_51_58y_female_NonICU COVID_52_71y_male_NonICU
## 1                  0.08                       0.21                     0.25
## 2                  0.00                       0.00                     0.01
## 3                  0.01                       0.13                     0.00
## 4                  0.00                       0.00                     0.03
## 5                  0.00                       0.00                     0.00
## 6                  0.72                       0.00                     0.00
##   COVID_53_35y_female_NonICU COVID_55_62y_female_ICU COVID_56_33y_female_NonICU
## 1                       0.25                    0.09                       0.28
## 2                       0.00                    0.00                       0.00
## 3                       0.64                    0.09                       0.16
## 4                       0.10                    0.01                       0.09
## 5                       0.00                    0.00                       0.23
## 6                       0.00                    0.00                       0.00
##   COVID_57_30y_female_NonICU COVID_58_62y_male_NonICU COVID_59_55y_male_NonICU
## 1                       0.42                     0.39                     0.33
## 2                       0.00                     0.00                     0.00
## 3                       0.27                     0.08                     0.10
## 4                       0.01                     0.00                     0.00
## 5                       0.19                     0.00                     0.07
## 6                       0.05                     0.00                     0.00
##   COVID_60_49y_male_NonICU COVID_61_54y_female_NonICU COVID_62_78y_female_ICU
## 1                     0.22                       0.25                    0.21
## 2                     0.00                       0.00                    0.00
## 3                     0.14                       0.10                    0.04
## 4                     0.00                       0.03                    0.00
## 5                     0.00                       0.13                    0.05
## 6                     0.02                       0.00                    0.00
##   COVID_63_39y_female_ICU COVID_64_65y_male_ICU COVID_65_84y_male_NonICU
## 1                    0.29                  0.38                     0.40
## 2                    0.00                  0.01                     0.01
## 3                    0.01                  0.04                     0.07
## 4                    0.00                  0.02                     0.00
## 5                    0.14                  0.56                     0.58
## 6                    0.00                  0.00                     0.00
##   COVID_66_66y_female_NonICU COVID_67_57y_male_ICU COVID_68_79y_male_ICU
## 1                       0.64                  0.37                  0.58
## 2                       0.00                  0.00                  0.00
## 3                       0.00                  0.35                  0.15
## 4                       0.00                  0.00                  0.01
## 5                       0.00                  0.00                  0.00
## 6                       0.00                  0.00                  0.05
##   COVID_69_77y_female_NonICU COVID_70_81y_male_NonICU COVID_71_37y_male_ICU
## 1                       0.52                     0.27                  0.07
## 2                       0.00                     0.00                  0.01
## 3                       0.29                     0.07                  0.12
## 4                       0.02                     0.00                  0.01
## 5                       0.00                     0.00                  0.00
## 6                       0.00                     0.06                  0.00
##   COVID_72_50y_female_NonICU COVID_73_82y_male_NonICU COVID_74_55y_female_ICU
## 1                       0.52                     0.46                    0.24
## 2                       0.00                     0.01                    0.00
## 3                       0.10                     0.02                    0.12
## 4                       0.01                     0.02                    0.02
## 5                       0.00                     0.17                    0.26
## 6                       0.00                     0.04                    0.00
##   COVID_75_55y_male_NonICU COVID_76_73y_female_ICU COVID_77_55y_female_ICU
## 1                     0.23                    0.17                    0.05
## 2                     0.01                    0.00                    0.00
## 3                     0.14                    0.09                    0.01
## 4                     0.00                    0.01                    0.00
## 5                     0.00                    0.04                    0.00
## 6                     0.00                    0.00                    0.00
##   COVID_78_80y_male_NonICU COVID_79_27y_male_NonICU COVID_80_71y_male_ICU
## 1                     0.19                     0.08                  0.28
## 2                     0.00                     0.01                  0.00
## 3                     0.20                     0.03                  0.05
## 4                     0.00                     0.00                  0.00
## 5                     0.00                     0.00                  0.05
## 6                     0.00                     0.00                  0.00
##   COVID_82_67y_male_NonICU COVID_83_85y_female_NonICU
## 1                     0.39                       0.47
## 2                     0.01                       0.00
## 3                     0.10                       0.18
## 4                     0.00                       0.05
## 5                     0.00                       0.00
## 6                     0.00                       0.00
##   COVID_84_75y_female_NonICU COVID_85_62y_male_ICU COVID_86_52y_female_NonICU
## 1                       0.35                  0.29                       0.60
## 2                       0.00                  0.00                       0.00
## 3                       0.03                  0.04                       0.27
## 4                       0.00                  0.00                       0.02
## 5                       0.17                  0.00                       0.00
## 6                       0.00                  0.00                       0.00
##   COVID_87_61y_male_ICU COVID_89_90y_female_NonICU COVID_90_86y_female_NonICU
## 1                  0.65                       0.20                       0.40
## 2                  0.00                       0.00                       0.00
## 3                  0.15                       0.07                       0.05
## 4                  0.00                       0.03                       0.01
## 5                  0.00                       0.14                       0.31
## 6                  0.00                       0.00                       0.02
##   COVID_91_29y_female_NonICU COVID_92_82y_female_ICU COVID_93_81y_female_ICU
## 1                       0.60                    0.34                    0.37
## 2                       0.00                    0.00                    0.00
## 3                       0.03                    0.02                    0.11
## 4                       0.02                    0.04                    0.00
## 5                       0.05                    0.58                    0.05
## 6                       0.00                    0.00                    0.00
##   COVID_94_24y_female_NonICU COVID_95_49y_male_NonICU COVID_96_51y_male_NonICU
## 1                       0.81                     0.37                     1.61
## 2                       0.00                     0.01                     0.00
## 3                       0.17                     0.20                     0.02
## 4                       0.02                     0.02                     0.00
## 5                       0.00                     0.15                     0.00
## 6                       0.06                     0.00                     0.00
##   COVID_97_76y_male_ICU COVID_98_81y_male_NonICU COVID_99_71y_male_ICU
## 1                  0.19                     0.78                  0.33
## 2                  0.00                     0.00                  0.00
## 3                  0.02                     0.26                  0.02
## 4                  0.05                     0.00                  0.00
## 5                  0.12                     0.37                  0.04
## 6                  0.03                     0.00                  0.00
##   COVID_100_74y_female_NonICU COVID_101_58y_male_ICU COVID_102_84y_male_NonICU
## 1                        0.30                   0.33                      0.12
## 2                        0.00                   0.00                      0.00
## 3                        0.09                   0.11                      0.01
## 4                        0.00                   0.03                      0.01
## 5                        0.04                   0.05                      0.00
## 6                        0.00                   0.00                      0.07
##   COVID_103_83y_male_NonICU NONCOVID_01_54y_female_NonICU
## 1                      0.20                          0.89
## 2                      0.00                          0.00
## 3                      0.03                          0.04
## 4                      0.03                          0.00
## 5                      0.04                          0.00
## 6                      0.00                          0.00
##   NONCOVID_02_65y_male_ICU NONCOVID_03_65y_male_ICU NONCOVID_04_90y_male_NonICU
## 1                     0.32                     0.44                        0.21
## 2                     0.00                     0.00                        0.00
## 3                     0.01                     0.05                        0.05
## 4                     0.00                     0.02                        0.00
## 5                     0.04                     0.04                        0.21
## 6                     0.00                     0.00                        0.00
##   NONCOVID_05_83y_female_NonICU NONCOVID_06_75y_female_ICU
## 1                          0.31                       0.89
## 2                          0.00                       0.00
## 3                          0.01                       0.14
## 4                          0.01                       0.01
## 5                          0.00                       0.00
## 6                          0.00                       0.06
##   NONCOVID_07_50y_male_ICU NONCOVID_08_53y_female_ICU
## 1                     0.45                       0.47
## 2                     0.00                       0.01
## 3                     0.07                       0.04
## 4                     0.02                       0.00
## 5                     0.00                       0.15
## 6                     0.00                       0.00
##   NONCOVID_09_49y_female_NonICU NONCOVID_10_67y_male_ICU
## 1                          0.40                     0.33
## 2                          0.00                     0.00
## 3                          0.04                     0.05
## 4                          0.00                     0.01
## 5                          0.00                     0.23
## 6                          0.00                     0.08
##   NONCOVID_11_58y_female_NonICU NONCOVID_12_82y_male_ICU
## 1                          0.58                     0.12
## 2                          0.00                     0.00
## 3                          0.03                     0.02
## 4                          0.00                     0.00
## 5                          0.00                     0.00
## 6                          0.00                     0.02
##   NONCOVID_13_65y_male_ICU NONCOVID_14_75y_female_ICU
## 1                     0.31                       0.16
## 2                     0.00                       0.00
## 3                     0.04                       0.08
## 4                     0.01                       0.00
## 5                     0.32                       0.05
## 6                     0.02                       0.02
##   NONCOVID_15_83y_unknown_ICU NONCOVID_16_40y_female_ICU
## 1                        0.59                       0.34
## 2                        0.00                       0.00
## 3                        0.03                       0.07
## 4                        0.04                       0.00
## 5                        0.00                       0.13
## 6                        0.19                       0.00
##   NONCOVID_17_84y_female_ICU NONCOVID_18_88y_male_ICU
## 1                       0.37                     0.33
## 2                       0.00                     0.00
## 3                       0.07                     0.06
## 4                       0.01                     0.00
## 5                       0.18                     0.00
## 6                       0.00                     0.00
##   NONCOVID_19_66y_female_ICU NONCOVID_20_62y_female_ICU
## 1                       0.25                       0.20
## 2                       0.00                       0.00
## 3                       0.11                       0.01
## 4                       0.00                       0.02
## 5                       0.04                       0.00
## 6                       0.03                       0.07
##   NONCOVID_21_71y_male_NonICU NONCOVID_22_63y_male_NonICU
## 1                        0.40                        0.30
## 2                        0.00                        0.00
## 3                        0.04                        0.02
## 4                        0.02                        0.02
## 5                        0.00                        0.00
## 6                        0.00                        0.00
##   NONCOVID_23_42y_female_NonICU NONCOVID_24_32y_female_NonICU
## 1                          0.70                          0.75
## 2                          0.00                          0.00
## 3                          0.02                          0.27
## 4                          0.01                          0.00
## 5                          0.00                          0.06
## 6                          0.00                          0.00
##   NONCOVID_25_62y_male_NonICU NONCOVID_26_36y_male_ICU
## 1                        2.80                     0.22
## 2                        0.00                     0.00
## 3                        0.04                     0.28
## 4                        0.00                     0.00
## 5                        0.00                     0.00
## 6                        0.00                     0.00
```

```
head(metadata)
```

```
##             participant_id geo_accession                status
## 1 COVID_01_39y_male_NonICU    GSM4753021 Public on Aug 29 2020
## 2 COVID_02_63y_male_NonICU    GSM4753022 Public on Aug 29 2020
## 3 COVID_03_33y_male_NonICU    GSM4753023 Public on Aug 29 2020
## 4 COVID_04_49y_male_NonICU    GSM4753024 Public on Aug 29 2020
## 5 COVID_05_49y_male_NonICU    GSM4753025 Public on Aug 29 2020
## 6  COVID_06_:y_male_NonICU    GSM4753026 Public on Aug 29 2020
##   X.Sample_submission_date last_update_date type channel_count
## 1              Aug 28 2020      Aug 29 2020  SRA             1
## 2              Aug 28 2020      Aug 29 2020  SRA             1
## 3              Aug 28 2020      Aug 29 2020  SRA             1
## 4              Aug 28 2020      Aug 29 2020  SRA             1
## 5              Aug 28 2020      Aug 29 2020  SRA             1
## 6              Aug 28 2020      Aug 29 2020  SRA             1
##               source_name_ch1 organism_ch1          disease_status age   sex
## 1 Leukocytes from whole blood Homo sapiens disease state: COVID-19  39  male
## 2 Leukocytes from whole blood Homo sapiens disease state: COVID-19  63  male
## 3 Leukocytes from whole blood Homo sapiens disease state: COVID-19  33  male
## 4 Leukocytes from whole blood Homo sapiens disease state: COVID-19  49  male
## 5 Leukocytes from whole blood Homo sapiens disease state: COVID-19  49  male
## 6 Leukocytes from whole blood Homo sapiens disease state: COVID-19   :  male
##   icu_status apacheii charlson_score mechanical_ventilation
## 1         no       15              0                    yes
## 2         no  unknown              2                     no
## 3         no  unknown              2                     no
## 4         no  unknown              1                     no
## 5         no       19              1                    yes
## 6         no  unknown              1                     no
##   ventilator.free_days hospital.free_days_post_45_day_followup ferritin.ng.ml.
## 1                    0                                       0             946
## 2                   28                                      39            1060
## 3                   28                                      18            1335
## 4                   28                                      39             583
## 5                   23                                      27             800
## 6                   28                                      36             563
##   crp.mg.l. ddimer.mg.l_feu. procalcitonin.ng.ml.. lactate.mmol.l. fibrinogen
## 1      73.1              1.3                    36             0.9        513
## 2   unknown             1.03                  0.37         unknown    unknown
## 3      53.2             1.48                  0.07         unknown        513
## 4     251.1             1.32                  0.98            0.87        949
## 5     355.8             0.69                  4.92            1.48        929
## 6     129.1          unknown                  0.67            0.86        769
##       sofa
## 1        8
## 2  unknown
## 3  unknown
## 4  unknown
## 5        7
## 6  unknown
```

```r
# checking structure of gene expression data and metadata data
#str(gene_expression)
#str(metadata)

# melting gene_expression data (using Tidyverse) from wide data to long data so the two files can be me
gene_long <- gene_expression %>%
  tidyr::gather(key = "ParticipantID", value = "Expression", -X)

# renaming the gene column to "Gene"
names(gene_long)[names(gene_long) == "X"] <- "Gene"

# checking the first 6 rows of the melted data
head(gene_long)
```

```
##      Gene            ParticipantID Expression
## 1    A1BG COVID_01_39y_male_NonICU       0.49
## 2    A1CF COVID_01_39y_male_NonICU       0.00
## 3     A2M COVID_01_39y_male_NonICU       0.21
## 4   A2ML1 COVID_01_39y_male_NonICU       0.04
## 5 A3GALT2 COVID_01_39y_male_NonICU       0.07
## 6  A4GALT COVID_01_39y_male_NonICU       0.00
```

```
# merging the melted gene expression data with the metadata using the shared column of "ParticipantID"
merged_data <- merge(gene_long, metadata, by.x = "ParticipantID", by.y = "participant_id")
head(merged_data)
```

```
##              ParticipantID    Gene Expression geo_accession
## 1 COVID_01_39y_male_NonICU    A1CF       0.00    GSM4753021
## 2 COVID_01_39y_male_NonICU    A1BG       0.49    GSM4753021
## 3 COVID_01_39y_male_NonICU   AADAC       0.00    GSM4753021
## 4 COVID_01_39y_male_NonICU AADACL2       0.00    GSM4753021
## 5 COVID_01_39y_male_NonICU AADACL3       0.00    GSM4753021
## 6 COVID_01_39y_male_NonICU AADACL4       0.00    GSM4753021
##                  status X.Sample_submission_date last_update_date type
## 1 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
## 2 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
## 3 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
## 4 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
## 5 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
## 6 Public on Aug 29 2020              Aug 28 2020      Aug 29 2020  SRA
##   channel_count             source_name_ch1 organism_ch1
## 1             1 Leukocytes from whole blood Homo sapiens
## 2             1 Leukocytes from whole blood Homo sapiens
## 3             1 Leukocytes from whole blood Homo sapiens
## 4             1 Leukocytes from whole blood Homo sapiens
## 5             1 Leukocytes from whole blood Homo sapiens
## 6             1 Leukocytes from whole blood Homo sapiens
##            disease_status age   sex icu_status apacheii charlson_score
## 1 disease state: COVID-19  39  male         no       15              0
## 2 disease state: COVID-19  39  male         no       15              0
## 3 disease state: COVID-19  39  male         no       15              0
## 4 disease state: COVID-19  39  male         no       15              0
## 5 disease state: COVID-19  39  male         no       15              0
## 6 disease state: COVID-19  39  male         no       15              0
##   mechanical_ventilation ventilator.free_days
## 1                    yes                    0
## 2                    yes                    0
## 3                    yes                    0
## 4                    yes                    0
## 5                    yes                    0
## 6                    yes                    0
##   hospital.free_days_post_45_day_followup ferritin.ng.ml. crp.mg.l.
## 1                                       0             946      73.1
## 2                                       0             946      73.1
## 3                                       0             946      73.1
## 4                                       0             946      73.1
## 5                                       0             946      73.1
## 6                                       0             946      73.1
##   ddimer.mg.l_feu. procalcitonin.ng.ml.. lactate.mmol.l. fibrinogen sofa
## 1              1.3                    36             0.9        513    8
## 2              1.3                    36             0.9        513    8
## 3              1.3                    36             0.9        513    8
## 4              1.3                    36             0.9        513    8
## 5              1.3                    36             0.9        513    8
## 6              1.3                    36             0.9        513    8
```

```
# filtered data using 'filter(Gene == A1CF) to only extract rows for where the gene is A1CF
# selecting columns for the covariate variables that I picked
clean_data <- merged_data %>%
  filter(Gene == "ABCA1") %>%
  select(Gene, ParticipantID,Expression, age, sex, icu_status)

head(clean_data)
```

```
##    Gene              ParticipantID Expression age    sex icu_status
## 1 ABCA1   COVID_01_39y_male_NonICU      32.30  39   male         no
## 2 ABCA1   COVID_02_63y_male_NonICU      15.84  63   male         no
## 3 ABCA1   COVID_03_33y_male_NonICU      34.38  33   male         no
## 4 ABCA1   COVID_04_49y_male_NonICU      14.24  49   male         no
## 5 ABCA1   COVID_05_49y_male_NonICU      18.39  49   male         no
## 6 ABCA1 COVID_07_38y_female_NonICU      14.66  38 female         no
```

```
# checking data types of the columns
str(clean_data)
```

```
## ’data.frame’:    125 obs. of  6 variables:
##  $ Gene         : chr  "ABCA1" "ABCA1" "ABCA1" "ABCA1" ...
##  $ ParticipantID: chr  "COVID_01_39y_male_NonICU" "COVID_02_63y_male_NonICU" "COVID_03_33y_male_NonI
##  $ Expression   : num  32.3 15.8 34.4 14.2 18.4 ...
##  $ age          : chr  "39" "63" "33" "49" ...
##  $ sex          : chr  " male" " male" " male" " male" ...
##  $ icu_status   : chr  " no" " no" " no" " no" ...
```

```
# converting age data to numeric - if not already
clean_data$age <- as.numeric(clean_data$age)
```

```
## Warning: NAs introduced by coercion
```

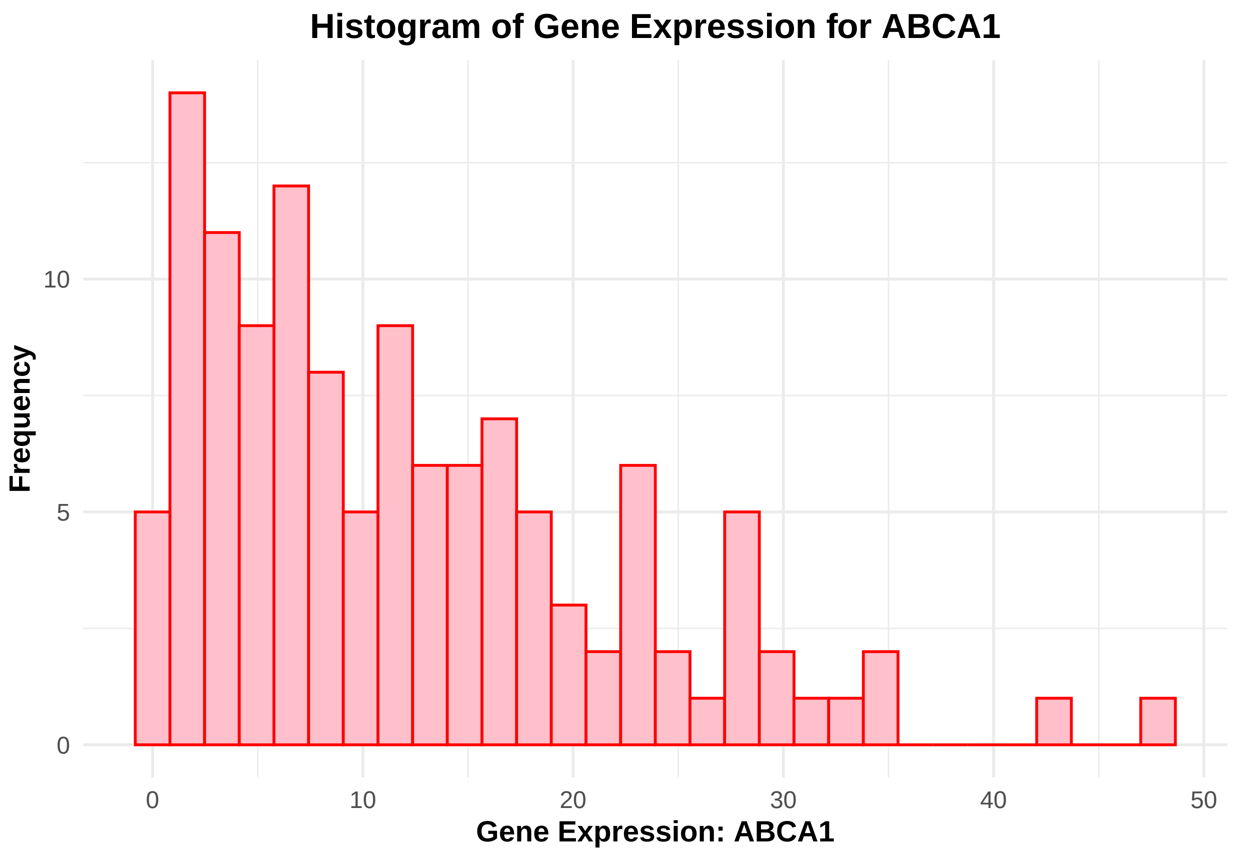
```
# converting sex and icu_status to factors - if not already
clean_data$sex <- as.factor(clean_data$sex)
clean_data$icu_status <- as.factor(clean_data$icu_status)

# confirming conversions
str(clean_data)
```

```
## ’data.frame’:    125 obs. of  6 variables:
##  $ Gene         : chr  "ABCA1" "ABCA1" "ABCA1" "ABCA1" ...
##  $ ParticipantID: chr  "COVID_01_39y_male_NonICU" "COVID_02_63y_male_NonICU" "COVID_03_33y_male_NonI
##  $ Expression   : num  32.3 15.8 34.4 14.2 18.4 ...
##  $ age          : num  39 63 33 49 49 38 78 64 62 74 ...
##  $ sex          : Factor w/ 3 levels " female"," male",..: 2 2 2 2 2 1 2 1 2 1 ...
##  $ icu_status   : Factor w/ 2 levels " no"," yes": 1 1 1 1 1 1 2 2 2 1 ...
```

```r
# removing rows with missing values to 'final_data" which will be utilized for data visualization
final_data <- clean_data %>%
  filter(!is.na(sex) & sex != " unknown",
         !is.na(icu_status) & icu_status != " unknown")
```

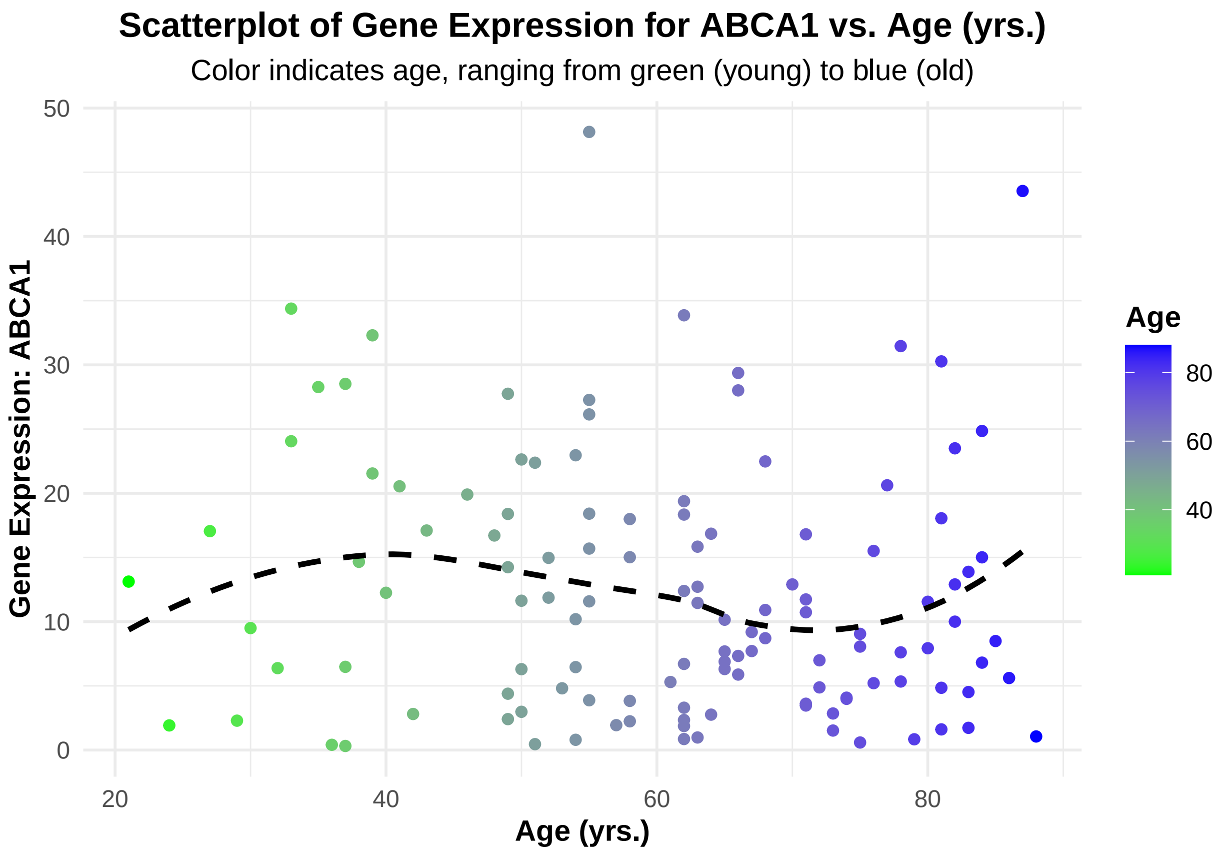
```r
#Histogram for Gene Expression

library(ggplot2)

# initializes the plot with 'final_data' and maps all 'Expression' values to the x-axis
ggplot(final_data, aes(x = Expression)) +
  geom_histogram(fill = "pink", color = "red") +
  # plots the histogram with bars outlined and filled
  labs(title = "Histogram of Gene Expression for ABCA1", # adds title and axis labels
       x = "Gene Expression: ABCA1",
       y = "Frequency") +
  theme_minimal() + # applied minimal theme for appearance
  theme( # making the titles of plot and axis bold
    plot.title = element_text(hjust = 0.5, face = "bold"),
    axis.title = element_text(face = "bold"),
    legend.title = element_text(face = "bold")
  )
```

```
## ‘stat_bin()‘ using ‘bins = 30‘. Pick better value with ‘binwidth‘.
```

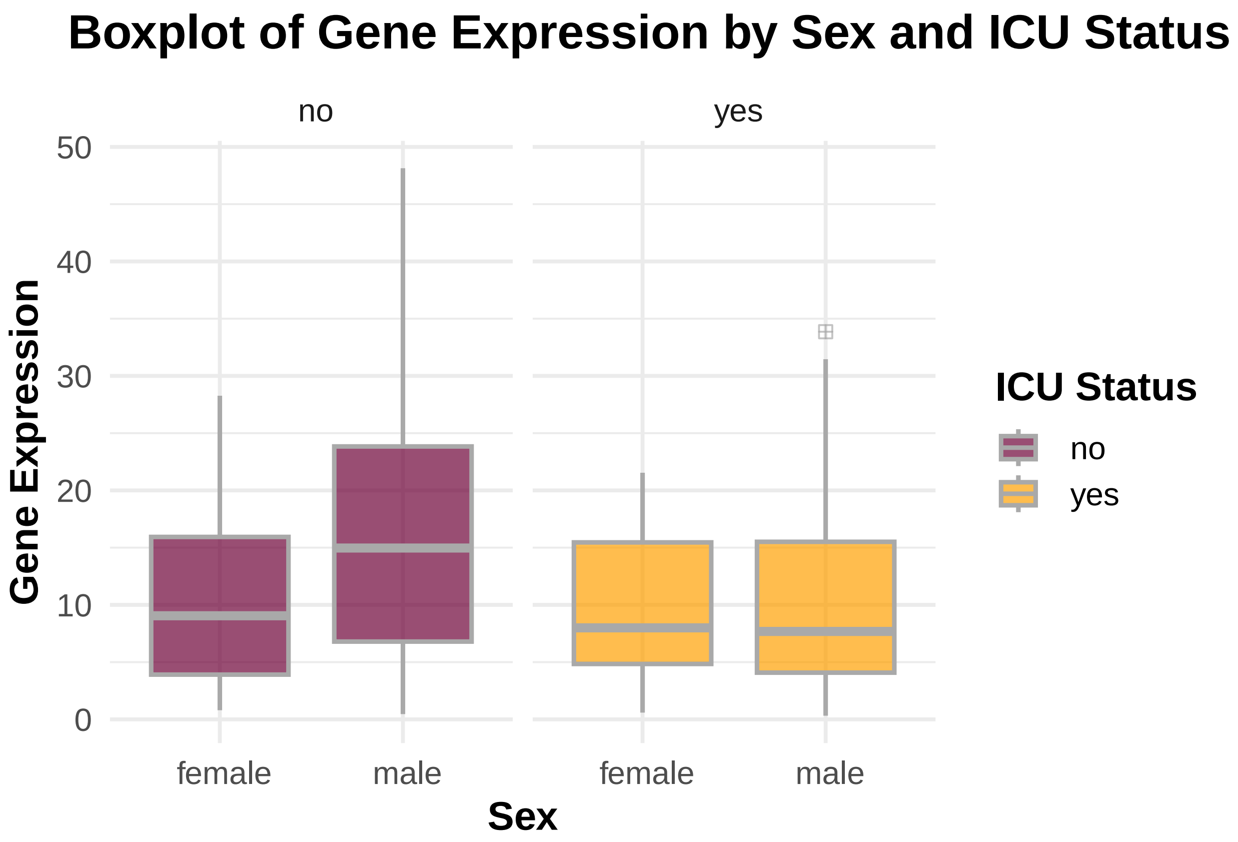


```
# Scatterplot for gene expression and continuous covariate (Age)

library(ggplot2)

# initializes the plot with 'final_data' and maps all 'age' values to x-axis 'Expression' values to the
ggplot(final_data,aes(x = age,y = Expression ,color = age)) +
  geom_point() +
  scale_color_gradient(low = "green", high = "blue") + # color gradient for age
  labs(title = "Scatterplot of Gene Expression for ABCA1 vs. Age (yrs.)", # title for plot and axis
       subtitle = "Color indicates age, ranging from green (young) to blue (old)",
       x = "Age (yrs.)",
       y = "Gene Expression: ABCA1",
       color = "Age") +
  theme_minimal() +
  theme( # making the titles of axis and plot bold
    plot.title = element_text(hjust = 0.5, face = "bold"),
    plot.subtitle = element_text(hjust = 0.5),
    axis.title = element_text(face = "bold"),
    legend.title = element_text(face = "bold")
  ) +

# adding a smooth line to show trend in data
geom_smooth(method = "loess", se = FALSE, color = "black", linetype = "dashed")
```

```
## ‘geom_smooth()‘ using formula = ’y ~ x’
## Warning: Removed 2 rows containing non-finite outside the scale range
## ('stat_smooth()').

## Warning: Removed 2 rows containing missing values or values outside the scale range
## ('geom_point()').
```



```
# Boxplot of gene expression separated by both categorical covariates (Sex and ICU Status)

library(ggplot2)
library(harrypotter)

# create boxplot with categorical covariates
ggplot(final_data,aes(x = sex ,y = Expression, fill = icu_status)) +
   geom_boxplot(outlier.shape = 12, outlier.size = 2, color = "darkgray", lwd = 0.8, alpha = 0.7) +
    scale_fill_hp_d(option = "ronweasley") + # change border color and box details
  facet_wrap(~ icu_status) + # separate plots by ICU status
  labs(title = "Boxplot of Gene Expression by Sex and ICU Status", # assigned titles for axis and plot
       x = "Sex",
       y = "Gene Expression",
       fill = "ICU Status") +
  theme_minimal(base_size = 15) + # minimal theme with font size
  theme( # making the titles of axis and plot bold, changing placement of titles
    plot.title = element_text(hjust = 0.125, face = "bold"),
    axis.title = element_text(face = "bold"),
    legend.title = element_text(face = "bold")
  )
```


Boxplot of Gene Expression by Sex and ICU Status
no
yes
Gene Expression
0
10
20
30
40
50
female
male
female
male
Sex
ICU Status
no
yes