Sodium and Blood Pressure

```
library(haven)
library(data.table)
library(ggplot2)

sav1 <- "UKDA-6533-spss/spss/spss25/ndns_rp_yr1-4a_personleveldietarydata_uk_v2.sav"
sav2 <- "UKDA-6533-spss/spss/spss25/ndns_rp_yr1-4a_indiv_uk.sav"
sav3 <- "UKDA-6533-spss/spss/spss25/ndns_yr1-3indiva_weights.sav"
```

Does Blood pressure correlate with sodium intake when controlling for income, race and age In A representative UK population NDNS is raised intake of sodium >rda associated with raised Blood pressure readings?

Introduction

Sodium is a key electrolyte in cellular physiology. One core function of the cell is to maintain a sodium concentration gradient across the cell wall. Maintaining sodium levels is therefore an essential part of all higher organisms. This role is largely taken by the kidney and modified by receptors and hormones from across the organism. It also relies on ingestion and taste, or diet.

I would like to understand what to tell my patients. Current advice is to reduce sodium intake but it can be difficult to identify the best way to do this. Recent critiques of the role of ingested sodium in blood pressure have looked again at the best form for this advice. The National dietary nutrition dataset is a rolling cross sectional study with linked data on ingestion of sodium and of blood pressure. It also contains data on potential confounding factors such as age sex weight race and income.

Machine learning is a way of interrogating data sets to identify potential models to explain and predict an outcome. In this case the outcome is systolic or diastolic blood pressure.

Causation analysis working with regression models can help to better identify the directional role of particular variables in a model. This helps to identify which variables to include in models and which combination is most likely to give a clinically significant answer.

```
#savx <- "UKDA-6533-spss/spss/spss25/"

sav1d <- read_sav(sav1)
#View(sav1d)

sav2d <- read_sav(sav2)
#View(sav2d)

#savxd <- read_sav(savx)

sav3d <- read_sav(sav3)



#yr1-4a person level dietary data_uk_v2 data
persdat <- subset(sav1d[c("seriali","Age", "Sex","Country","Sodiummg","Calciummg","TotalEMJ")])
```

```
sugarset <- subset(sav1d[c("seriali", "Totalsugarsg","Glucoseg","Sucroseg","Fructoseg","Lactoseg","SOFTD

persdat <- as.data.table(persdat)
sugarset <- as.data.table(sugarset)

persdat[, Sex := factor(Sex, levels = 1:2, labels = c("Male", "Female"))]
persdat[, Country := factor(Country)]

summary(persdat)
```

```
##     seriali               Age            Sex                    Country
##  Min.   :10101032   Min.   : 1.00   Male  :3157   England         :3441
##  1st Qu.:20204104   1st Qu.:10.00   Female:3671   Northern Ireland: 982
##  Median :30208051   Median :20.00                 Scotland        :1695
##  Mean   :27237093   Mean   :29.73                 Wales           : 710
##  3rd Qu.:40213171   3rd Qu.:48.00
##  Max.   :90305261   Max.   :96.00
##     Sodiummg        Calciummg          TotalEMJ
##  Min.   : 133.6   Min.   :  95.19   Min.   : 0.4161
##  1st Qu.:1528.7   1st Qu.: 583.12   1st Qu.: 5.4673
##  Median :1959.9   Median : 754.97   Median : 6.7228
##  Mean   :2067.2   Mean   : 794.85   Mean   : 7.0154
##  3rd Qu.:2492.3   3rd Qu.: 961.04   3rd Qu.: 8.2618
##  Max.   :7405.5   Max.   :3234.23   Max.   :22.3664
```

```
summary(sugarset)
```

```
##     seriali          Totalsugarsg        Glucoseg         Sucroseg
##  Min.   :10101032   Min.   :  3.607   Min.   : 0.000   Min.   :  0.2567
##  1st Qu.:20204104   1st Qu.: 65.309   1st Qu.: 9.215   1st Qu.: 25.9719
##  Median :30208051   Median : 87.685   Median :13.975   Median : 38.4110
##  Mean   :27237093   Mean   : 93.671   Mean   :15.838   Mean   : 42.5467
##  3rd Qu.:40213171   3rd Qu.:115.656   3rd Qu.:19.931   3rd Qu.: 54.2214
##  Max.   :90305261   Max.   :369.092   Max.   :86.768   Max.   :283.2085
##    Fructoseg         Lactoseg      SOFTDRINKSLOWCALORIE SOFTDRINKSNOTLOWCALORIE
##  Min.   : 0.000   Min.   : 0.000   Min.   :   0.0       Min.   :   0.0
##  1st Qu.: 8.899   1st Qu.: 6.243   1st Qu.:   0.0       1st Qu.:   0.0
##  Median :13.968   Median :10.436   Median :   0.0       Median :  50.0
##  Mean   :15.812   Mean   :12.117   Mean   : 144.4       Mean   : 144.8
##  3rd Qu.:20.428   3rd Qu.:16.179   3rd Qu.: 198.0       3rd Qu.: 200.0
##  Max.   :84.123   Max.   :79.406   Max.   :5050.8       Max.   :2197.5
##  TEACOFFEEANDWATER
##  Min.   :   0.0
##  1st Qu.: 200.0
##  Median : 556.5
##  Mean   : 696.1
##  3rd Qu.:1052.9
##  Max.   :5295.9
```

```
 #measured and recorded data yr1-4a_indiv_uk
#subsets of the table to identify grouped information
bpset <- subset(sav2d[c("seriali","Sys", "Dias", "Sys2", "Dias2","omsysval","omdiaval","CutIll")])
ethnset <- subset(sav2d[c("seriali", "EthGrG","EthGrU" ,"ethgr5","ethgr2")])
saltset <- subset(sav2d[c("seriali","SaltChk","SalHowC","SltSHow", "Na_mmol", "Na_mmol_Corrected" ,"Na_
medsset <- subset(sav2d[c("seriali", "bpmedc","bpmedd")])
```

```
hypset <- subset(sav2d[c("seriali", "hyper140", "hibp140", "hyper1", "highbp1")])
incset <- subset(sav2d[c("seriali","eqvinc","nssec8","hhinc")])
measset <- subset(sav2d[c("seriali","htval","wtval","bmival")])
ageset <- subset(sav2d[c("seriali","agegad1", "agegad2", "agegch1","agegr1","age")])
```

```
#change subsets to datatables
 bpset <- as.data.table(bpset)
 saltset <- as.data.table(saltset)
 medsset <- as.data.table(medsset)
 hypset <- as.data.table(hypset)
 ethnset <- as.data.table(ethnset)
 incset <- as.data.table(incset)
 measset <- as.data.table(measset)
 ageset <- as.data.table(ageset)

 #define factors
 #saltset
 saltset[, SaltChk := factor(SaltChk, levels = 1:8, labels = c("Salt",
    "Salt substitute",
    "Neither",
    "Item not applicable",
    "No answer/refused",
    "Don't know",
    "Qn not applicable to survey year",
    "Schedule not applicable"))]
 saltset[, SalHowC := factor(SalHowC, levels = 1:8,labels = c("Always",
"Usually",
"Sometimes",
    ",Item not applicable",
    "No answer/refused",
    " Don't know",
"Qn not applicable to survey year",
"Schedule not applicable"))]
 saltset[, SltSHow := factor(SltSHow,levels = 1:8,labels = c("Always",
                                                            "Usually",
                                                            "Sometimes",
                                                            ",Item not applicable",
                                                            "No answer/refused",
                                                            " Don't know",
                                                            "Qn not applicable to survey year",
                                                            "Schedule not applicable"))]

#medset
  medsset[, bpmedc := factor(bpmedc)]
 medsset[, bpmedd := factor(bpmedd)]


 #hypeset
 hypset[,hyper140 := factor(hyper140,levels = 1:9, labels = c(" Normotensive untreated",
" Normotensive treated",
    "Hypertensive treated",
"Hypertensive untreated",
"No answer/refused",
    "Don't know",
```

```
"Refused, attempted but not obtained, not attempted",
     "Qn not applicable to survey year",
"Item not applicable")) ]
 hypset[, hibp140 := factor(hibp140, levels = 1:7, labels = c("Not high BP",
"High BP",
    "No answer/refused",
    "Don't know",
    "Refused, attempted but not obtained, not attempted",
    "Qn not applicable to survey year",
    "Item not applicable")) ]
 hypset[, hyper1 := factor(hyper1,levels = 1:9, labels = c(" Normotensive untreated",
                                                           " Normotensive treated",
                                                           "Hypertensive treated",
                                                           "Hypertensive untreated",
                                                           "No answer/refused",
                                                           "Don't know",
                                                           "Refused, attempted but not obtained, not att
                                                           "Qn not applicable to survey year",
                                                           "Item not applicable"))]
 hypset[, highbp1 := factor(highbp1, levels = 1:7, labels = c("Not high BP",
                                                              "High BP",
                                                              "No answer/refused",
                                                              "Don't know",
                                                              "Refused, attempted but not obtained, not
                                                              "Qn not applicable to survey year",
                                                              "Item not applicable")) ]


 cutillcat <- c("Cancer (neoplasm) including lumps, masses, tumours and growths and benign (non-malignan
                ,"Diabetes. Incl. Hyperglycemia"
                , "Other endocrine/metabolic"
                ,"Mental illness/anxiety/depression/nerves (nes)"
                ,"Mental handicap"
                , "Epilepsy/fits/convulsions"
                ,"Migraine/headaches
                "," Other problems of nervous system
                "," Cataract/poor eye sight/blindness
                ","Other eye complaints
                ","Poor hearing/deafness
                ","Tinnitus/noises in the ear
                ","Menieres disease/ear complaints causing balance problems
"," Other ear complaints
    "," Stroke/cerebral haemorrhage/cerebral thrombosis
    ","Heart attack/angina
","Hypertension/high blood pressure/blood pressure (nes)
    "," Other heart problems
    ","Piles/haemorrhoids incl. Varicose Veins in anus
    "," Varicose veins/phlebitis in lower extremities
","Other blood vessels/embolic
    ","Bronchitis/emphysema
    ","Asthma
    "," Hayfever
    ","Other respiratory complaints
```

```
    ","Stomach ulcer/ulcer (nes)/abdominal hernia/rupture
    ","Other digestive complaints (stomach, liver, pancreas, bile ducts, small intestine)
    ","Complaints of bowel/colon (large intestine, caecum, bowel, colon, rectum)
    ","Complaints of teeth/mouth/tongue
    ","Kidney complaints
    ","Urinary tract infection
    ","Other bladder problems/incontinence
    ","Reproductive system disorders
    ","Arthritis/rheumatism/fibrositis
    ","Back problems/slipped disc/spine/neck
","Other problems of bones/joints/muscles
"," Infectious and parasitic disease
","Disorders of blood and blood forming organs and immunity disorders
    ","Skin complaints
    ","Other complaints
","Unclassifiable (no other codable complaint)
    ","Complaint no longer present
","No answer/refused
    ","Dont know"
                ,"Qn not applicable to survey year"
                ,"Item not applicable")

#incset

 hhinccat <- c("Under £5,000","
    £5,000 - £9,999","
    £10,000 - £14,999","
    £15,000 - £19,999","
     £20,000 - £24,999","
     £25,000 - £29,999","
     £30,000 - £34,999","
     £35,000 - £39,999","
     £40,000 - £44,999","
    £45,000 - £49,999","
£50,000 - £74,999","
    £75,000 - £99,999","
£100,000 or more","
    No answer/refused","
     Dont know","
Qn not applicable to survey year","
Item not applicable")


#bpset
 bpset[, CutIll := factor(CutIll, levels = 1:46, labels = cutillcat)]
 bpset[, "omsysval" := as.numeric(omsysval)]
 bpset[,Sys := as.numeric(Sys)]


#ethnset
ethnset[ , EthGrG := factor(EthGrG)]
ethnset[ , EthGrU := factor(EthGrU)]
ethnset[ , ethgr5 := factor(ethgr5, levels = 1:5, labels = c( 'White'
```

```
                                                                , 'Mixed ethnic group'
                                                                , 'Black or Black British'
                                                                , 'Asian or asian British'
                                                                , 'Any other group'))]
ethnset[ , ethgr2 := factor(ethgr2, levels = 1:2, labels = c( 'White'
                                                                , 'Non-white'))]

#incset
incset[ , nssec8 := factor(nssec8, levels = 1:9, labels = c(  "Higher managerial and professional occupa
               , "Intermediate occupations"
                           , "Small employers and own account workers"
                           , "Lower supervisory and technical occupations"
                           , "Semi-routine occupations"
                           , "Routine occupations"
                           , "Never worked"
                           , "Other"))]
incset[ , hhinc := factor (hhinc, levels = 1:17,labels = hhinccat)]


#ageset
ageset[,agegad1 := factor(agegad1, levels = 1:4 ,labels = c("16-24","25-49","50-64","65+ years"))]
ageset[,agegad2 := factor(agegad2, levels = 1:5, labels = c("16-18","19-34","35-49","50-64","65+ years"
ageset[,agegch1 := factor(agegch1, levels = 1:3, labels = c("8-10","11-12","13-15"))]
ageset[,agegr1 := factor(agegr1, levels = 1:5, labels = c("1.5-3 years","4-10 years","11-18 years","19-

#add columns for g equivalent of mmol for sodium
saltset$Na_g_Corrected <- saltset$Na_mmol_Corrected/17.1
saltset$Na_g <- saltset$Na_mmol/17.1
saltset$Na_g_24h_4_10CLAIM <- saltset$Na_mmol_24h_4_10CLAIM/17.1
saltset$Na_g_24h_4_10CLAIM_Corrected <- saltset$Na_mmol_24h_4_10CLAIM_Corrected/17.1
```

the literature

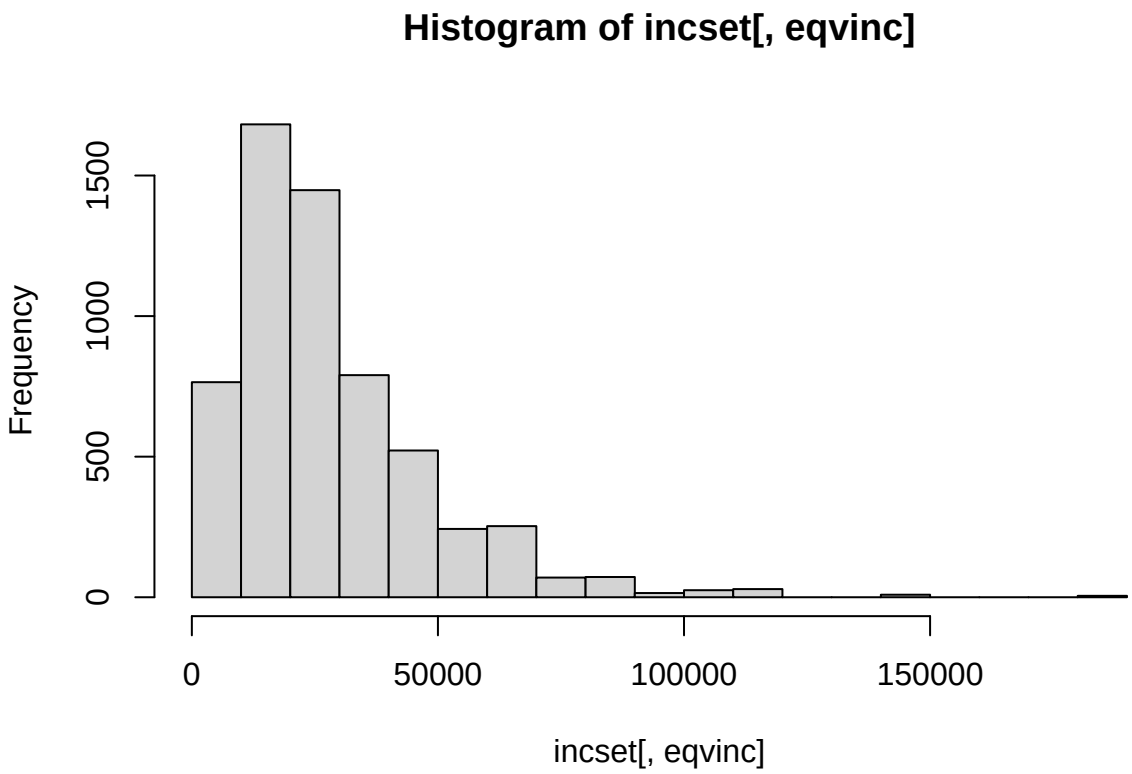
The time trend analysis showed changes in salt intake. Whilst BP measurements were made the results are not reported on in the paper.

It would be useful to understand if the predicted improvements in BP were found in the same population.

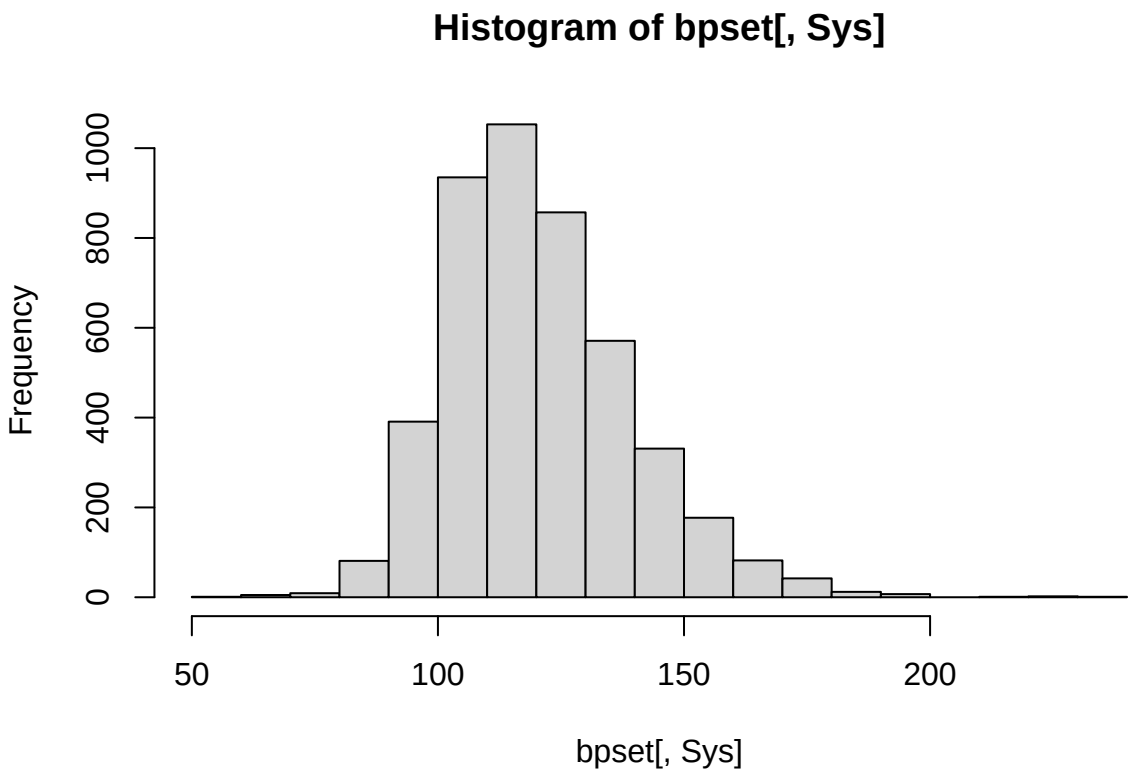
Then the meaning of these results needs to be understandable at the level of those able to implement policy. The NDNS population is structured to match UK age and sex profiles as well as regional representation.

Rebasing this population to match practice, LA or ICB populations will give a better understanding of how the results apply to populations for which commissioners have responsibility.

```
 #View(bpset)
#description of dataset
#bpset

hist(incset[,eqvinc])
```




```
hist(bpset[,Sys])
```

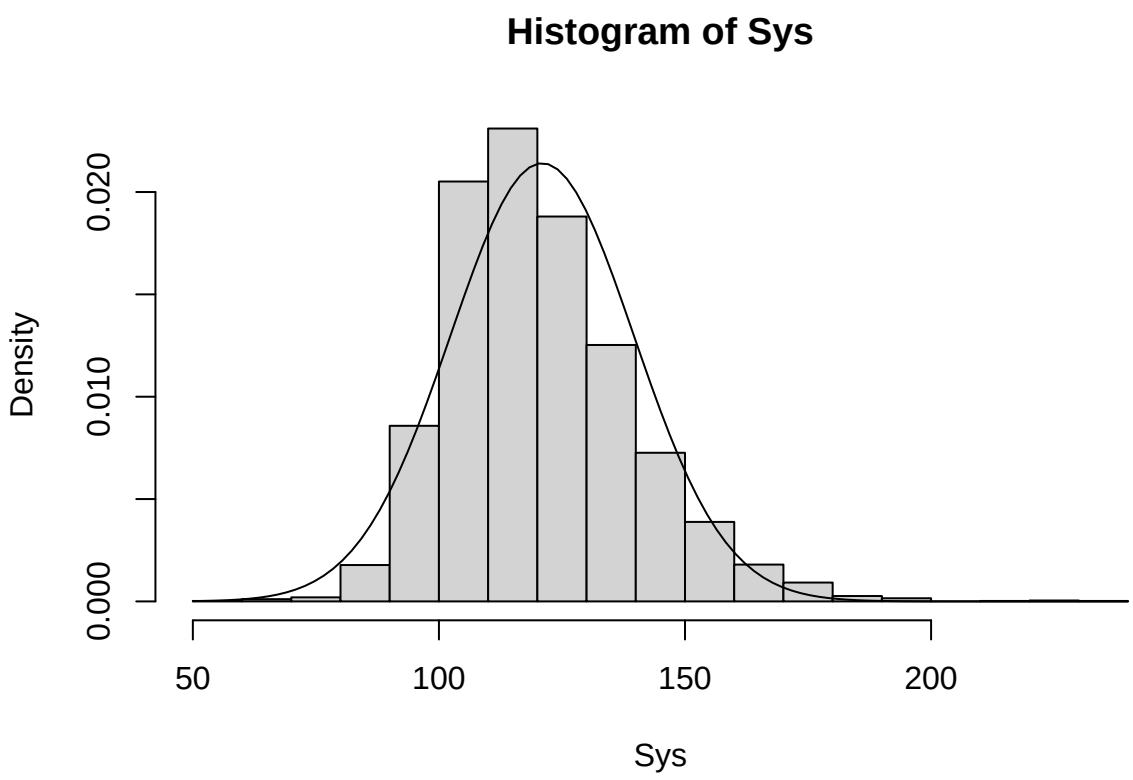



```
bpset[, hist(Sys, prob = TRUE)] # histogram
```

```
## $breaks
##  [1]  50  60  70  80  90 100 110 120 130 140 150 160 170 180 190 200 210 220 230
## [20] 240
##
## $counts
##  [1]    1    5    9   81  391  935 1053  857  571  331  177   82   42   12    7
## [16]    0    1    2    1
##
## $density
##  [1] 2.193945e-05 1.096972e-04 1.974550e-04 1.777095e-03 8.578324e-03
##  [6] 2.051338e-02 2.310224e-02 1.880211e-02 1.252742e-02 7.261957e-03
## [11] 3.883282e-03 1.799035e-03 9.214568e-04 2.632734e-04 1.535761e-04
## [16] 0.000000e+00 2.193945e-05 4.387889e-05 2.193945e-05
##
## $mids
##  [1]  55  65  75  85  95 105 115 125 135 145 155 165 175 185 195 205 215 225 235
##
## $xname
## [1] "Sys"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
```

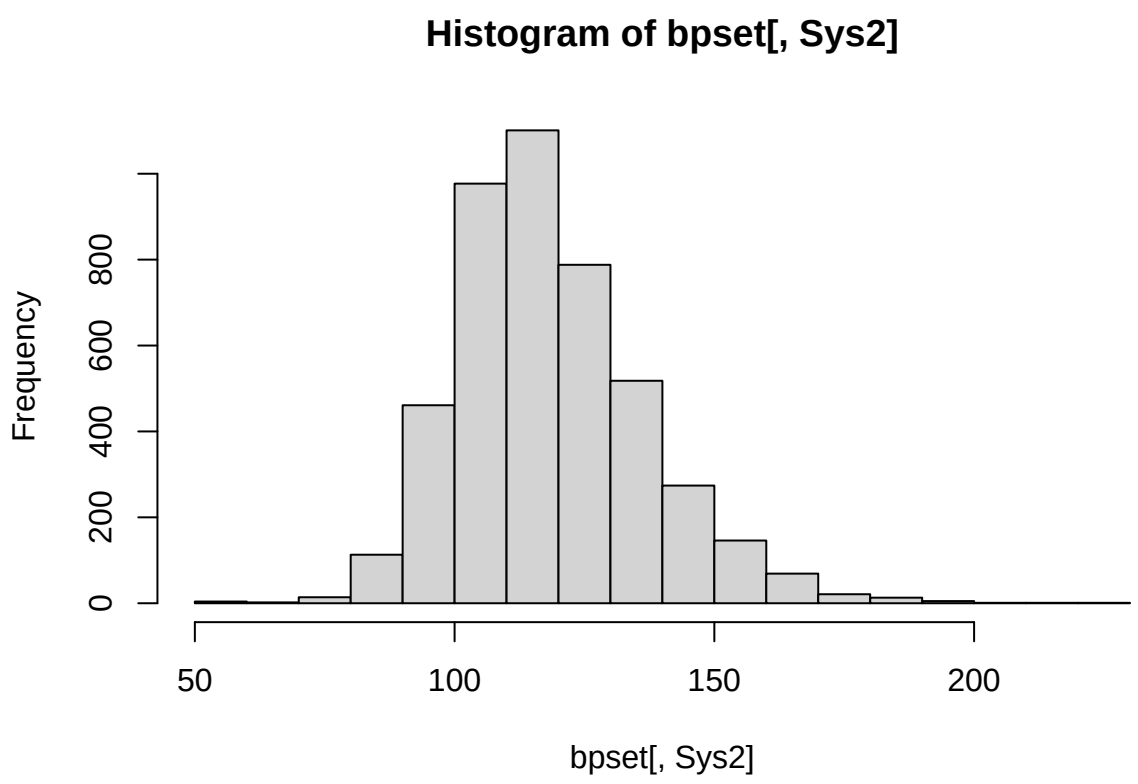
```
## [1] "histogram"
```

```
bpset[, curve(
  dnorm(x, mean(Sys, na.rm = TRUE), sd(Sys, na.rm = TRUE)),
  add = TRUE)] # superimpose a Normal distribution
```

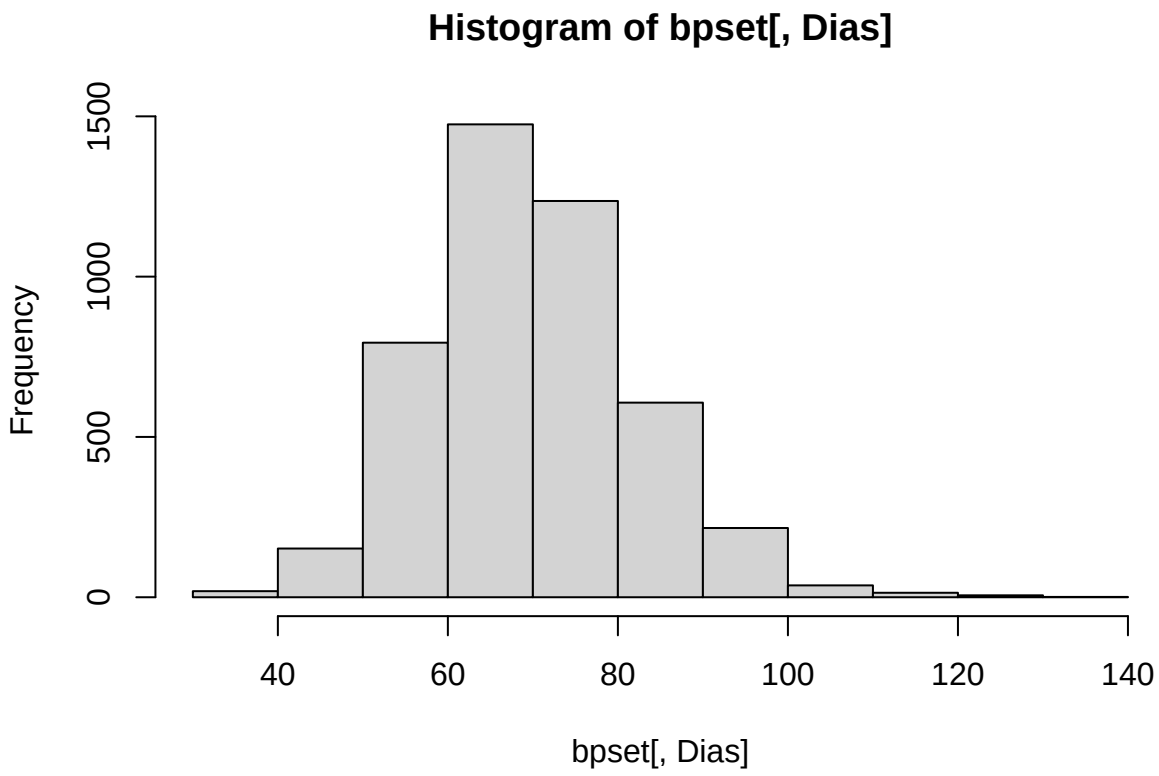



```
##          x           y
##   1:  50.0 1.516881e-05
##   2:  51.9 2.224979e-05
##   3:  53.8 3.229877e-05
##   4:  55.7 4.640147e-05
##   5:  57.6 6.597254e-05
##  ---
##  97: 232.4 3.695316e-10
##  98: 234.3 1.998262e-10
##  99: 236.2 1.069397e-10
## 100: 238.1 5.663845e-11
## 101: 240.0 2.968720e-11
```

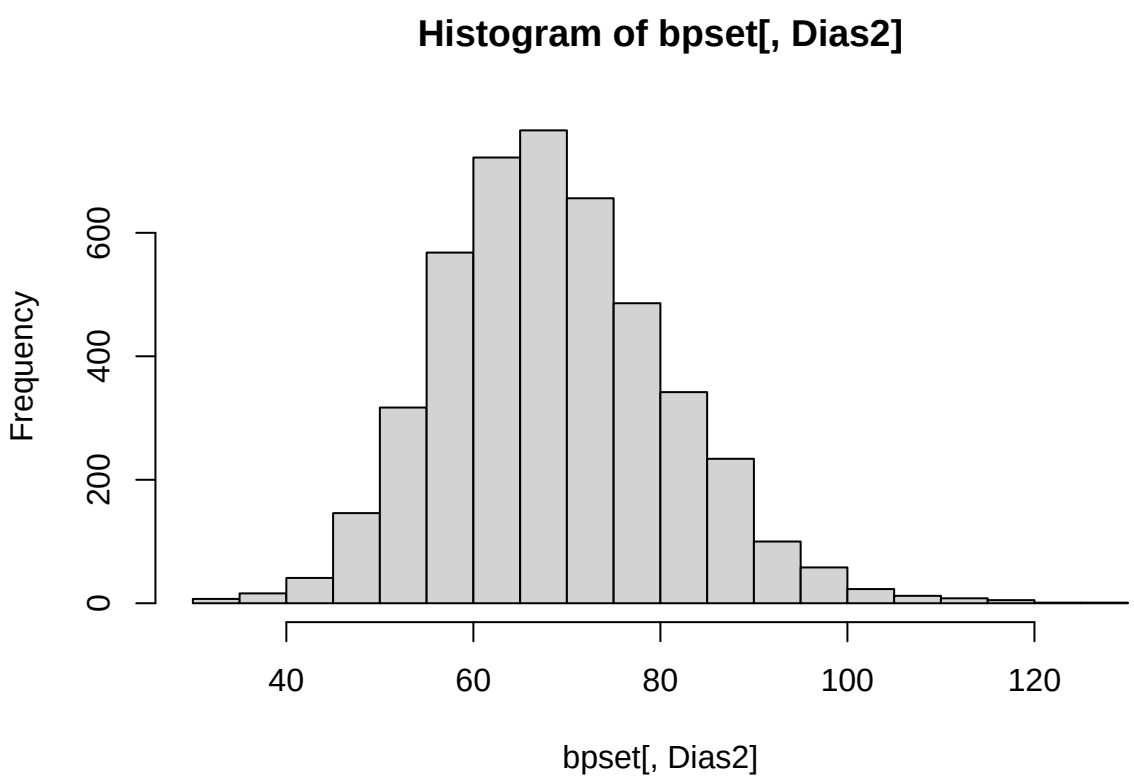
```
hist(bpset[,Sys2])
```



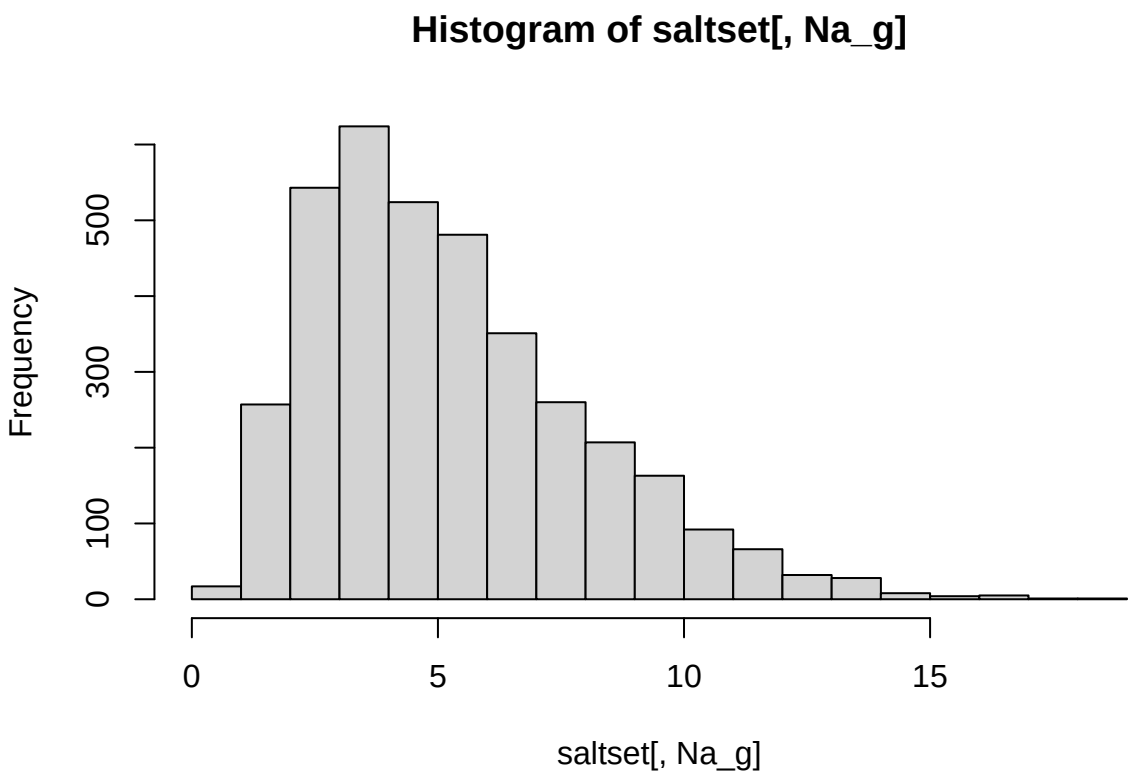

```
hist(bpset[,Dias])
```



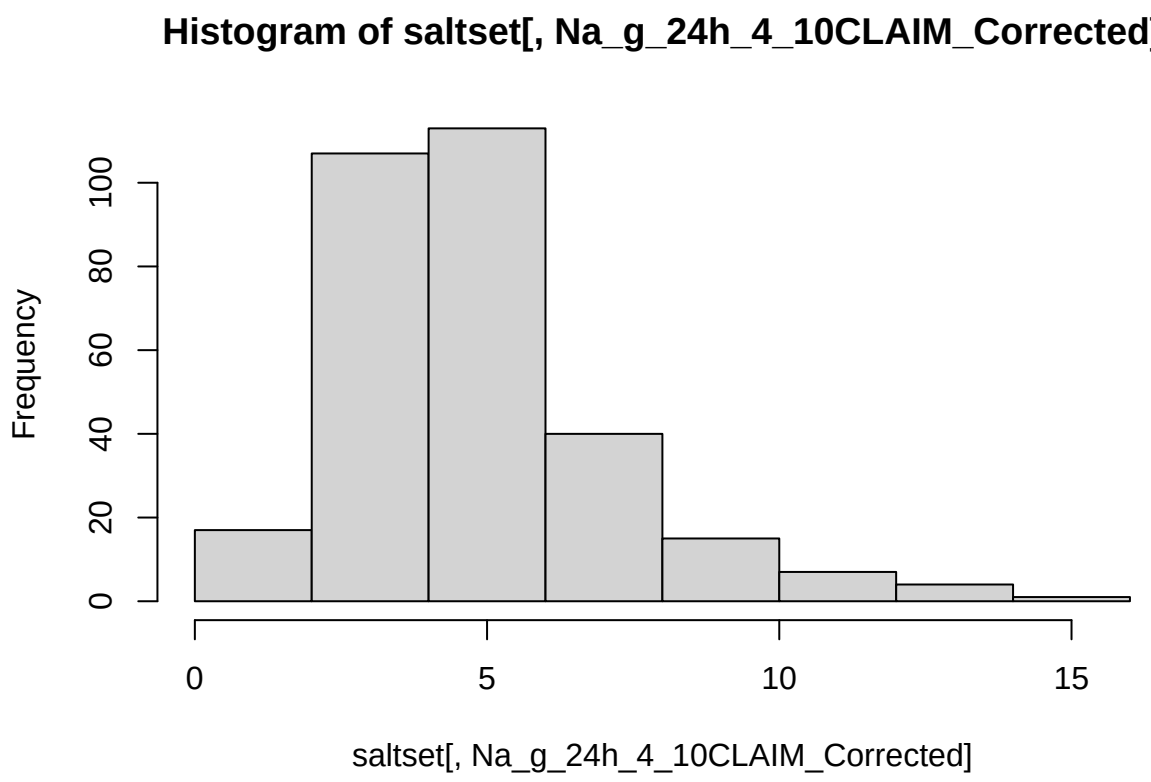

```
hist(bpset[,Dias2])
```




```
hist(saltset[,Na_g])
```




```
hist(saltset[,Na_g_24h_4_10CLAIM_Corrected])
```




```
#cutillgraph <- ggplot(bpset,aes(CutIll,Sys))+geom_col()
#cutillgraph
```

```
summary(bpset)
```

```
##     seriali              Sys            Dias            Sys2
##  Min.   :10101032   Min.   : 52    Min.   : 31.00   Min.   : 54
##  1st Qu.:20204104   1st Qu.:108    1st Qu.: 62.00   1st Qu.:107
##  Median :30208051   Median :118    Median : 69.00   Median :117
##  Mean   :27237093   Mean   :121    Mean   : 70.38   Mean   :119
##  3rd Qu.:40213171   3rd Qu.:132    3rd Qu.: 78.00   3rd Qu.:129
##  Max.   :90305261   Max.   :234    Max.   :137.00   Max.   :227
##                     NA's   :2270   NA's   :2271     NA's   :2319
##      Dias2           omsysval        omdiaval
##  Min.   : 31.00   Min.   : 77.5   Min.   : 35.00
##  1st Qu.: 61.00   1st Qu.:106.5   1st Qu.: 61.00
##  Median : 69.00   Median :116.0   Median : 68.50
##  Mean   : 69.23   Mean   :119.1   Mean   : 69.24
##  3rd Qu.: 77.00   3rd Qu.:129.5   3rd Qu.: 76.50
##  Max.   :129.00   Max.   :220.0   Max.   :127.50
##  NA's   :2319     NA's   :3321    NA's   :3321
##                                                                                  CutIll
##  Other respiratory complaints\n\t                                                    : 193
##  Other problems of bones/joints/muscles\n                                            : 127
##  Unclassifiable (no other codable complaint)\n\t                                     : 105
##  Other digestive complaints (stomach, liver, pancreas, bile ducts, small intestine)\n\t:  81
##  Back problems/slipped disc/spine/neck\n                                             :  52
```

```
##  (Other)                                                                  : 245
##  NA's                                                                     :6025
```

```
summary(saltset)
```

```
##     seriali                          SaltChk                     SalHowC
##  Min.   :10101032   Salt                :3469   Always              :1806
##  1st Qu.:20204104   Neither             :3176   Sometimes           : 914
##  Median :30208051   Salt substitute     : 181   Usually             : 747
##  Mean   :27237093   Item not applicable:   0   ,Item not applicable:   0
##  3rd Qu.:40213171   No answer/refused   :   0   No answer/refused   :   0
##  Max.   :90305261   (Other)             :   0   (Other)             :   0
##                     NA's                :   2   NA's                :3361
##                  SltSHow        Na_mmol       Na_mmol_Corrected
##  Always              :  73   Min.   :  3.54   Min.   :  3.70
##  Usually             :  57   1st Qu.: 54.30   1st Qu.: 57.10
##  Sometimes           :  51   Median : 80.65   Median : 84.85
##  ,Item not applicable:   0   Mean   : 90.03   Mean   : 94.71
##  No answer/refused   :   0   3rd Qu.:116.92   3rd Qu.:123.03
##  (Other)             :   0   Max.   :312.20   Max.   :328.40
##  NA's                :6647   NA's   :3164     NA's   :3164
##  Na_mmol_24h_4_10CLAIM Na_mmol_24h_4_10CLAIM_Corrected Na_g_Corrected
##  Min.   : 10.50        Min.   : 11.00                  Min.   : 0.216
##  1st Qu.: 51.75        1st Qu.: 54.45                  1st Qu.: 3.339
##  Median : 71.40        Median : 75.10                  Median : 4.962
##  Mean   : 77.75        Mean   : 81.80                  Mean   : 5.539
##  3rd Qu.: 94.72        3rd Qu.: 99.62                  3rd Qu.: 7.194
##  Max.   :250.30        Max.   :263.30                  Max.   :19.205
##  NA's   :6524          NA's   :6524                    NA's   :3164
##       Na_g        Na_g_24h_4_10CLAIM Na_g_24h_4_10CLAIM_Corrected
##  Min.   : 0.207   Min.   : 0.614     Min.   : 0.643
##  1st Qu.: 3.175   1st Qu.: 3.026     1st Qu.: 3.184
##  Median : 4.716   Median : 4.175     Median : 4.392
##  Mean   : 5.265   Mean   : 4.547     Mean   : 4.783
##  3rd Qu.: 6.838   3rd Qu.: 5.539     3rd Qu.: 5.826
##  Max.   :18.257   Max.   :14.637     Max.   :15.398
##  NA's   :3164     NA's   :6524       NA's   :6524
```

```
summary(medsset)
```

```
##     seriali          bpmedc      bpmedd
##  Min.   :10101032   0   :1412   0   :1550
##  1st Qu.:20204104   1   : 450   1   : 312
##  Median :30208051   NA's:4966   NA's:4966
##  Mean   :27237093
##  3rd Qu.:40213171
##  Max.   :90305261
```

```
summary(hypset)
```

```
##     seriali                            hyper140
##  Min.   :10101032    Normotensive untreated:2877
##  1st Qu.:20204104   Hypertensive untreated : 368
##  Median :30208051    Normotensive treated  : 142
##  Mean   :27237093   Hypertensive treated   : 120
##  3rd Qu.:40213171   No answer/refused      :   0
```

```
##  Max.   :90305261   (Other)                :   0
##                     NA's                   :3321
##                                                hibp140
##  Not high BP                                       : 630
##  High BP                                           :   0
##  No answer/refused                                 :   0
##  Don't know                                        :   0
##  Refused, attempted but not obtained, not attempted:   0
##  (Other)                                           :   0
##  NA's                                              :6198
##                      hyper1
##   Normotensive untreated:3149
##   Normotensive treated  : 221
##  Hypertensive untreated :  96
##  Hypertensive treated   :  41
##  No answer/refused      :   0
##  (Other)                :   0
##  NA's                   :3321
##                                                highbp1
##  Not high BP                                       : 358
##  High BP                                           :   0
##  No answer/refused                                 :   0
##  Don't know                                        :   0
##  Refused, attempted but not obtained, not attempted:   0
##  (Other)                                           :   0
##  NA's                                              :6470
```

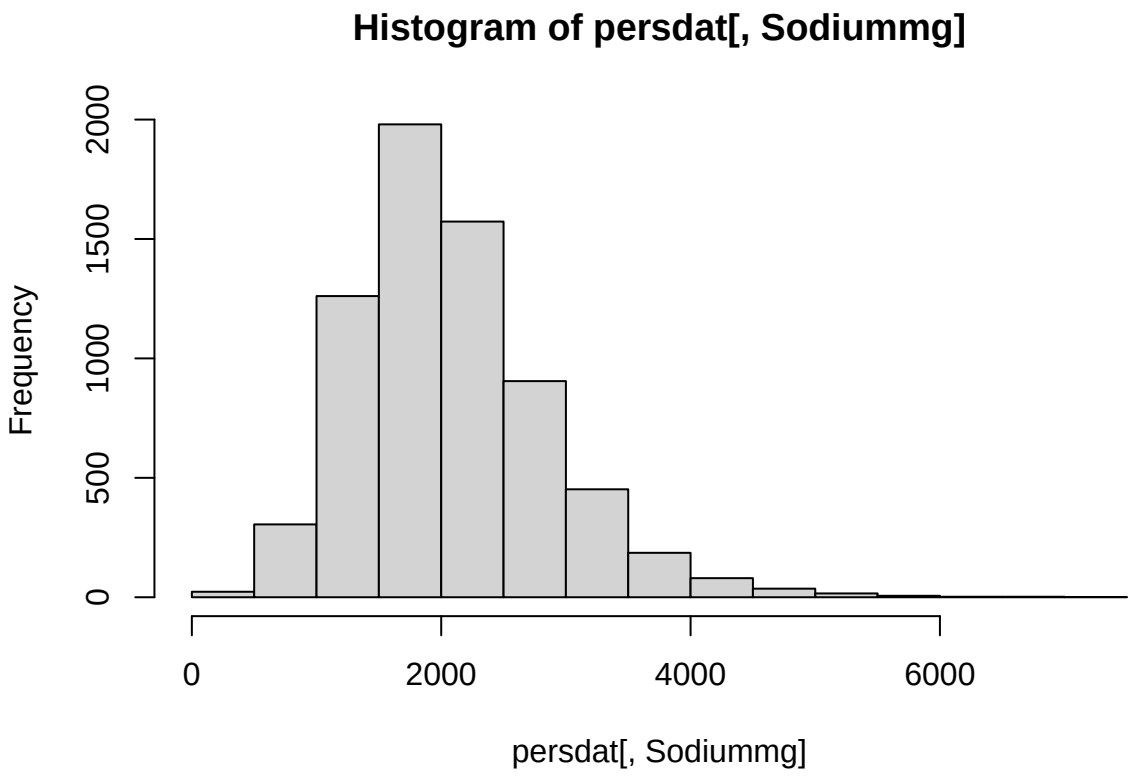
```
summary(ageset)
```

```
##     seriali              agegad1          agegad2      agegch1
##  Min.   :10101032   16-24    : 821   16-18    : 575   8-10 : 546
##  1st Qu.:20204104   25-49    :1583   19-34    : 770   11-12: 328
##  Median :30208051   50-64    : 868   35-49    :1059   13-15: 594
##  Mean   :27237093   65+ years: 753   50-64    : 868   NA's :5360
##  3rd Qu.:40213171   NA's     :2803   65+ years: 753
##  Max.   :90305261                   NA's     :2803
##          agegr1          age
##  1.5-3 years: 604   Min.   : 1.00
##  4-10 years :1277   1st Qu.:10.00
##  11-18 years:1497   Median :20.00
##  19-64 years:2697   Mean   :29.73
##  65+ years  : 753   3rd Qu.:48.00
##                     Max.   :96.00
```

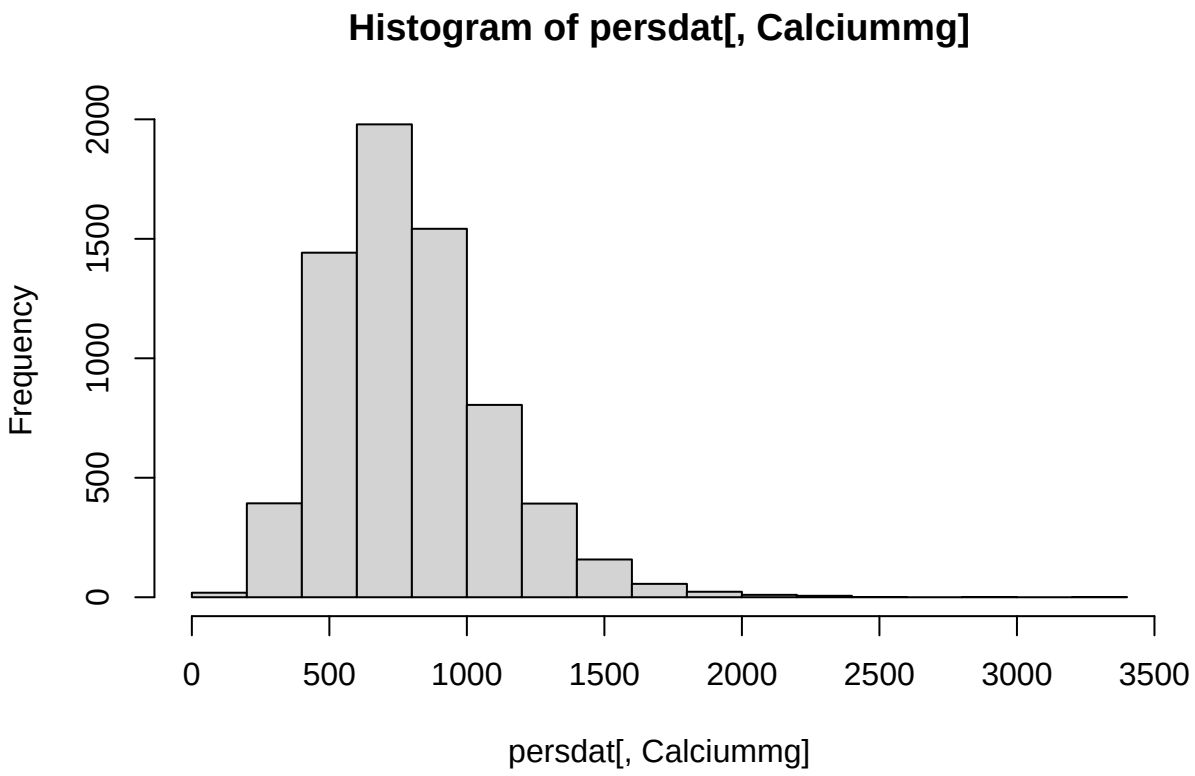
#method The NDNS is a postcode randomised survey which approaches approximately 1000 people each year. The sample selects 500 adults and 500 children. The numbers are managed to deliver a representative sample for the UK.

These participants are asked some basic questions and if they agree to take part are given a 4 day dietary diary. The recorded intake is then analysed for intake by food. These foods have defined contents which can then be reduced to their elemental constituents.

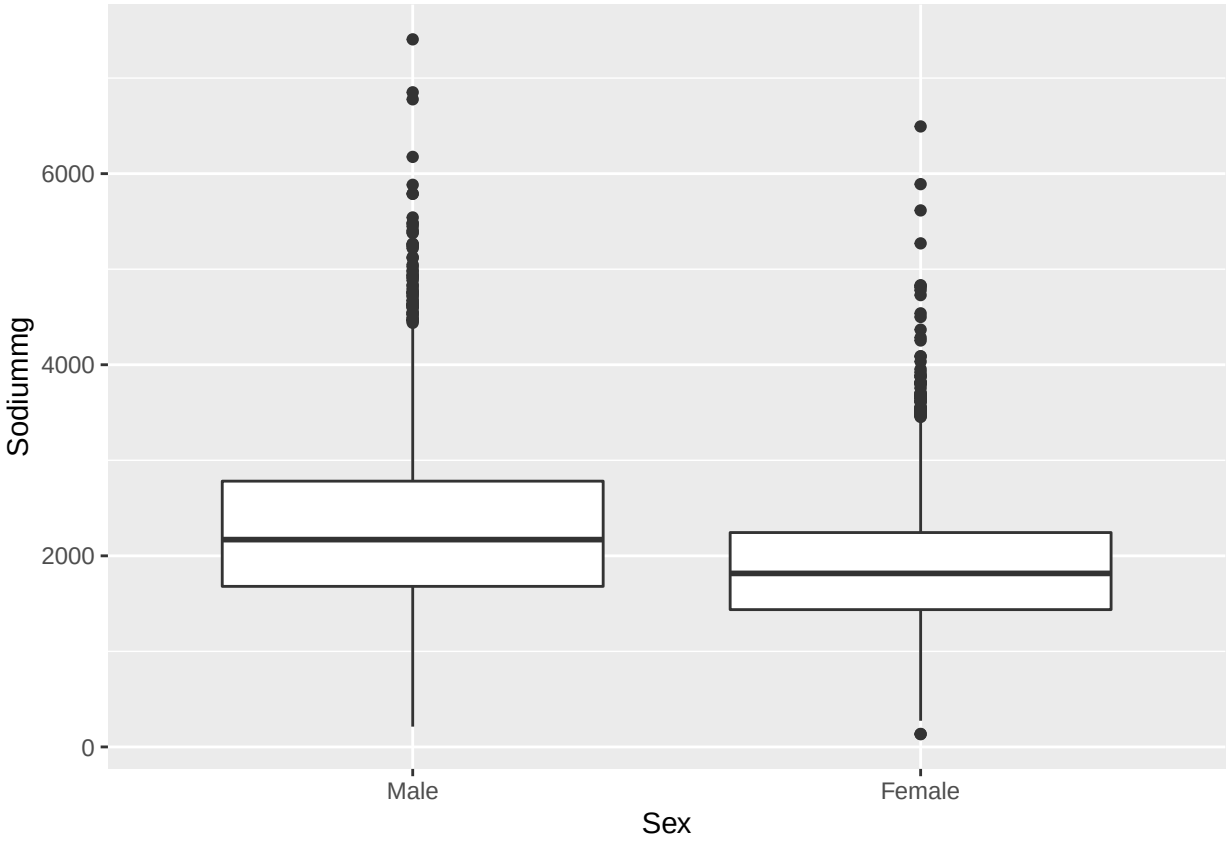
```
hist(persdat[,Sodiummg])
```



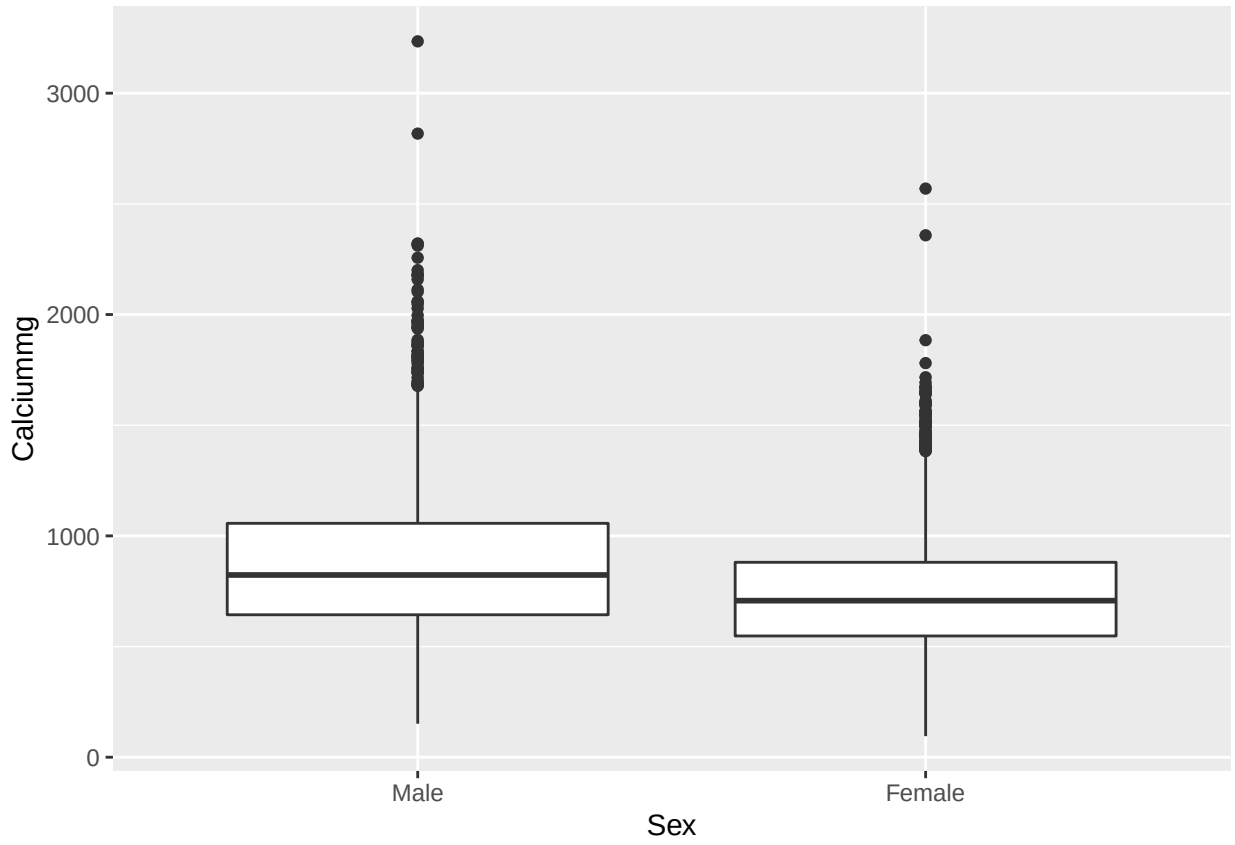

```
hist(persdat[,Calciummg])
```




```
dietnagraph <- ggplot(persdat, aes(Sex,Sodiummg))+ geom_boxplot()
dietnagraph
```




```
dietcagraph <- ggplot(persdat, aes(Sex,Calciummg))+ geom_boxplot()
dietcagraph
```



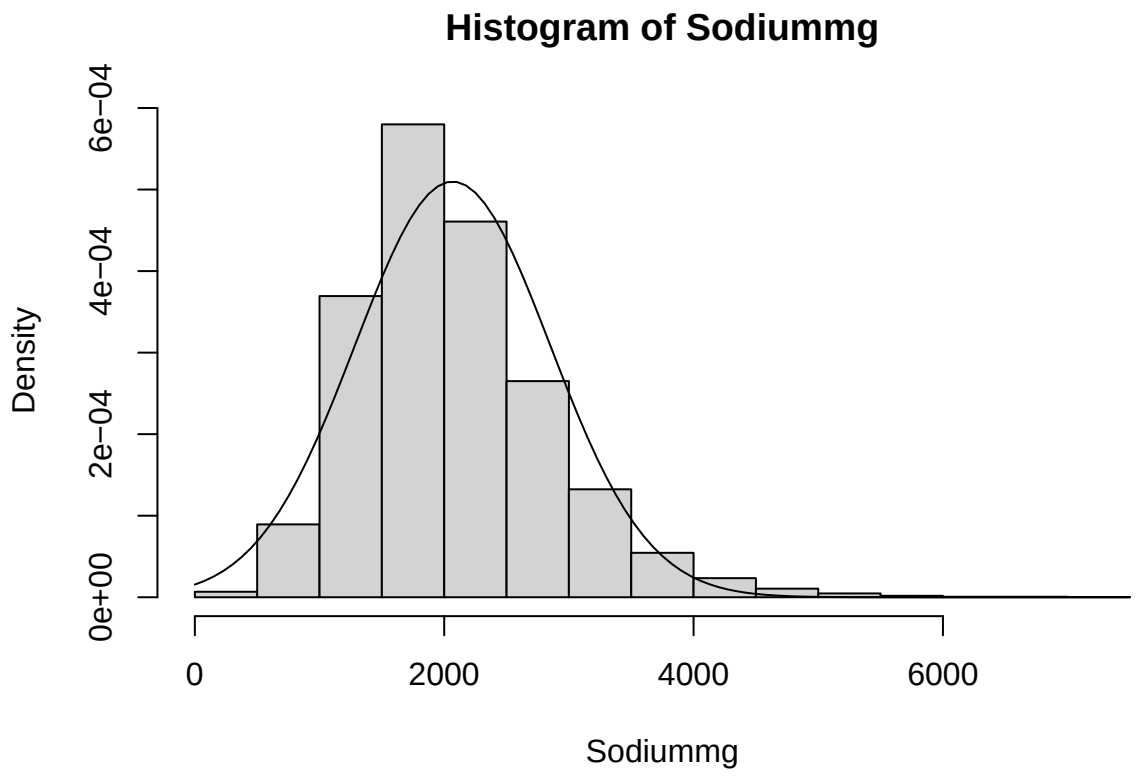

```
#combine data from tables

persugar <- merge(persdat,sugarset, by = "seriali")
persethnsugar <- merge(ethnset , persugar, by = "seriali")
incethsugar <- merge(persethnsugar, incset , by = "seriali")

bpdietdat <- merge(persdat,bpset, by = "seriali" )
medhypdat <- merge(medsset, hypset, by = "seriali")
medbppers <- merge(medhypdat, bpset, by ="seriali")

meaage <- merge(measset,ageset, by ="seriali" )
meaages <- merge(meaage, saltset, by = "seriali")


nearlyalldata <- merge(incethsugar, medbppers, by ="seriali")
alldata <- merge(nearlyalldata, meaages, by ="seriali")

alldatam <- alldata[Sex == "Male"]
alldataf <- alldata[Sex == "Female"]
#View(alldata)
```

```
#bpdietdatq <- subset(bpdietdat[,c("seriali","Age","Sodiummg","eqvinc","Sys", "Dias", "Sys2", "Dias2","
#bpdietdatq <- bpdietdatq[,is.na(bpdietdat[Sys]) ]
#View(bpdietdatq)
#Summary(bpdietdatq)
```

```r
bpdietdat[, hist(Sodiummg, prob = TRUE)] # histogram
```

```
## $breaks
##  [1]    0  500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500 6000 6500 7000
## [16] 7500
##
## $counts
##  [1]   23  305 1261 1980 1573  905  452  186   80   36   16    6    2    2    1
##
## $density
##  [1] 6.736965e-06 8.933802e-05 3.693615e-04 5.799649e-04 4.607499e-04
##  [6] 2.650849e-04 1.323960e-04 5.448155e-05 2.343292e-05 1.054482e-05
## [11] 4.686585e-06 1.757469e-06 5.858231e-07 5.858231e-07 2.929115e-07
##
## $mids
##  [1]  250  750 1250 1750 2250 2750 3250 3750 4250 4750 5250 5750 6250 6750 7250
##
## $xname
## [1] "Sodiummg"
##
## $equidist
## [1] TRUE
##
## attr(,"class")
## [1] "histogram"
```

```r
bpdietdat[, curve(
  dnorm(x, mean(Sodiummg, na.rm = TRUE), sd(Sodiummg, na.rm = TRUE)),
  add = TRUE
)] # superimpose a Normal distribution
```

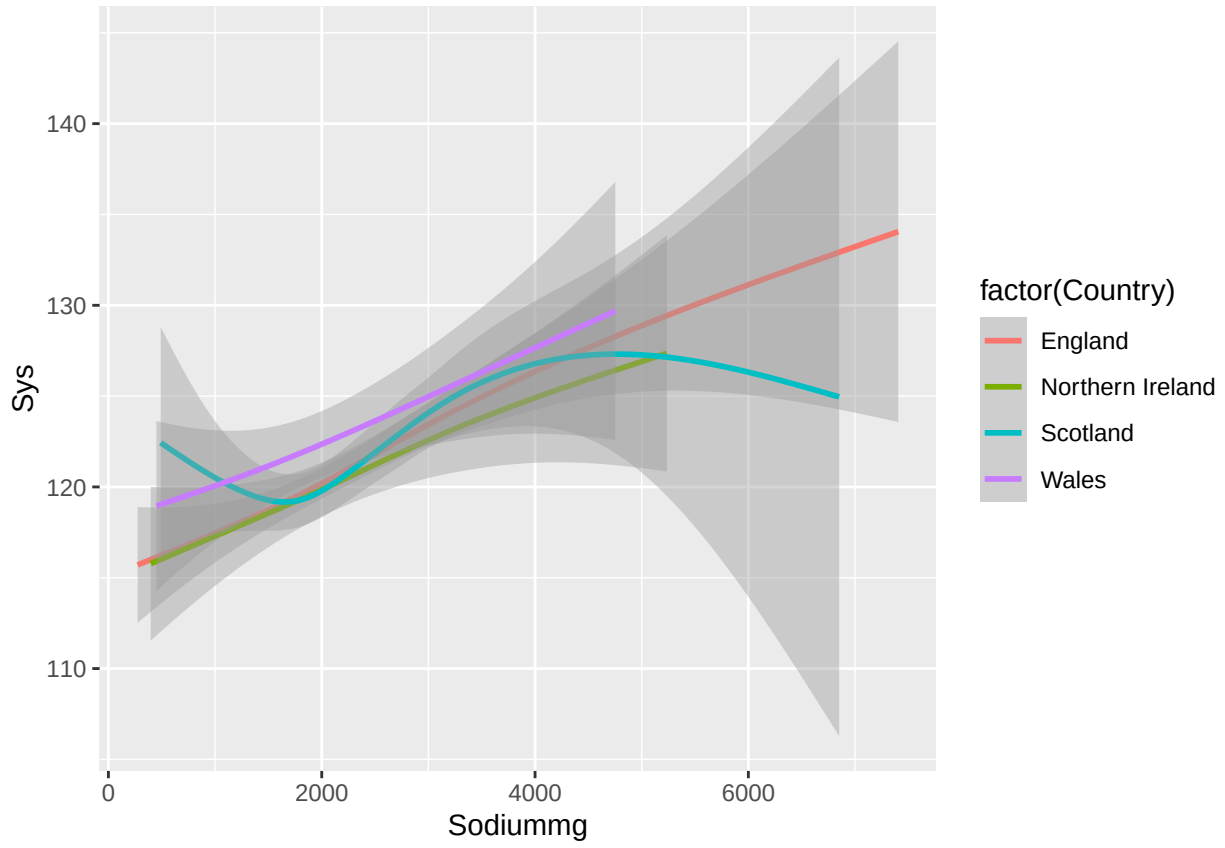



```
##         x           y
##   1:    0 1.556061e-05
##   2:   75 1.995210e-05
##   3:  150 2.534902e-05
##   4:  225 3.191130e-05
##   5:  300 3.980509e-05
##  ---
##  97: 7200 2.319412e-13
##  98: 7275 1.231322e-13
##  99: 7350 6.477031e-14
## 100: 7425 3.375913e-14
## 101: 7500 1.743481e-14
```

```
# graph section view the data
#bpdietdat[Sex == "2" ,plot("Sodiummg","Sys")]
graph1 <- ggplot(bpdietdat, aes(Sodiummg, Sys, colour = factor(Country)) ) + geom_smooth()
graph1
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

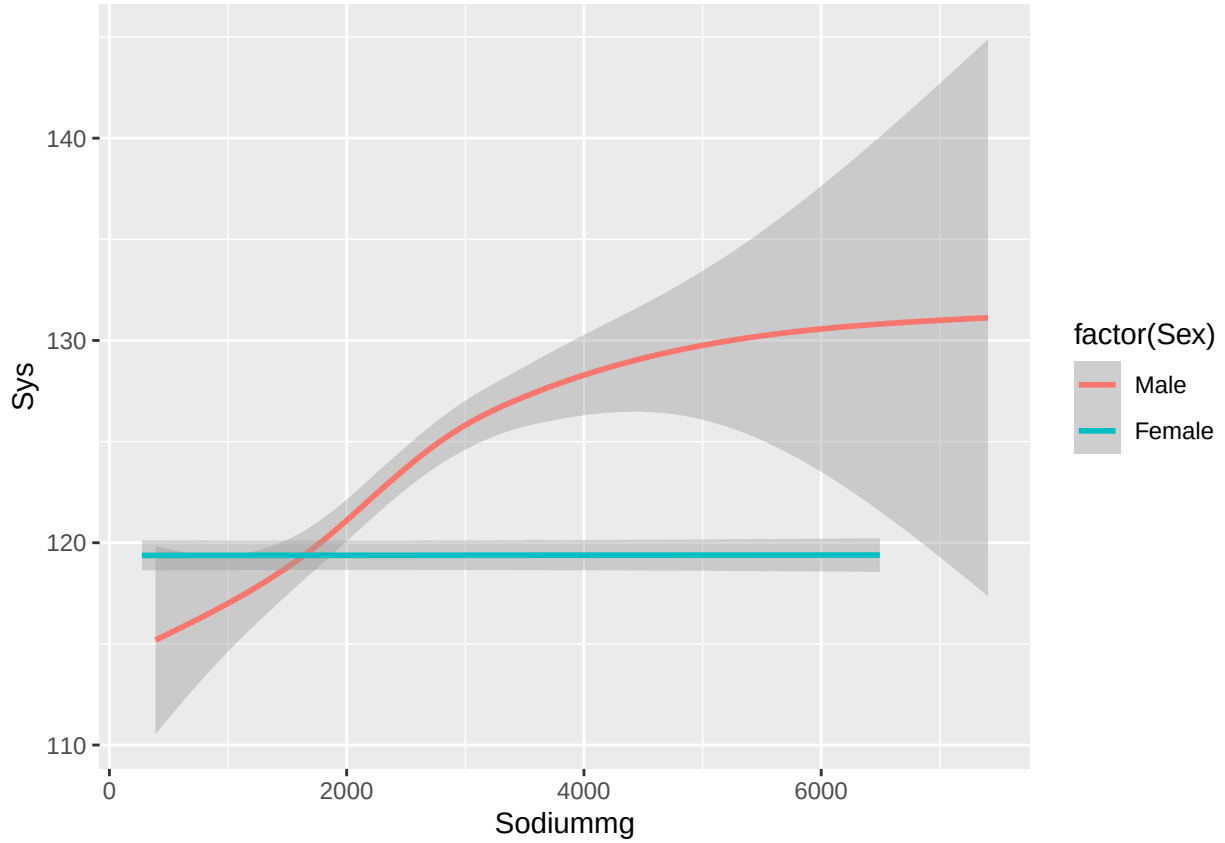
```
## Warning: Removed 2270 rows containing non-finite values (stat_smooth).
```




```
graph1a <- ggplot(bpdietdat, aes(Sodiummg, Sys, colour = factor(Sex)) )+ geom_smooth()
graph1a
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

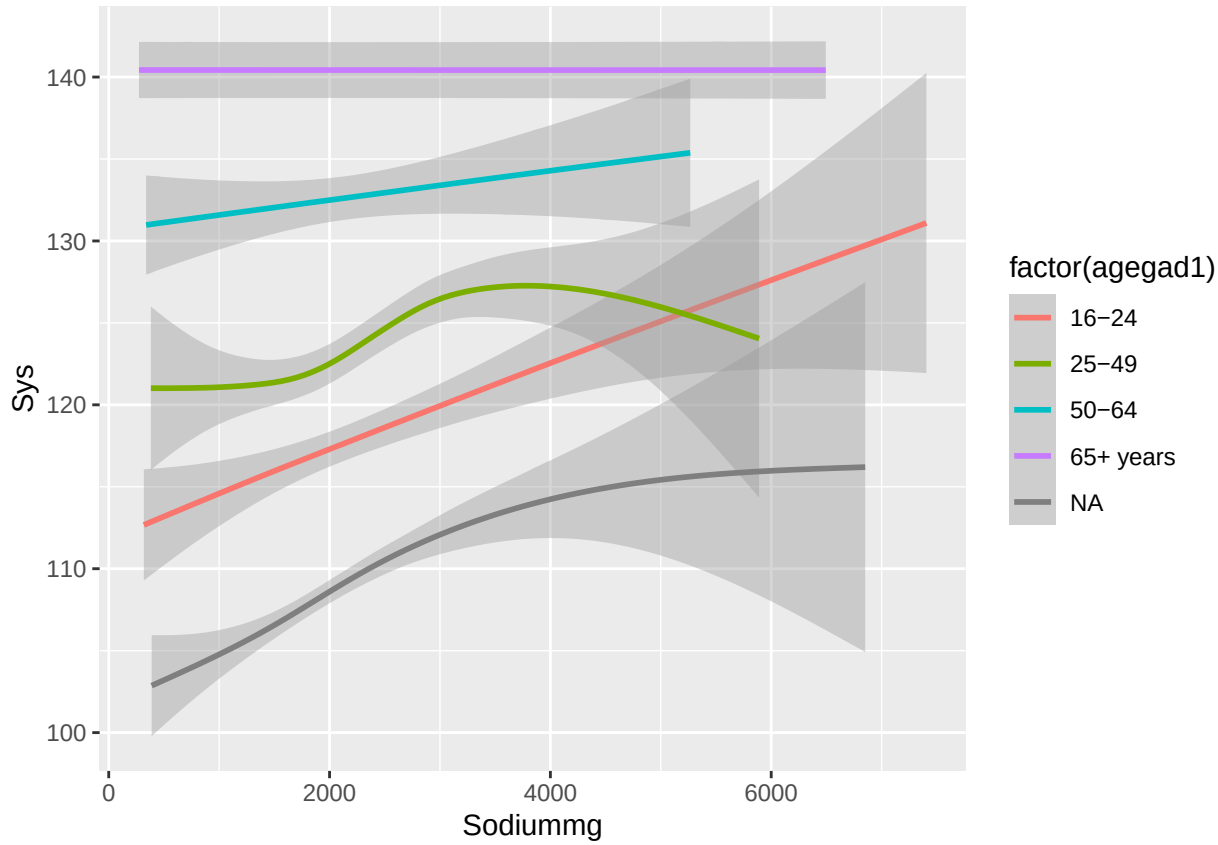
```
## Warning: Removed 2270 rows containing non-finite values (stat_smooth).
```




```
graph1b <- ggplot(alldata, aes(Sodiummg, Sys, colour = factor(agegad1)) ) + geom_smooth()
graph1b
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

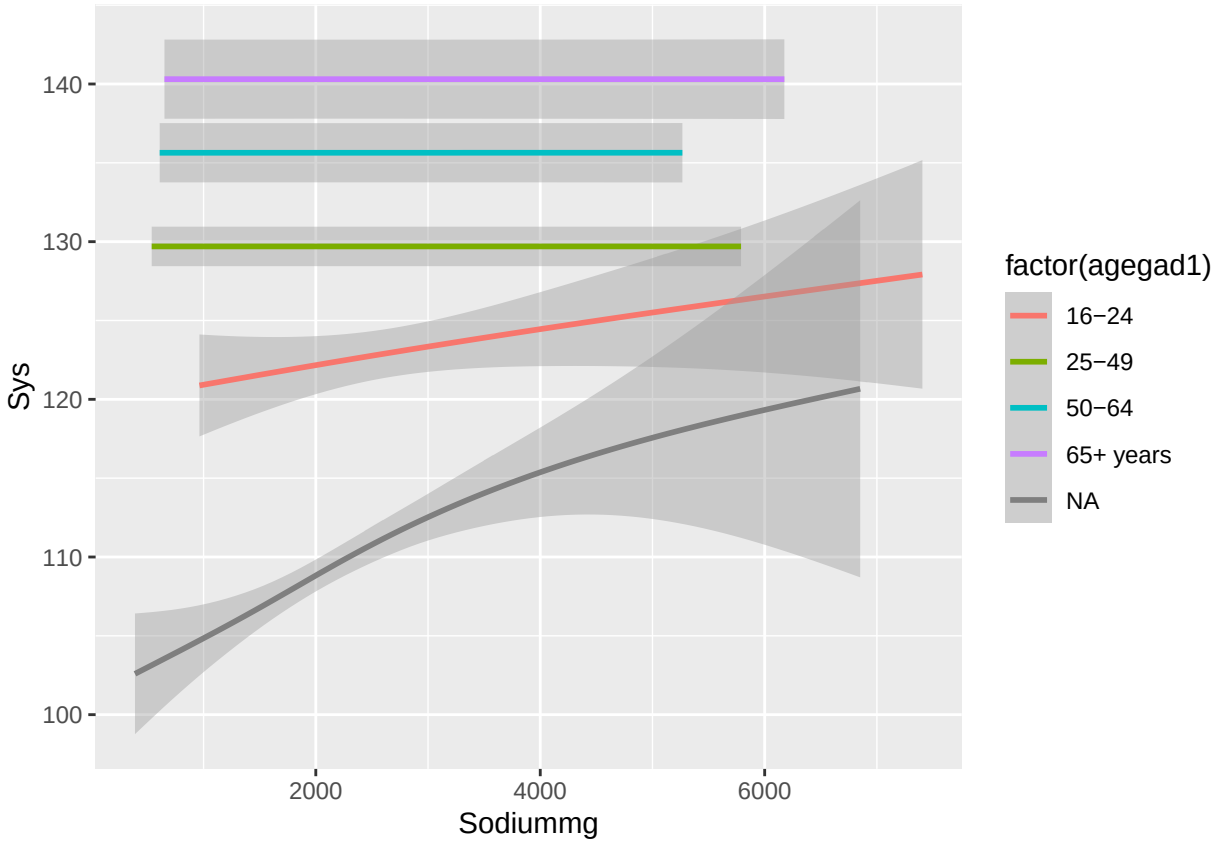
```
## Warning: Removed 2270 rows containing non-finite values (stat_smooth).
```




```
graph1bm <- ggplot(alldatam, aes(Sodiummg, Sys, colour = factor(agegad1)) ) + geom_smooth()
graph1bm
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

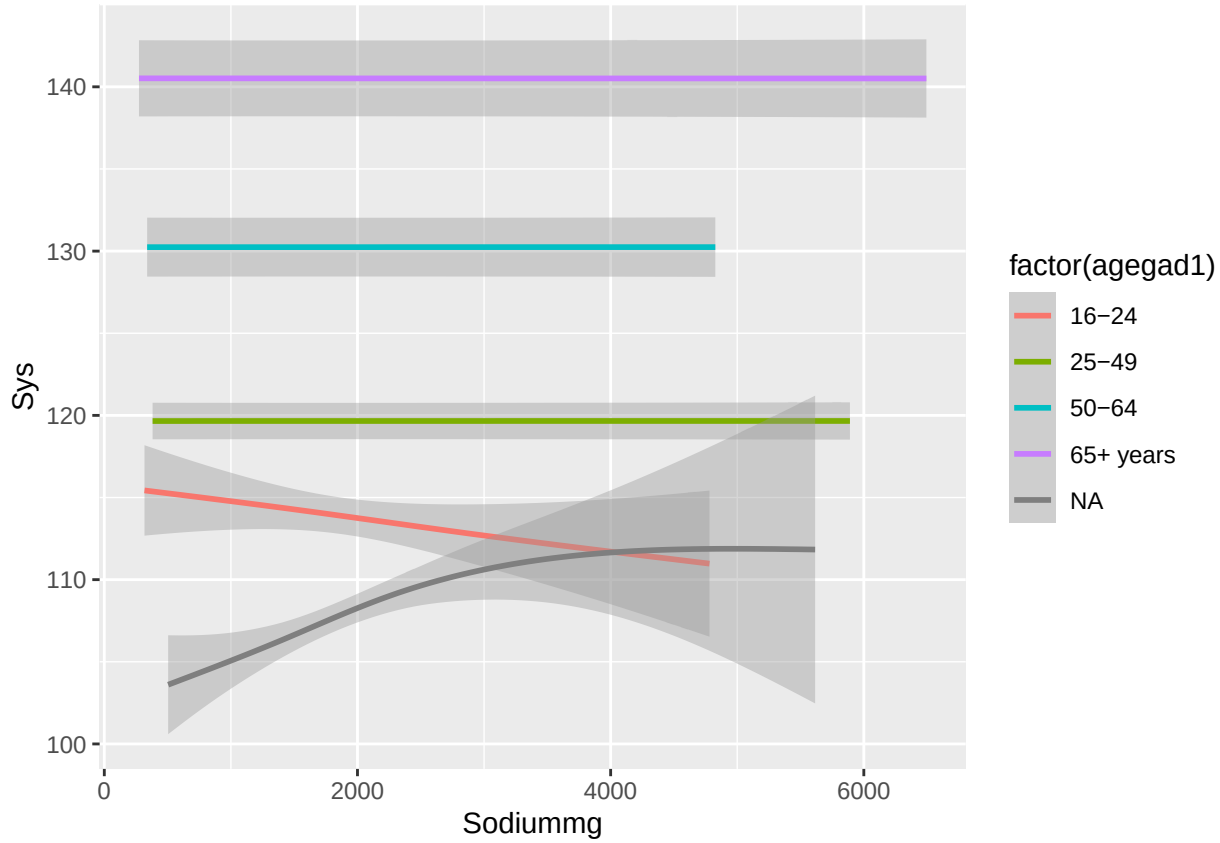
```
## Warning: Removed 1085 rows containing non-finite values (stat_smooth).
```




```
graph1bf <- ggplot(alldataf, aes(Sodiummg, Sys, colour = factor(agegad1)) ) + geom_smooth()
graph1bf
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

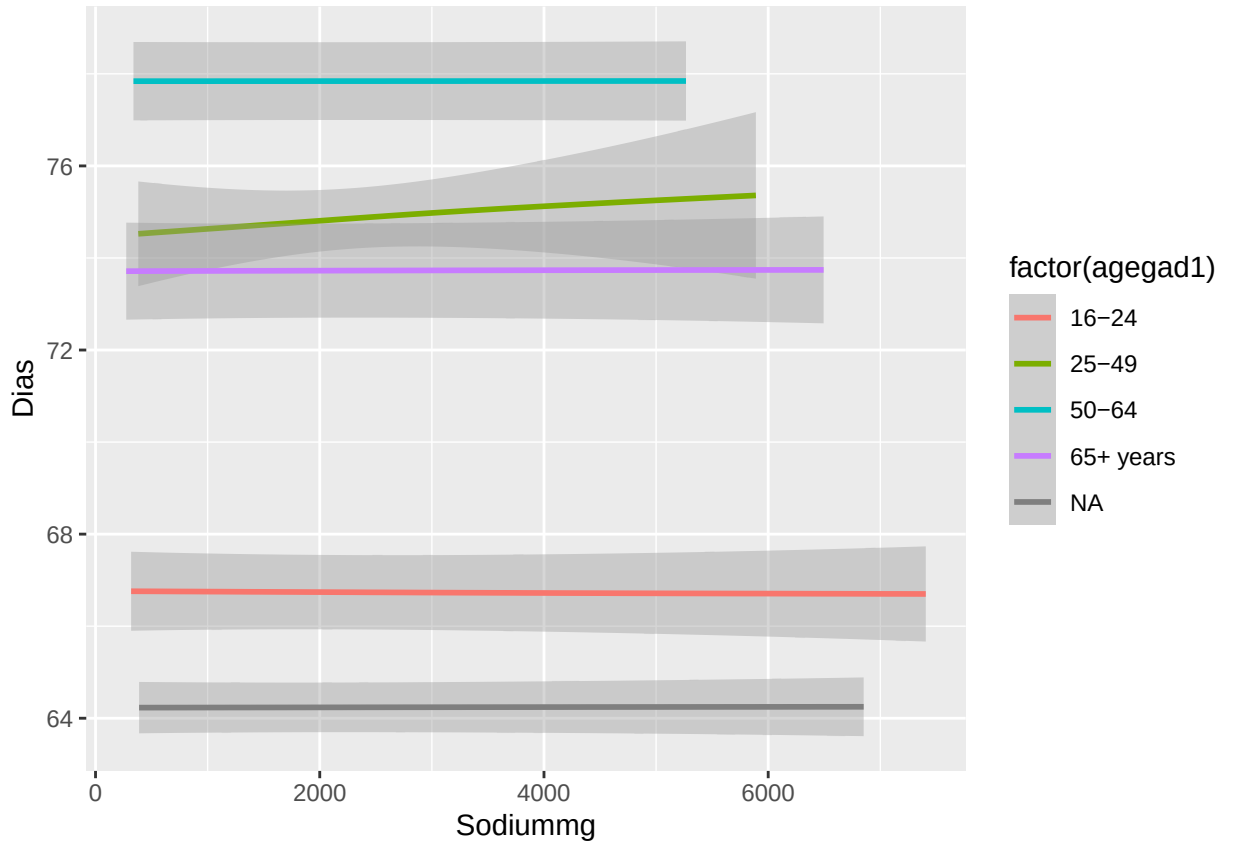
```
## Warning: Removed 1185 rows containing non-finite values (stat_smooth).
```




```
graph1bd <- ggplot(alldata, aes(Sodiummg, Dias, colour = factor(agegad1)) ) + geom_smooth()
graph1bd
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

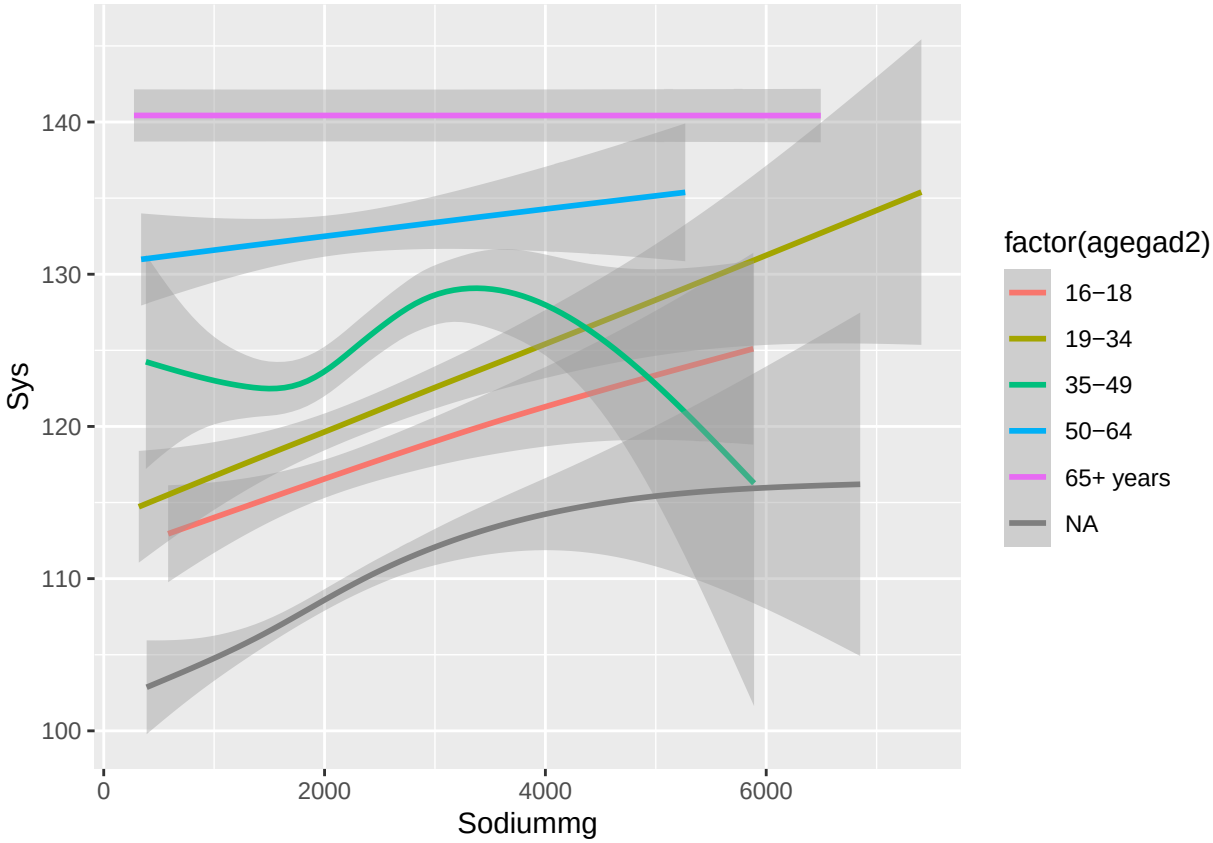
```
## Warning: Removed 2271 rows containing non-finite values (stat_smooth).
```




```
graph1c <- ggplot(alldata, aes(Sodiummg, Sys, colour = factor(agegad2)) ) + geom_smooth()
graph1c
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

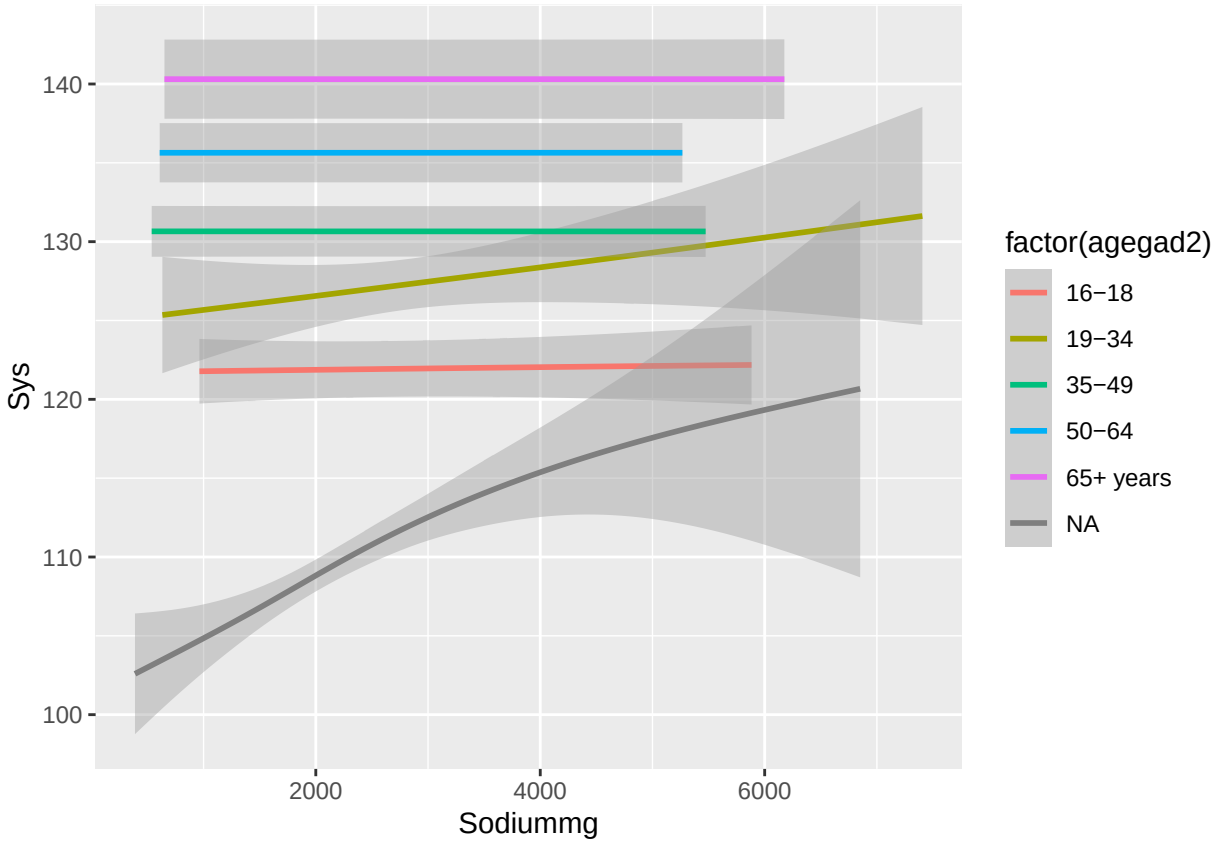
```
## Warning: Removed 2270 rows containing non-finite values (stat_smooth).
```




```
graph1bm <- ggplot(alldatam, aes(Sodiummg, Sys, colour = factor(agegad2)) ) + geom_smooth()
graph1bm
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

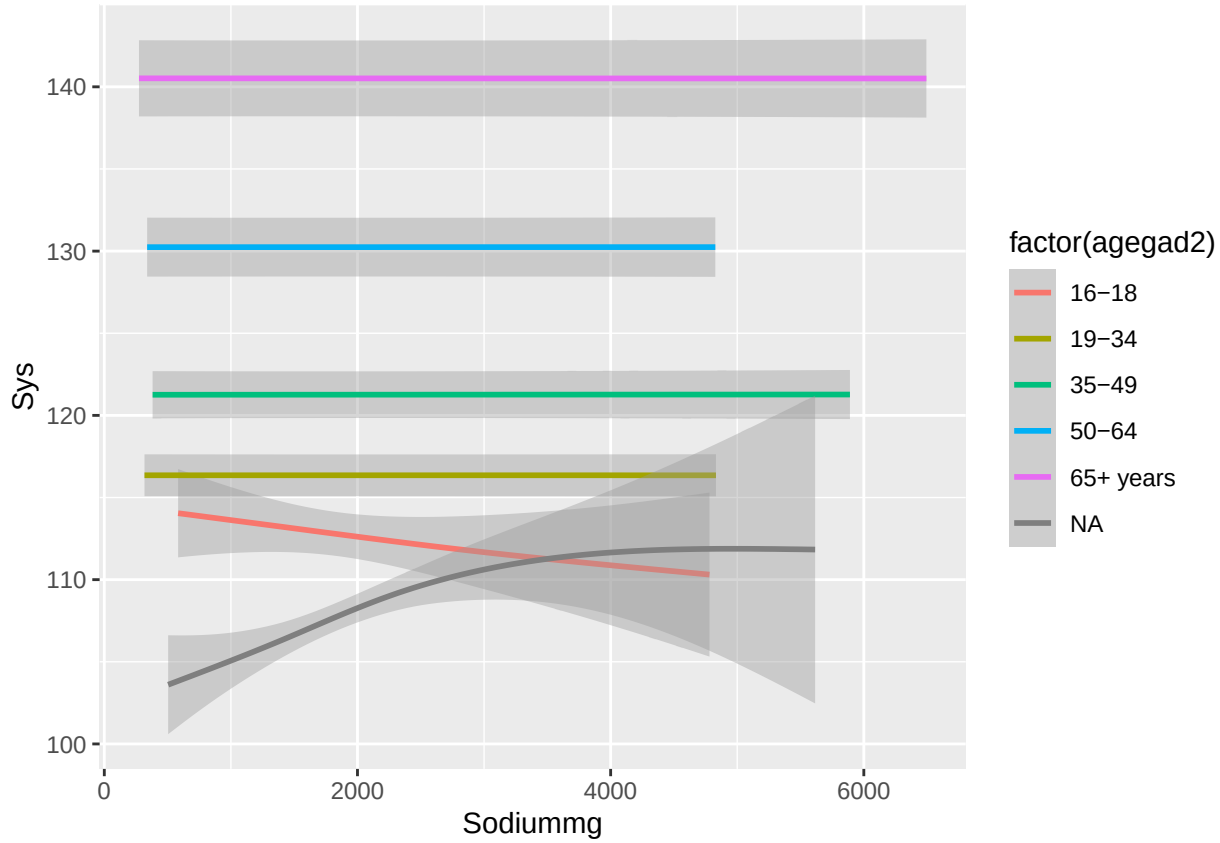
```
## Warning: Removed 1085 rows containing non-finite values (stat_smooth).
```




```
graph1bf <- ggplot(alldataf, aes(Sodiummg, Sys, colour = factor(agegad2)) ) + geom_smooth()
graph1bf
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

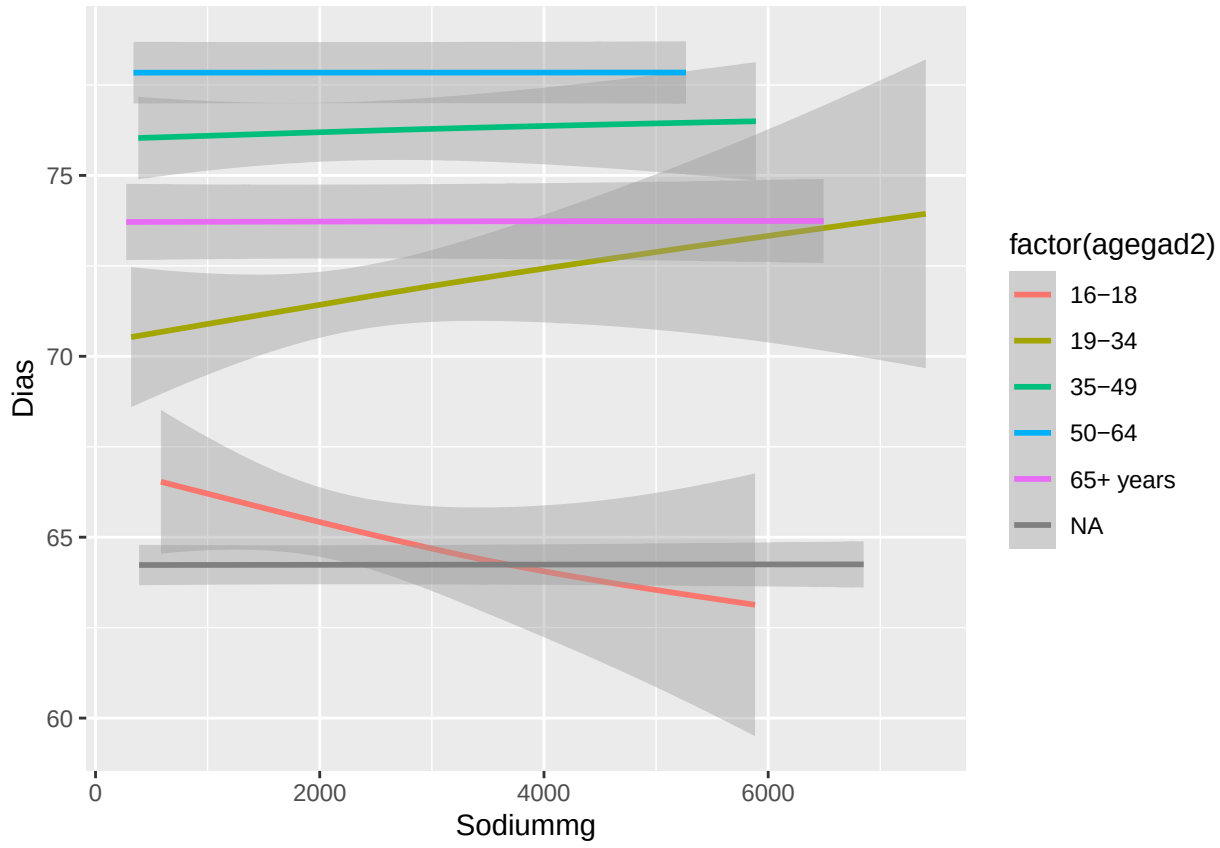
```
## Warning: Removed 1185 rows containing non-finite values (stat_smooth).
```




```
graph1cd <- ggplot(alldata, aes(Sodiummg, Dias, colour = factor(agegad2)) ) + geom_smooth()
graph1cd
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

```
## Warning: Removed 2271 rows containing non-finite values (stat_smooth).
```

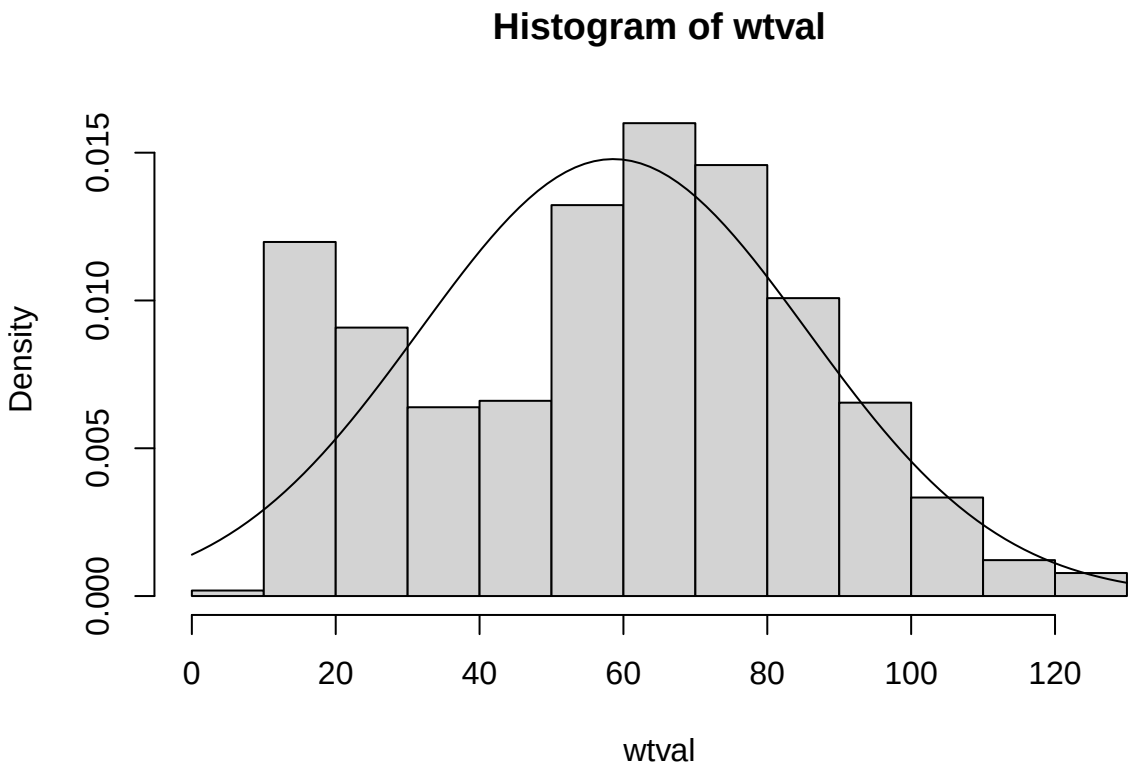



```
#bpdietdatq <- subset(bpdietdat[,c("seriali","Age","Sodiummg","eqvinc","Sys", "Dias", "Sys2", "Dias2","
#bpdietdatq <- bpdietdatq[,is.na(bpdietdat[Sys]) ]
#View(bpdietdatq)
#Summary(bpdietdatq)

alldata[, hist(wtval, prob = TRUE)] # histogram
```

```
## $breaks
##  [1]   0  10  20  30  40  50  60  70  80  90 100 110 120 130
##
## $counts
##  [1]   12  769  583  410  424  849 1027  936  647  420  214   78   50
##
## $density
##  [1] 0.0001869450 0.0119800592 0.0090824116 0.0063872877 0.0066053902
##  [6] 0.0132263592 0.0159993768 0.0145817105 0.0100794516 0.0065430752
## [11] 0.0033338526 0.0012151425 0.0007789375
##
## $mids
##  [1]   5  15  25  35  45  55  65  75  85  95 105 115 125
##
## $xname
## [1] "wtval"
##
## $equidist
## [1] TRUE
```

```
##
## attr(,"class")
## [1] "histogram"
```

```
alldata[, curve(
  dnorm(x, mean(wtval, na.rm = TRUE), sd(wtval, na.rm = TRUE)),
  add = TRUE
)] # superimpose a Normal distribution
```

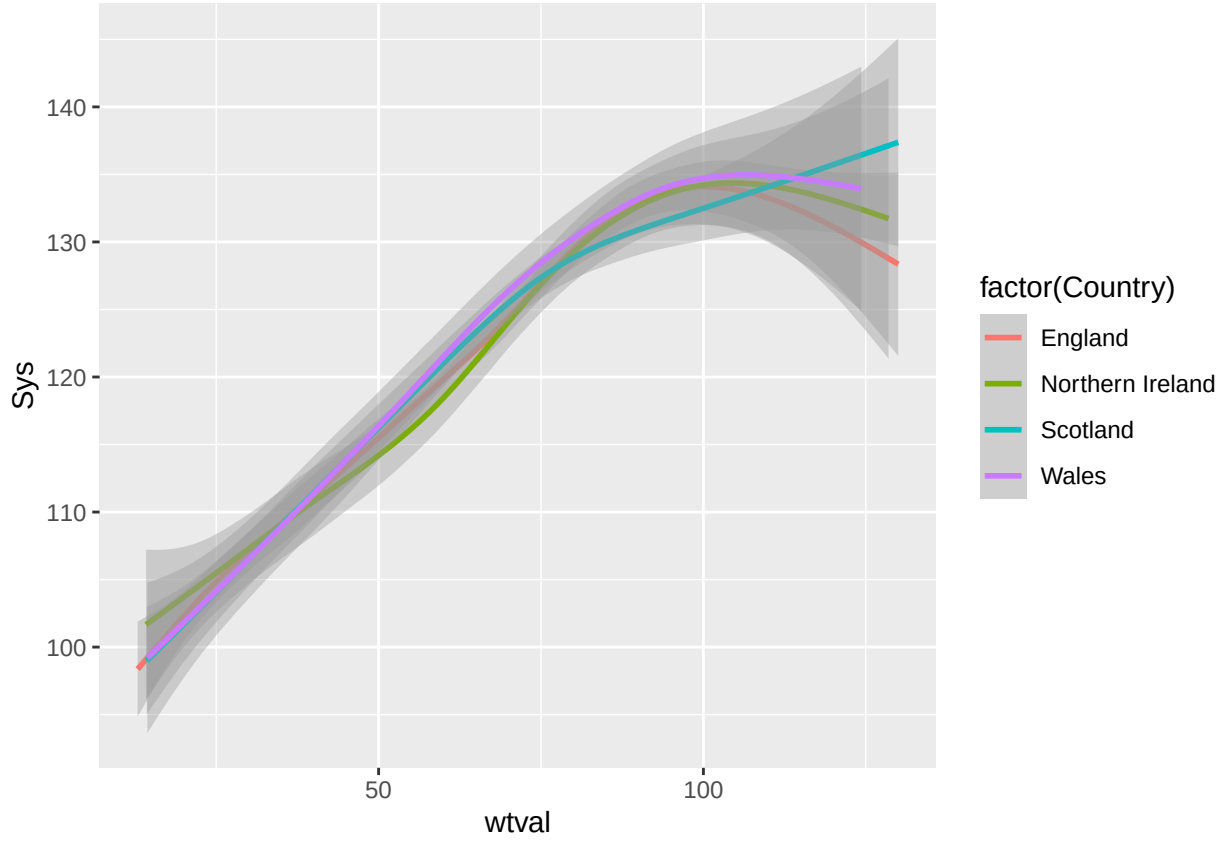



```
##                  x           y
##   1: -8.881784e-16 0.0013992842
##   2:  1.300000e+00 0.0015517911
##   3:  2.600000e+00 0.0017169302
##   4:  3.900000e+00 0.0018952395
##   5:  5.200000e+00 0.0020872171
##  ---
##  97:  1.248000e+02 0.0007290833
##  98:  1.261000e+02 0.0006470583
##  99:  1.274000e+02 0.0005729302
## 100:  1.287000e+02 0.0005061184
## 101:  1.300000e+02 0.0004460613
```

```
# graph section view the data
#bpdietdat[Sex == "2" ,plot("Sodiummg","Sys")]
graphw1 <- ggplot(alldata, aes(wtval, Sys, colour = factor(Country)) ) + geom_smooth()
graphw1
```

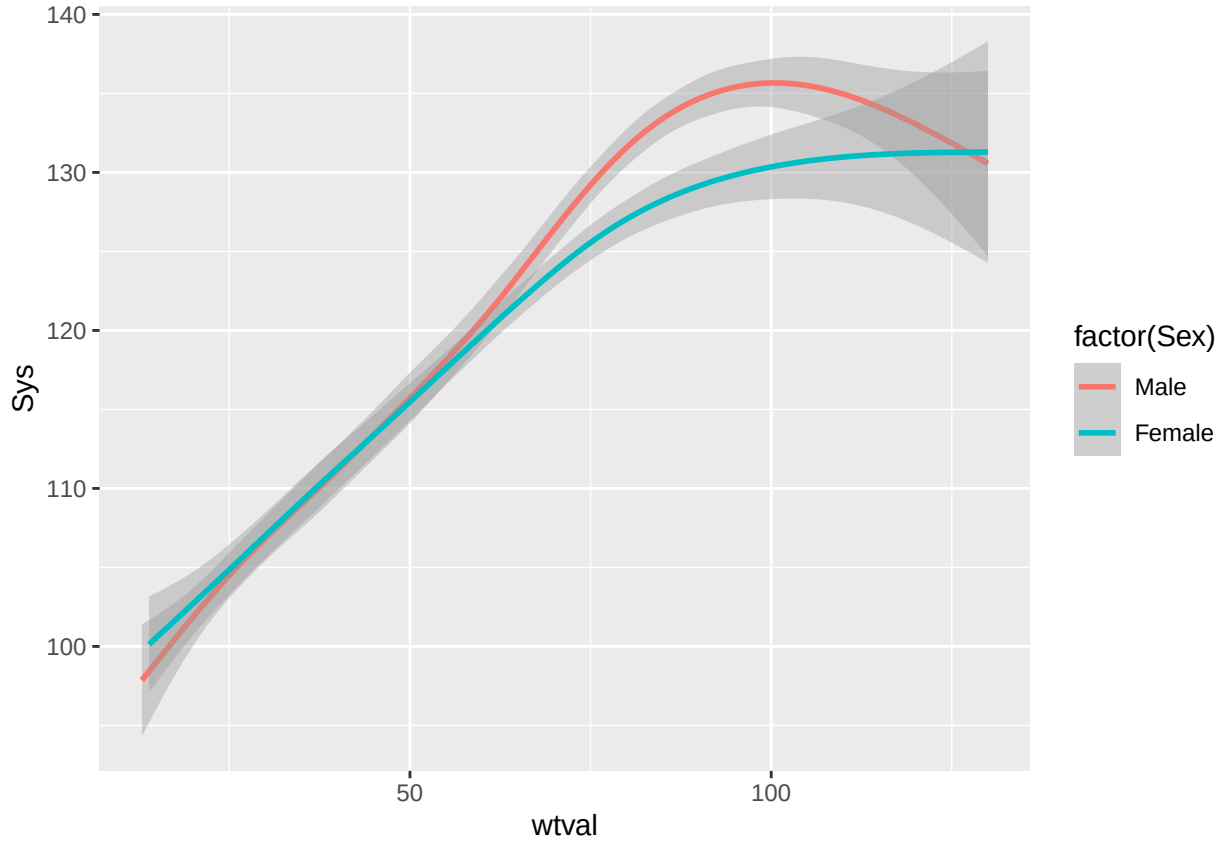
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## Warning: Removed 2423 rows containing non-finite values (stat_smooth).
```




```
graphw1a <- ggplot(alldata, aes(wtval, Sys, colour = factor(Sex)) )+ geom_smooth()
graphw1a
```

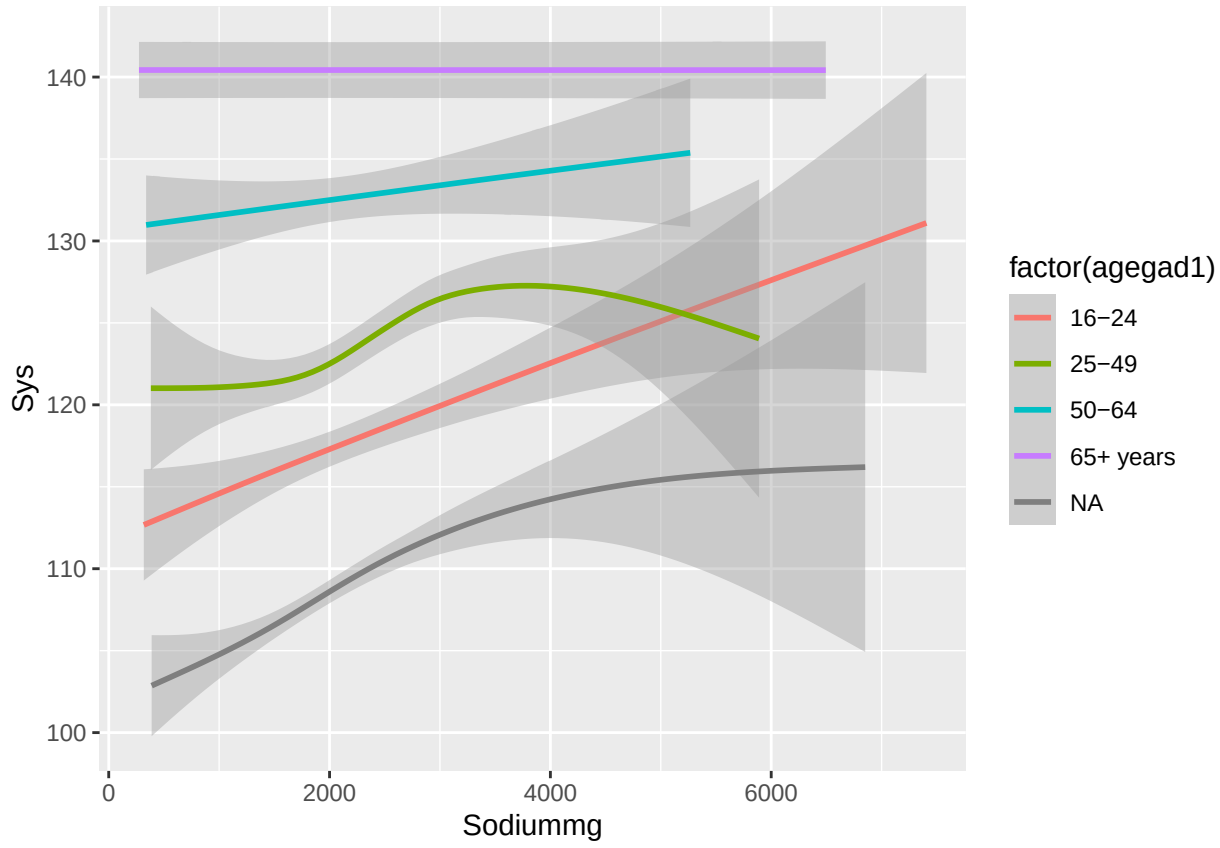
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## Warning: Removed 2423 rows containing non-finite values (stat_smooth).
```




```
graph1wb <- ggplot(alldata, aes(wtval, Sys, colour = factor(agegad1)) ) + geom_smooth()
graph1b
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

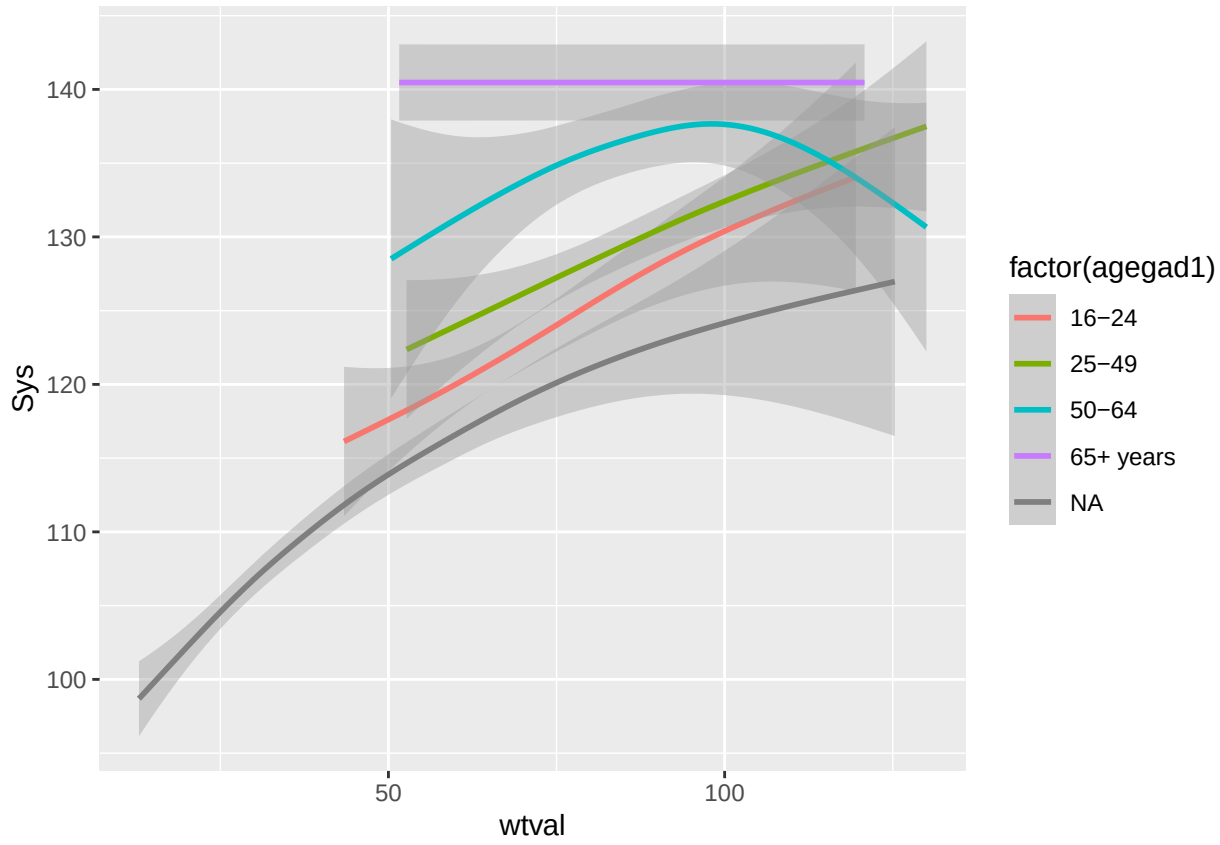
```
## Warning: Removed 2270 rows containing non-finite values (stat_smooth).
```




```
graphw1bm <- ggplot(alldatam, aes(wtval, Sys, colour = factor(agegad1)) ) + geom_smooth()
graphw1bm
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

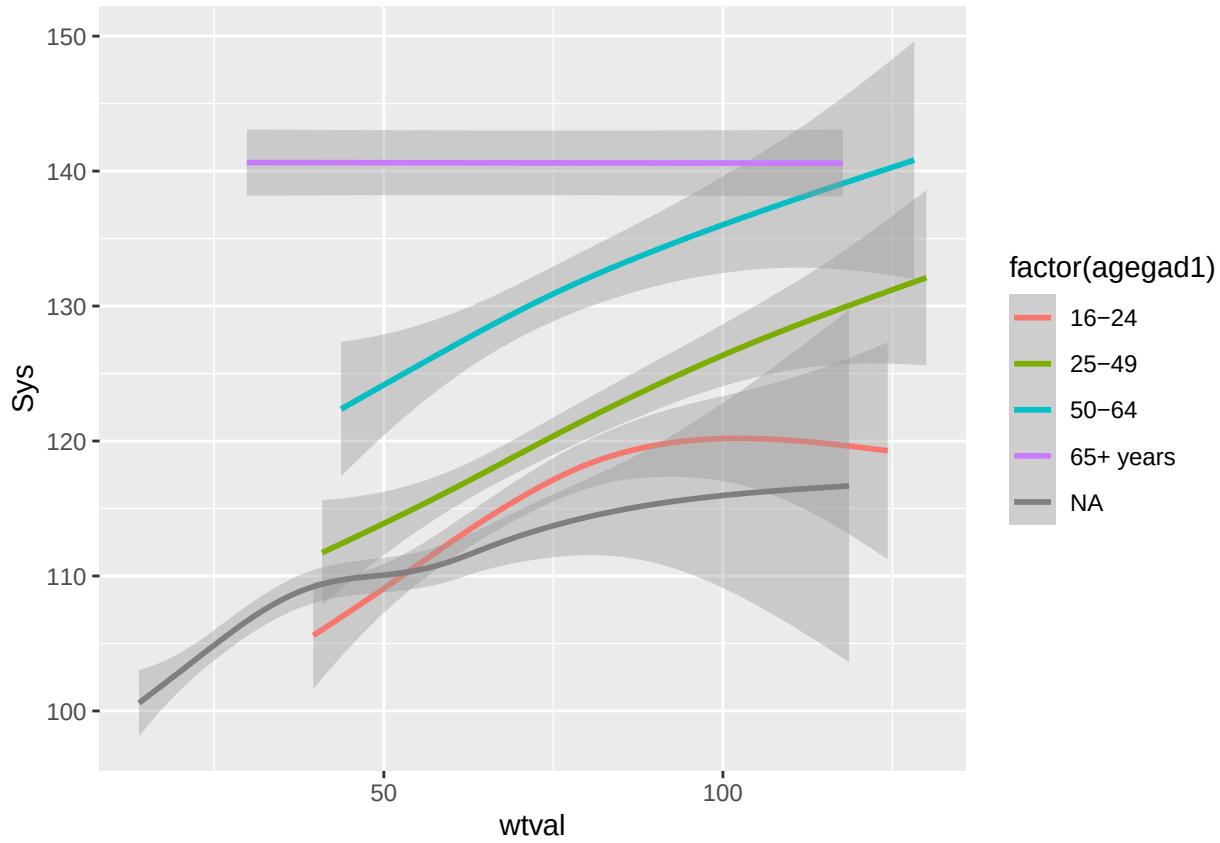
```
## Warning: Removed 1159 rows containing non-finite values (stat_smooth).
```




```
graphw1bf <- ggplot(alldataf, aes(wtval, Sys, colour = factor(agegad1)) ) + geom_smooth()
graphw1bf
```

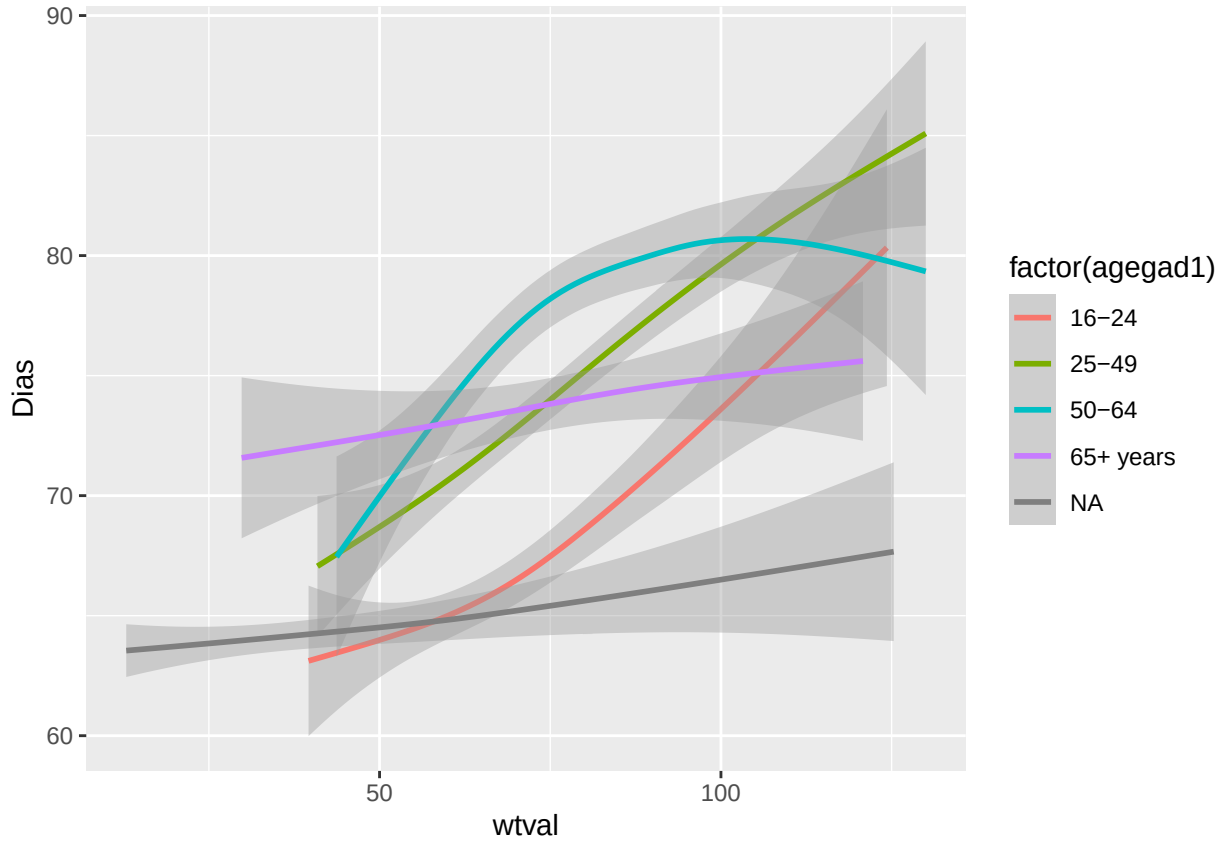
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

```
## Warning: Removed 1264 rows containing non-finite values (stat_smooth).
```




```
graphw1bd <- ggplot(alldata, aes(wtval, Dias, colour = factor(agegad1)) ) + geom_smooth()
graphw1bd
```

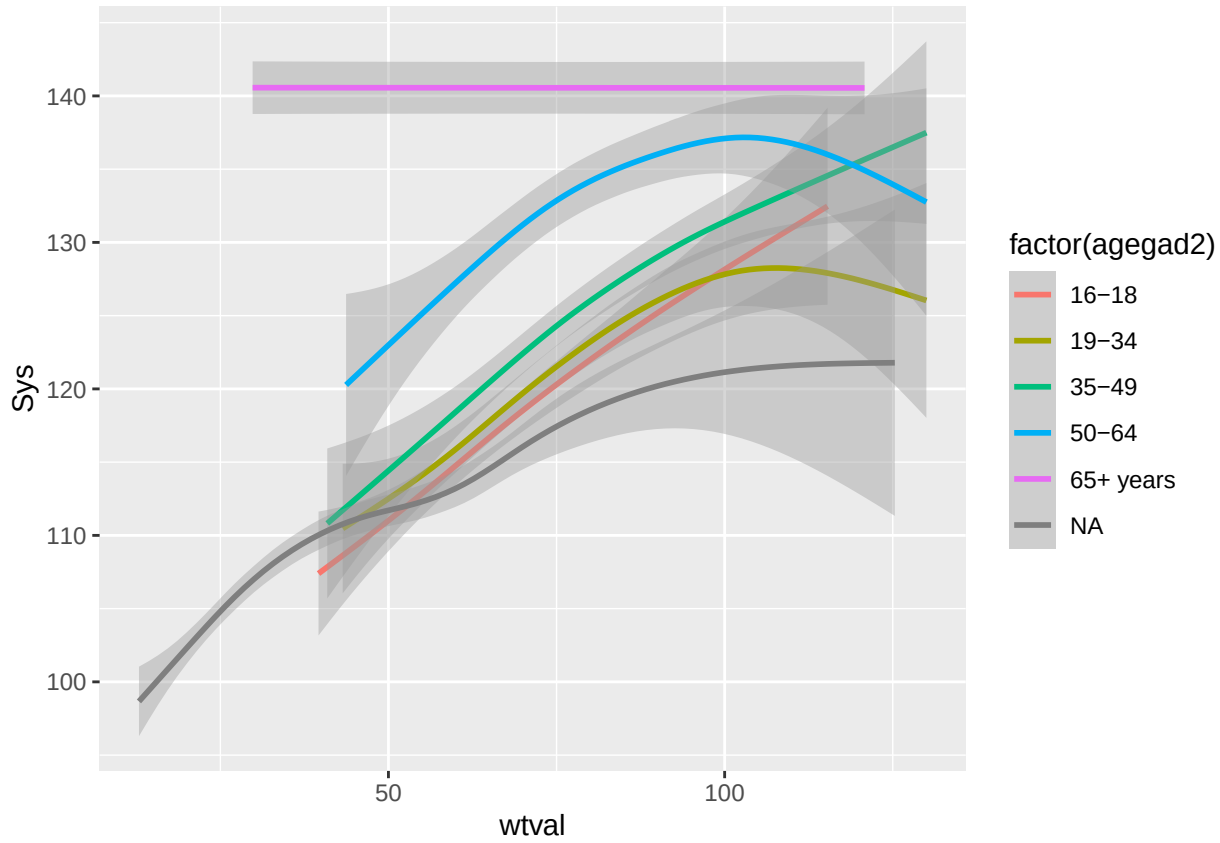
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## Warning: Removed 2424 rows containing non-finite values (stat_smooth).
```




```
graphw1c <- ggplot(alldata, aes(wtval, Sys, colour = factor(agegad2)) ) + geom_smooth()
graphw1c
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

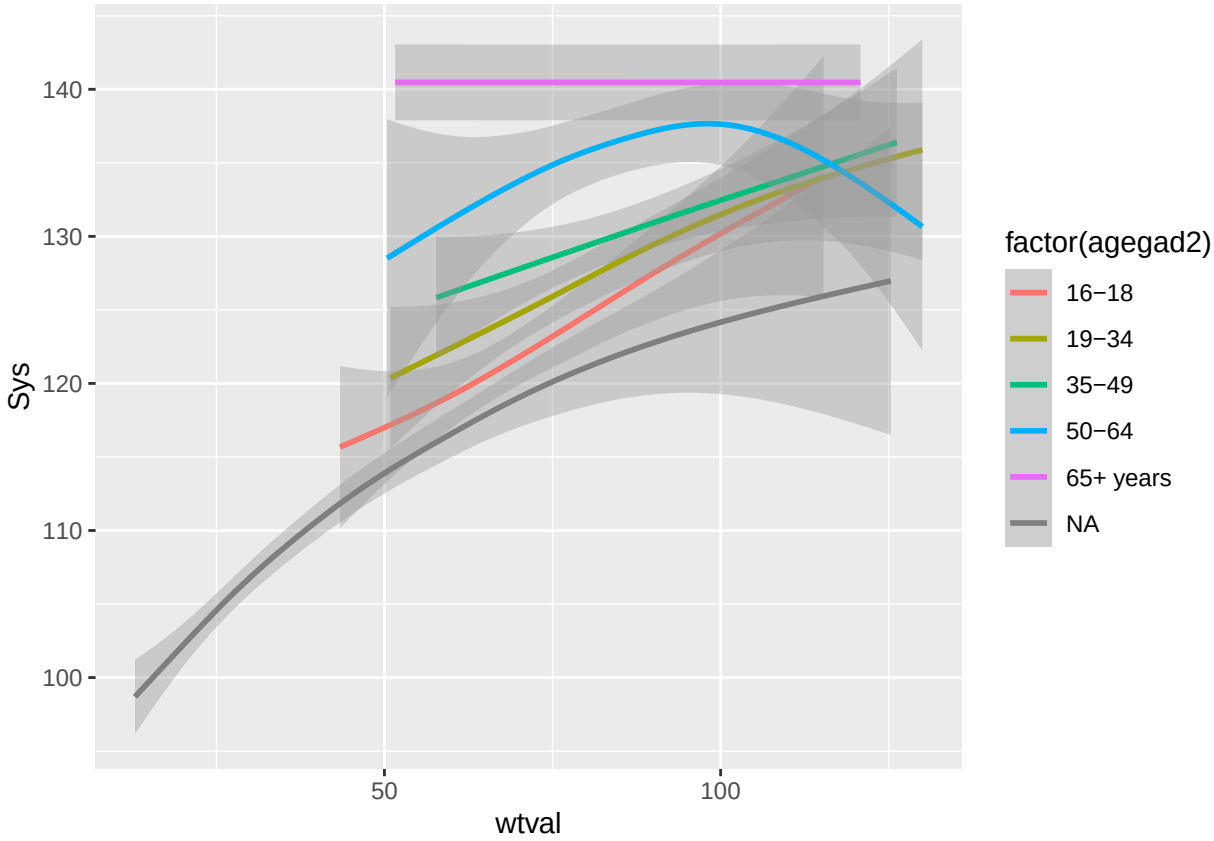
```
## Warning: Removed 2423 rows containing non-finite values (stat_smooth).
```




```
graphw1bm <- ggplot(alldatam, aes(wtval, Sys, colour = factor(agegad2)) ) + geom_smooth()
graphw1bm
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

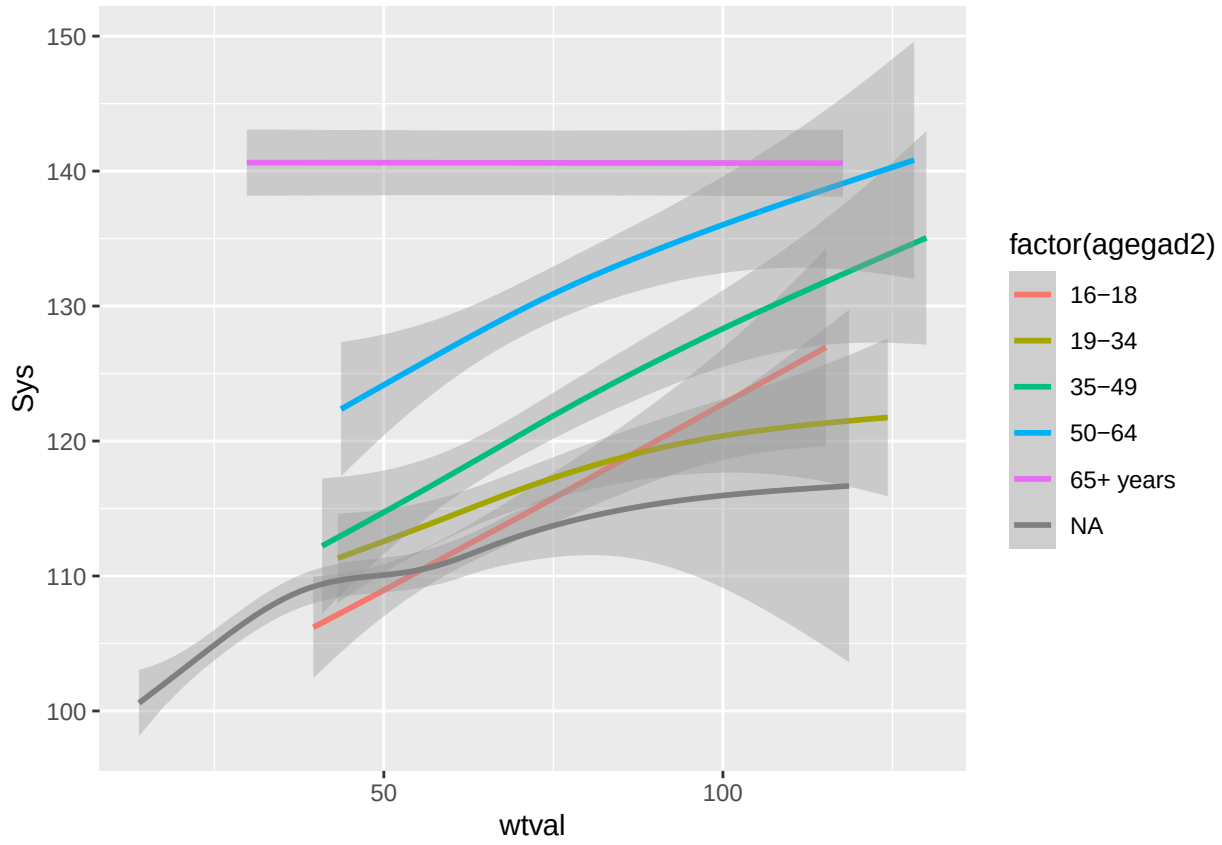
```
## Warning: Removed 1159 rows containing non-finite values (stat_smooth).
```




```
graphw1bf <- ggplot(alldataf, aes(wtval, Sys, colour = factor(agegad2)) ) + geom_smooth()
graphw1bf
```

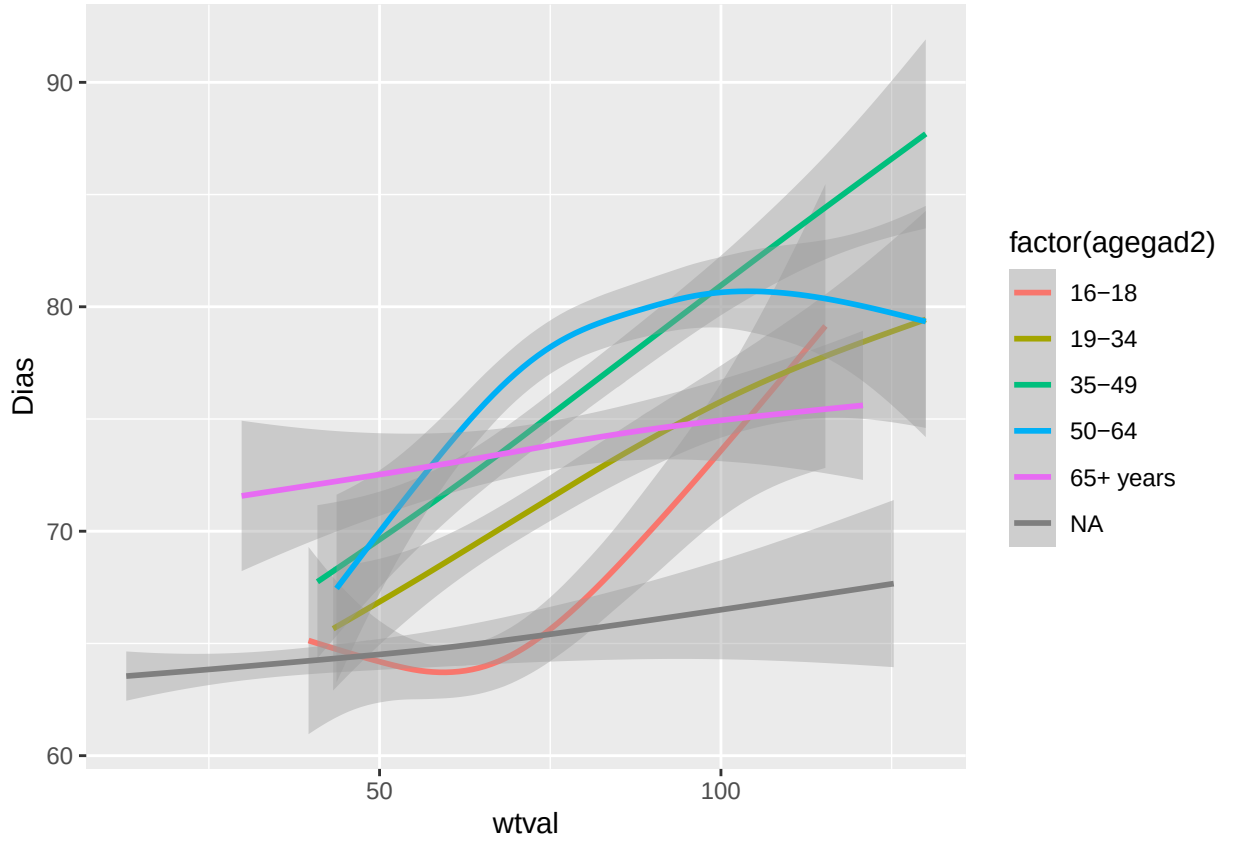
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

```
## Warning: Removed 1264 rows containing non-finite values (stat_smooth).
```




```
graphw1cd <- ggplot(alldata, aes(wtval, Dias, colour = factor(agegad2)) ) + geom_smooth()
graphw1cd
```

```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
## Warning: Removed 2424 rows containing non-finite values (stat_smooth).
```



#discussion

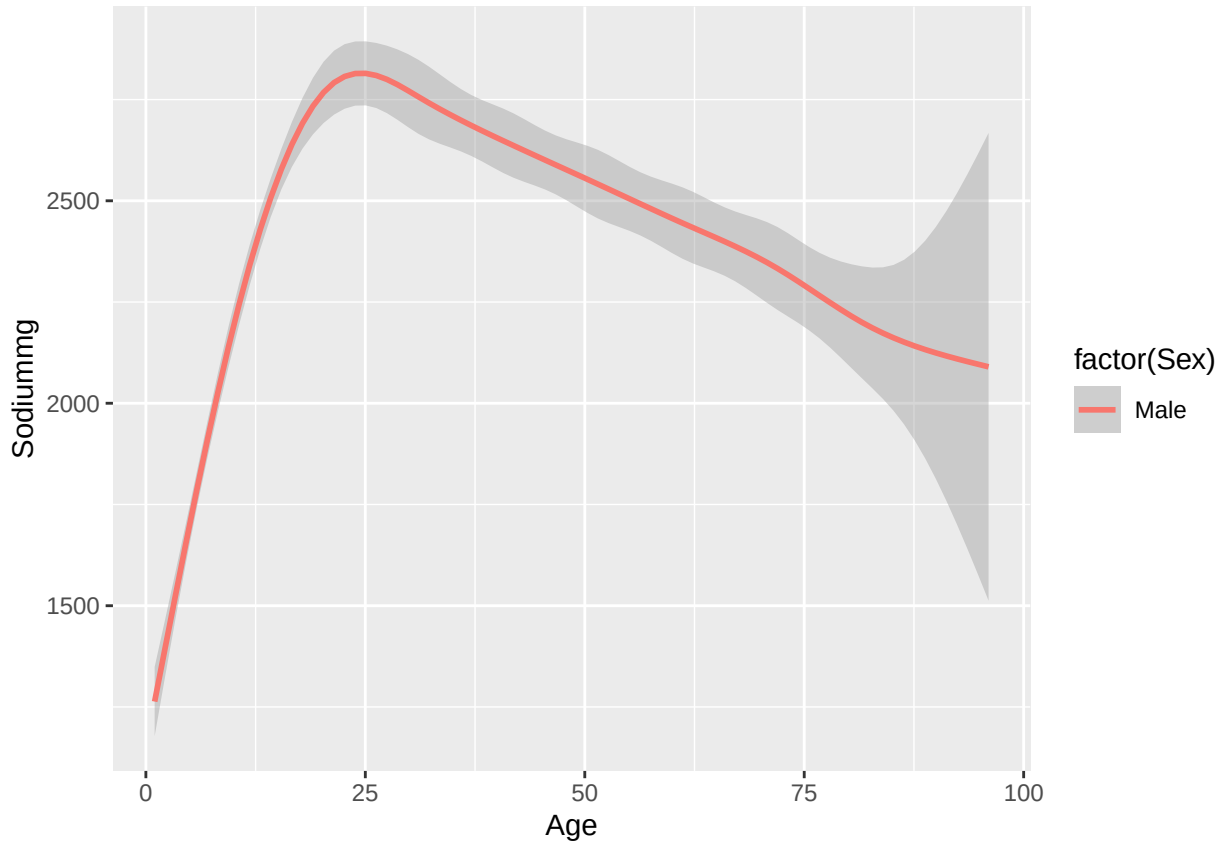
The dataset shows that sodium intake is related to systolic blood pressure in particualr age groups of men. There is much less of a relationship in women.

These relationships are different in different age groups.

The data support consideration of a more complex approach to preventing blood pressure. The simplest message for avoidance is to loose weight. Changing age and Sex are more complex. Salt reduction is an issue for men between 16 and 50, but even here it is more important to maintain a healthy weight than to reduce sodium intake. This may be due to the bodies ability to auto regulate sodium to much higher levels than oral intake allows.

```
graph2 <- ggplot(alldatam, aes(Age, Sodiummg, colour = factor(Sex)) )+ geom_smooth()
graph2
```

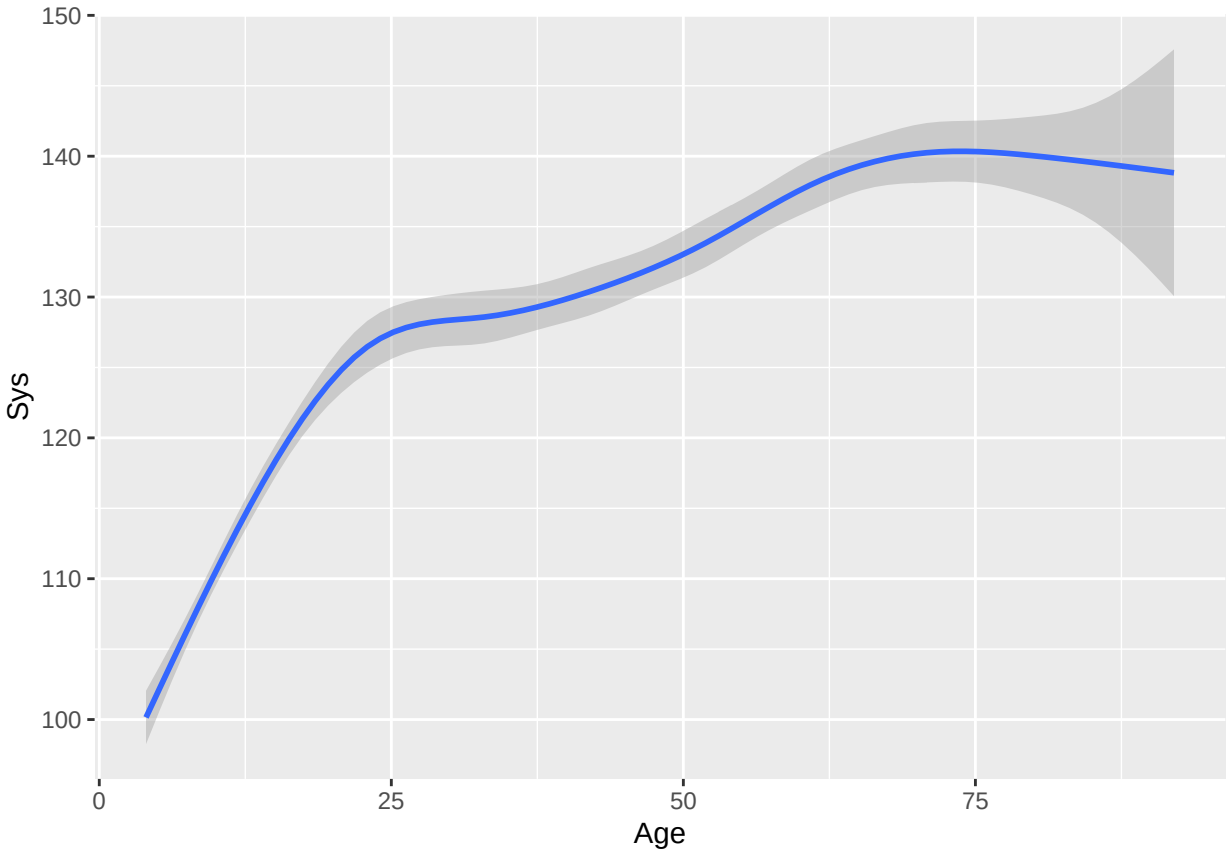
```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
graph2a <- ggplot(alldatam, aes(Age, Sys) ) + geom_smooth()
graph2a
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

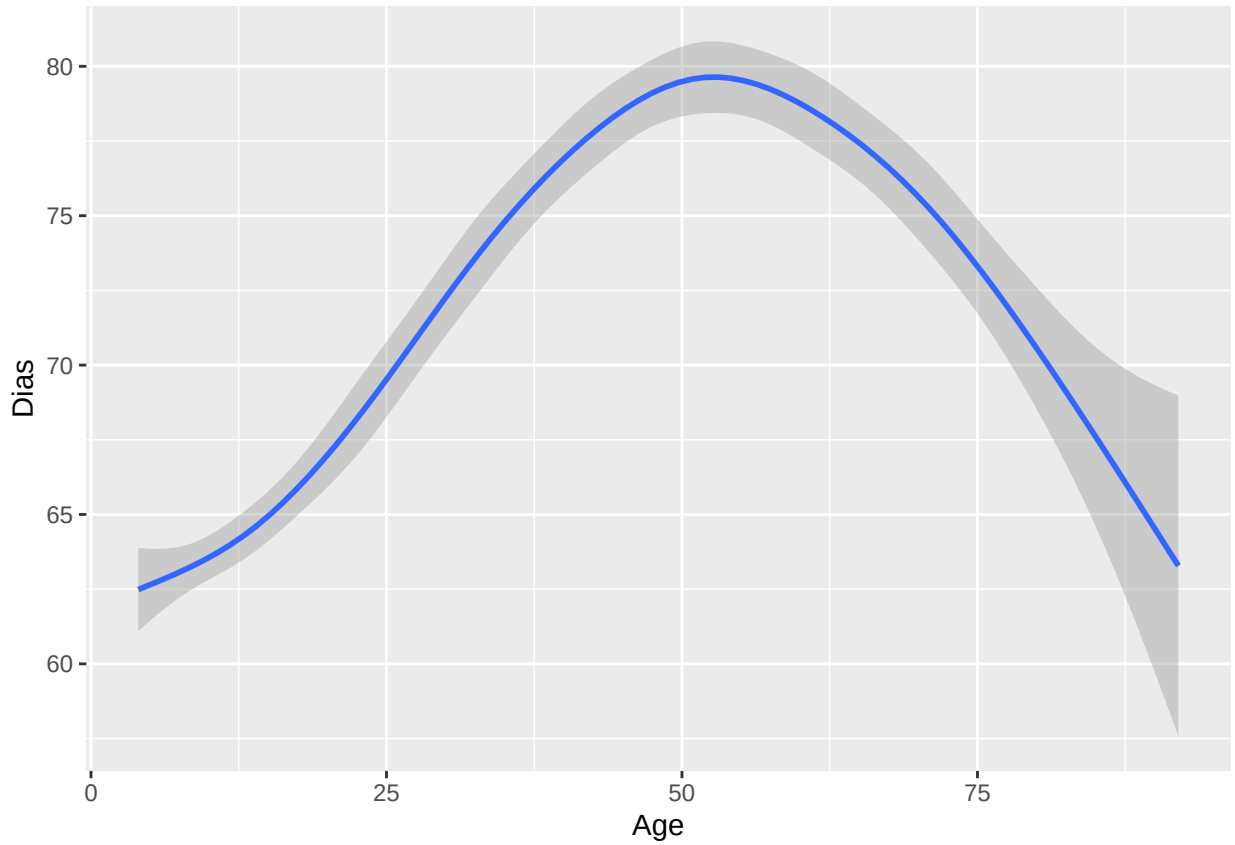
```
## Warning: Removed 1085 rows containing non-finite values (stat_smooth).
```




```
graph2b <- ggplot(alldatam, aes(Age, Dias) ) + geom_smooth()
graph2b
```

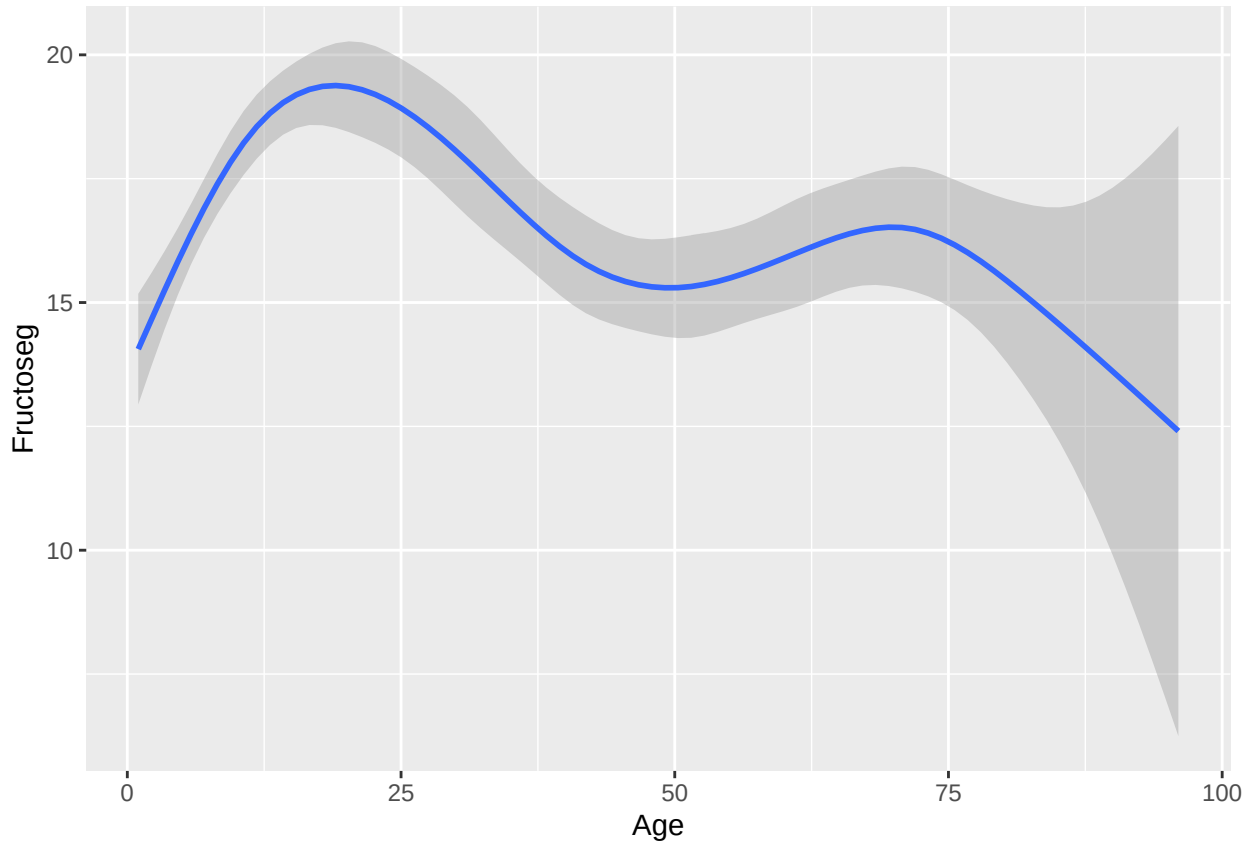
```
## Don't know how to automatically pick scale for object of type haven_labelled/vctrs_vctr/double. Defau
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```

```
## Warning: Removed 1086 rows containing non-finite values (stat_smooth).
```

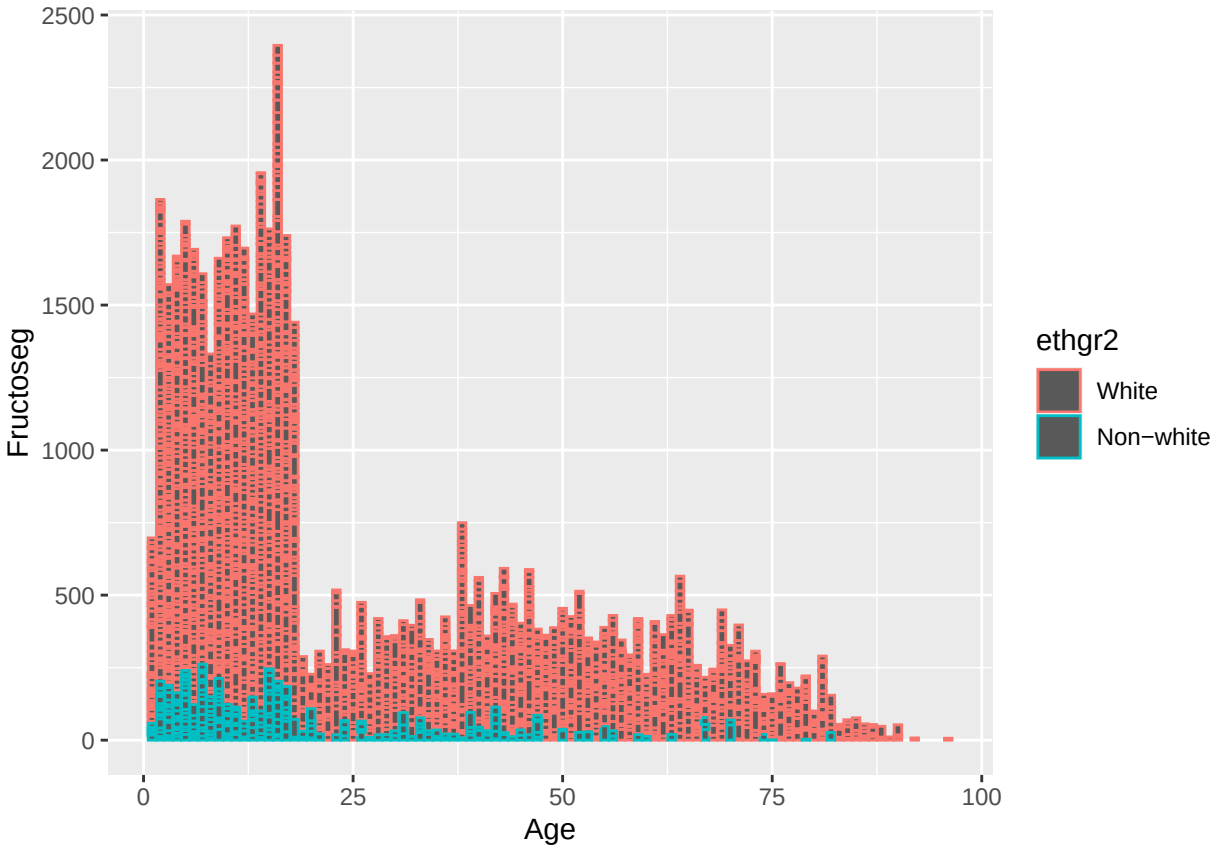



```
#graph3 <- ggplot(alldatam, aes(Sodiummg, equinc) )+ geom_smooth()
#graph3

#graph4 <- ggplot(alldatam, aes(Sys, equinc) ) +geom_smooth()
#graph4



#show persugstat

graph5 <- ggplot(alldatam, aes(Age, Fructoseg)) + geom_smooth()
graph5
```

```
## `geom_smooth()` using method = 'gam' and formula 'y ~ s(x, bs = "cs")'
```




```
#show ethnsugar

graph6 <- ggplot(alldatam, aes (Age , Fructoseg, colour = ethgr2))+geom_col()
graph6
```




```
# statistical analysis section

# comparison tables

incethtbl <- alldata[,table(nssec8, ethgr2)]
incethtbl
```

```
##                                                ethgr2
## nssec8                                          White Non-white
##   Higher managerial and professional occupations   869        79
##   Lower managerial and professional occupations   1602       126
##   Intermediate occupations                         576        39
##   Small employers and own account workers          679        58
##   Lower supervisory and technical occupations      648        44
##   Semi-routine occupations                         860        94
##   Routine occupations                              776        52
##   Never worked                                     154        32
##   Other                                              0         0
```

```
incethtbl2 <- alldata[,table(nssec8, ethgr5)]
incethtbl2
```

```
##                                                ethgr5
## nssec8                                          White Mixed ethnic group
##   Higher managerial and professional occupations   869                 17
##   Lower managerial and professional occupations   1602                 25
##   Intermediate occupations                         576                 12
##   Small employers and own account workers          679                 11
```

```
##   Lower supervisory and technical occupations      648                  3
##   Semi-routine occupations                         860                 24
##   Routine occupations                              776                  1
##   Never worked                                     154                  5
##   Other                                              0                  0
##                                                 ethgr5
## nssec8                                           Black or Black British
##   Higher managerial and professional occupations                      12
##   Lower managerial and professional occupations                       36
##   Intermediate occupations                                            10
##   Small employers and own account workers                              8
##   Lower supervisory and technical occupations                         11
##   Semi-routine occupations                                            33
##   Routine occupations                                                 18
##   Never worked                                                         9
##   Other                                                                0
##                                                 ethgr5
## nssec8                                           Asian or asian British
##   Higher managerial and professional occupations                      39
##   Lower managerial and professional occupations                       42
##   Intermediate occupations                                            12
##   Small employers and own account workers                             35
##   Lower supervisory and technical occupations                         17
##   Semi-routine occupations                                            27
##   Routine occupations                                                 25
##   Never worked                                                        13
##   Other                                                                0
##                                                 ethgr5
## nssec8                                           Any other group
##   Higher managerial and professional occupations              11
##   Lower managerial and professional occupations               23
##   Intermediate occupations                                     5
##   Small employers and own account workers                      4
##   Lower supervisory and technical occupations                 13
##   Semi-routine occupations                                    10
##   Routine occupations                                          8
##   Never worked                                                 5
##   Other                                                        0
```

```
agetbl1 <-alldata[,table(agegr1,Sex)]
agetbl1
```

```
##              Sex
## agegr1        Male Female
##   1.5-3 years  305    299
##   4-10 years   665    612
##   11-18 years  744    753
##   19-64 years 1126   1571
##   65+ years    317    436
```

```
#how many are on bp medication ?
medstbl1 <- alldata[ , table(bpmedc,bpmedd)]
medstbl1
```

```
##       bpmedd
## bpmedc    0    1
```

```
##      0 1412    0
##      1  138  312
```

```
hyptabl1 <- alldata[,table(hibp140, bpmedc)]
hyptabl1
```

```
##                                                      bpmedc
## hibp140                                                 0   1
##   Not high BP                                         180 292
##   High BP                                               0   0
##   No answer/refused                                     0   0
##   Don't know                                            0   0
##   Refused, attempted but not obtained, not attempted    0   0
##   Qn not applicable to survey year                      0   0
##   Item not applicable                                   0   0
```

```
hyptabl2 <- alldata[,table(hyper1, bpmedc)]
hyptabl2
```

```
##                                                      bpmedc
## hyper1                                                  0   1
##    Normotensive untreated                             970  96
##    Normotensive treated                                 0 221
##   Hypertensive treated                                  0  41
##   Hypertensive untreated                               48  12
##   No answer/refused                                     0   0
##   Don't know                                            0   0
##   Refused, attempted but not obtained, not attempted    0   0
##   Qn not applicable to survey year                      0   0
##   Item not applicable                                   0   0
```

```
hyptabl3 <- alldata[,table(hyper140, bpmedc)]
hyptabl3
```

```
##                                                      bpmedc
## hyper140                                                0   1
##    Normotensive untreated                             838  78
##    Normotensive treated                                 0 142
##   Hypertensive treated                                  0 120
##   Hypertensive untreated                              180  30
##   No answer/refused                                     0   0
##   Don't know                                            0   0
##   Refused, attempted but not obtained, not attempted    0   0
##   Qn not applicable to survey year                      0   0
##   Item not applicable                                   0   0
```

```
hyptabl4 <- alldata[,table(highbp1, bpmedc)]
hyptabl4
```

```
##                                                      bpmedc
## highbp1                                                 0   1
##   Not high BP                                          48 274
##   High BP                                               0   0
##   No answer/refused                                     0   0
##   Don't know                                            0   0
##   Refused, attempted but not obtained, not attempted    0   0
##   Qn not applicable to survey year                      0   0
```

```
##   Item not applicable                                    0   0
```

```
#random correlations

meds <- t.test(medstbl1 ,  na.rm = TRUE)

incSys <-  t.test( hyptabl1,  na.rm = TRUE)
incSys
```

```
##
##  One Sample t-test
##
## data:  hyptabl1
## t = 1.4259, df = 13, p-value = 0.1775
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -17.36693  84.79550
## sample estimates:
## mean of x
##  33.71429
```

```
meds
```

```
##
##  One Sample t-test
##
## data:  medstbl1
## t = 1.4461, df = 3, p-value = 0.2439
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -558.903 1489.903
## sample estimates:
## mean of x
##     465.5
```

```
#linear regression models
lm1 <- lm(Sys ~ agegad2 + Sex +Sodiummg + Calciummg + Fructoseg + eqvinc + ethgr2 +TotalEMJ +wtval + bpr
summary(lm1)
```

```
##
## Call:
## lm(formula = Sys ~ agegad2 + Sex + Sodiummg + Calciummg + Fructoseg +
##     eqvinc + ethgr2 + TotalEMJ + wtval + bpmedd, data = alldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -51.188 -10.878  -1.425   9.314  91.544
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       1.164e+02  3.596e+00  32.368  < 2e-16 ***
## agegad219-34      2.419e+00  2.156e+00   1.122 0.261976
## agegad235-49      8.248e+00  2.042e+00   4.038 5.72e-05 ***
## agegad250-64      1.377e+01  2.030e+00   6.783 1.83e-11 ***
## agegad265+ years  2.182e+01  2.034e+00  10.731  < 2e-16 ***
## SexFemale        -4.973e+00  1.180e+00  -4.216 2.67e-05 ***
## Sodiummg          6.433e-05  9.305e-04   0.069 0.944897
```

```
## Calciummg        -3.855e-03  2.089e-03  -1.846 0.065200 .
## Fructoseg        -5.880e-02  4.849e-02  -1.213 0.225467
## eqvinc            1.023e-05  2.336e-05   0.438 0.661347
## ethgr2Non-white  -2.083e+00  2.420e+00  -0.861 0.389549
## TotalEMJ          1.588e-01  3.783e-01   0.420 0.674782
## wtval             8.578e-02  3.094e-02   2.772 0.005658 **
## bpmedd1           4.434e+00  1.337e+00   3.316 0.000941 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 16.43 on 1212 degrees of freedom
##   (5602 observations deleted due to missingness)
## Multiple R-squared:  0.244,  Adjusted R-squared:  0.2359
## F-statistic: 30.08 on 13 and 1212 DF,  p-value: < 2.2e-16
```

```
lmD1 <- lm(Dias ~ agegad2 + Sex +Sodiummg + Calciummg + Fructoseg + eqvinc + ethgr2 +TotalEMJ +wtval + b
summary(lmD1)
```

```
##
## Call:
## lm(formula = Dias ~ agegad2 + Sex + Sodiummg + Calciummg + Fructoseg +
##     eqvinc + ethgr2 + TotalEMJ + wtval + bpmedd, data = alldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -30.338  -7.251  -0.417   7.033  53.604
##
## Coefficients:
##                    Estimate Std. Error t value Pr(>|t|)
## (Intercept)       5.460e+01  2.376e+00  22.983  < 2e-16 ***
## agegad219-34      3.660e+00  1.424e+00   2.569  0.01030 *
## agegad235-49      8.992e+00  1.350e+00   6.663 4.07e-11 ***
## agegad250-64      1.003e+01  1.341e+00   7.477 1.45e-13 ***
## agegad265+ years  6.525e+00  1.344e+00   4.855 1.36e-06 ***
## SexFemale         1.420e+00  7.795e-01   1.822  0.06874 .
## Sodiummg          2.374e-04  6.149e-04   0.386  0.69951
## Calciummg        -4.239e-03  1.380e-03  -3.071  0.00218 **
## Fructoseg        -6.314e-02  3.204e-02  -1.971  0.04900 *
## eqvinc            4.585e-06  1.543e-05   0.297  0.76645
## ethgr2Non-white   3.575e+00  1.599e+00   2.235  0.02557 *
## TotalEMJ          4.727e-01  2.500e-01   1.891  0.05885 .
## wtval             1.585e-01  2.045e-02   7.751 1.92e-14 ***
## bpmedd1          -2.793e-01  8.837e-01  -0.316  0.75201
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.86 on 1212 degrees of freedom
##   (5602 observations deleted due to missingness)
## Multiple R-squared:  0.1537, Adjusted R-squared:  0.1446
## F-statistic: 16.93 on 13 and 1212 DF,  p-value: < 2.2e-16
```

```
lm2 <- lm(Sys ~ Na_g_Corrected + Sex + age + TEACOFFEEANDWATER, alldata)
summary(lm2)
```

```
##
```

```
## Call:
## lm(formula = Sys ~ Na_g_Corrected + Sex + age + TEACOFFEEANDWATER,
##     data = alldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -57.943  -9.099  -1.066   8.482  83.734
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)        1.058e+02  8.557e-01 123.599  < 2e-16 ***
## Na_g_Corrected     2.877e-01  9.185e-02   3.133  0.00175 **
## SexFemale         -4.877e+00  4.870e-01 -10.014  < 2e-16 ***
## age                4.903e-01  1.284e-02  38.185  < 2e-16 ***
## TEACOFFEEANDWATER  2.444e-04  4.800e-04   0.509  0.61073
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14.48 on 3611 degrees of freedom
##   (3212 observations deleted due to missingness)
## Multiple R-squared:  0.3776, Adjusted R-squared:  0.3769
## F-statistic: 547.6 on 4 and 3611 DF,  p-value: < 2.2e-16
```

```
lmD2 <- lm(Dias ~ Na_g_Corrected + Sex + age + TEACOFFEEANDWATER, alldata)
summary(lmD2)
```

```
##
## Call:
## lm(formula = Dias ~ Na_g_Corrected + Sex + age + TEACOFFEEANDWATER,
##     data = alldata)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -39.333  -7.283  -0.579   6.598  65.101
##
## Coefficients:
##                     Estimate Std. Error t value Pr(>|t|)
## (Intercept)       62.153383   0.666838  93.206  < 2e-16 ***
## Na_g_Corrected     0.198544   0.071557   2.775  0.00555 **
## SexFemale         -0.002458   0.379429  -0.006  0.99483
## age                0.188483   0.010004  18.840  < 2e-16 ***
## TEACOFFEEANDWATER  0.001426   0.000374   3.813  0.00014 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 11.28 on 3610 degrees of freedom
##   (3213 observations deleted due to missingness)
## Multiple R-squared:  0.1488, Adjusted R-squared:  0.1478
## F-statistic: 157.7 on 4 and 3610 DF,  p-value: < 2.2e-16
```

```
library(caret)
```

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

```
set.seed(42)
```

```
alldataSys <- alldata[!is.na(alldata$Sys),]
alldataSys <- as.data.frame(alldataSys)
simplealldata <- subset(alldataSys[c("Sys", "Age","wtval","Sex")])


modelSys <- train(Sys ~ ., simplealldata,
               method = "lm",
               trControl = trainControl(method = "cv",
                                        number = 10,
                                        verboseIter = TRUE), na.action = na.pass)
```

```
## + Fold01: intercept=TRUE
## - Fold01: intercept=TRUE
## + Fold02: intercept=TRUE
## - Fold02: intercept=TRUE
## + Fold03: intercept=TRUE
## - Fold03: intercept=TRUE
## + Fold04: intercept=TRUE
## - Fold04: intercept=TRUE
## + Fold05: intercept=TRUE
## - Fold05: intercept=TRUE
## + Fold06: intercept=TRUE
## - Fold06: intercept=TRUE
## + Fold07: intercept=TRUE
## - Fold07: intercept=TRUE
## + Fold08: intercept=TRUE
## - Fold08: intercept=TRUE
## + Fold09: intercept=TRUE
## - Fold09: intercept=TRUE
## + Fold10: intercept=TRUE
## - Fold10: intercept=TRUE
## Aggregating results
## Fitting final model on full training set
```

```
modelSys
```

```
## Linear Regression
##
## 4558 samples
##    3 predictor
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 4103, 4102, 4103, 4101, 4102, 4102, ...
## Resampling results:
##
##   RMSE      Rsquared  MAE
##   14.16787  0.415836  10.70645
##
## Tuning parameter 'intercept' was held constant at a value of TRUE
```

```
p <- predict(modelSys, simplealldata)
error <- p - simplealldata$Sys
```

```
## Warning in p - simplealldata$Sys: longer object length is not a multiple of
```

```
## shorter object length
```

```
rmse_xval <- sqrt(mean(error^2)) ## xval RMSE
rmse_xval
```

```
## [1] 22.0307
```