

# Linear.R

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```
# Linear.R
# Demonstration of expected value and variance rules

# Load necessary libraries
library(ggplot2)
library(psych)

##
## Attaching package: 'psych'

## The following objects are masked from 'package:ggplot2':
##
##    %+%, alpha

# Generate 100000 random observations
n <- 100000
a <- 2
b <- 1

# Generate y, y1, y2, y3 with N(1,2) distribution
mu <- 1
sig2 <- 1
y <- rnorm(n,mu,sqrt(sig2))
y1 <- rnorm(n,mu,sqrt(sig2))
y2 <- rnorm(n,mu,sqrt(sig2))
y3 <- rnorm(n,mu,sqrt(sig2))

# Calculate a linear function of y, then sum, mean, and s2
yprime <- a*y + b
y123 <- cbind(y1,y2,y3)
ysum <- apply(y123,1,sum)
ybar <- apply(y123,1,mean)
s2 <- apply(y123,1,var)

# Make data frame for ggplot2
plotdata <- as.data.frame(cbind(y,yprime,ysum,ybar,s2))

# Print first 25 observations
plotdata[1:25,]
```

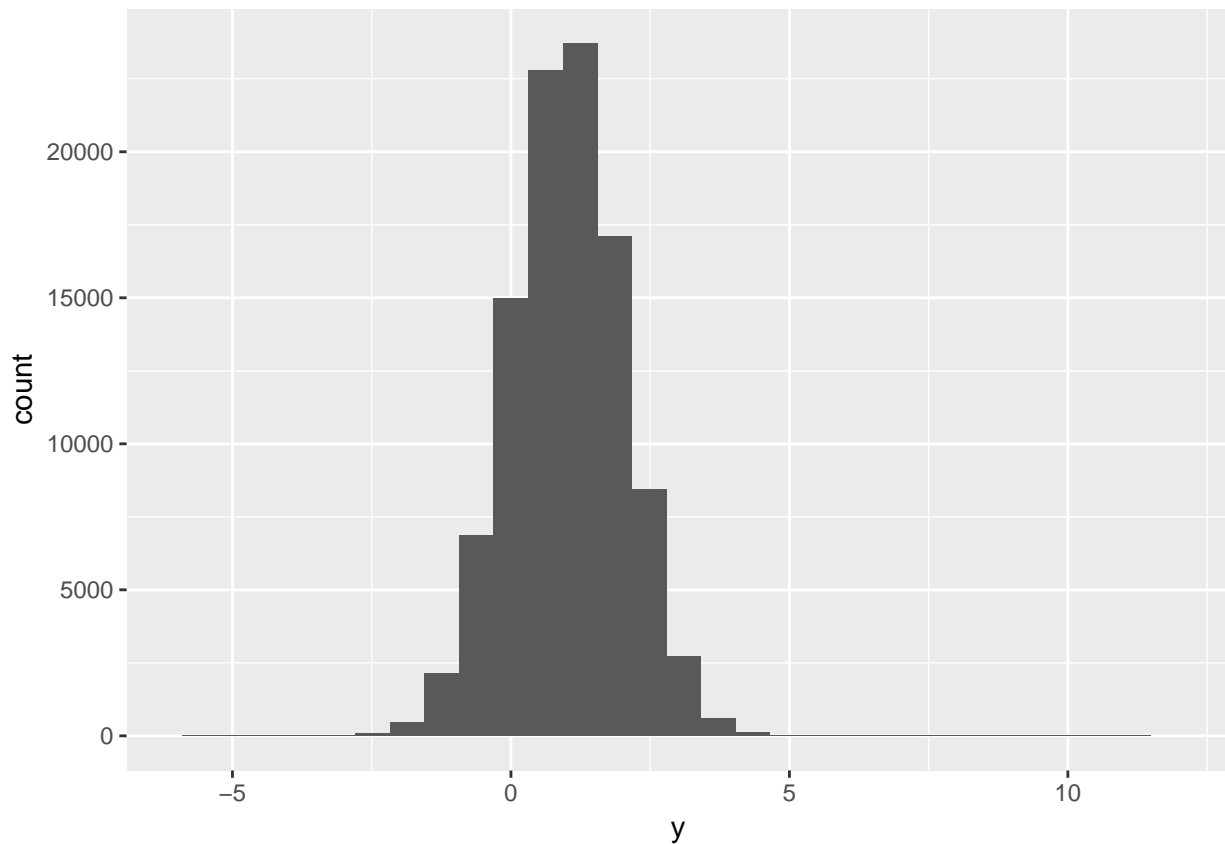
##	y	yprime	ysum	ybar	s2
## 1	1.4734450	3.9468901	3.8422675	1.28075583	0.10093578
## 2	2.4956188	5.9912377	3.7104483	1.23681611	0.19319596
## 3	-1.5150933	-2.0301867	3.7927842	1.26426139	1.92175896
## 4	1.1798322	3.3596644	3.4105982	1.13686607	1.83604996
## 5	0.2240634	1.4481267	-0.4342513	-0.14475043	1.24598217
## 6	0.4631946	1.9263892	3.3347497	1.11158323	0.80196918
## 7	1.6283512	4.2567024	2.6123333	0.87077776	0.10277185

```
## 8  1.2243690  3.4487379  3.9098672  1.30328905 0.50304223
## 9  1.6835117  4.3670234  3.7721119  1.25737065 0.40958731
## 10 1.7797365  4.5594730  0.5333194  0.17777313 0.59594369
## 11 1.1332593  3.2665186  4.5197074  1.50656912 0.44190317
## 12 2.5932583  6.1865167  0.4297183  0.14323943 0.18652156
## 13 1.6220112  4.2440225  2.3074419  0.76914731 1.95279338
## 14 1.9638371  4.9276743  0.2863508  0.09545026 0.25214059
## 15 2.2770179  5.5540359  5.8692820  1.95642734 0.08840592
## 16 1.8507513  4.7015025  3.9886456  1.32954854 2.55237620
## 17 -0.5748626 -0.1497251  3.9845224  1.32817415 1.72816889
## 18 2.6230787  6.2461573  3.1915881  1.06386270 0.54133826
## 19 -1.1375287 -1.2750574  2.1792684  0.72642279 0.56261704
## 20 1.6693024  4.3386047  4.0190295  1.33967650 0.14851172
## 21 0.1032850  1.2065699  3.8650090  1.28833634 0.07326915
## 22 0.5340146  2.0680291  4.2220704  1.40735679 1.21703225
## 23 -0.3378751  0.3242498  3.1881322  1.06271073 0.42313716
## 24 0.7350855  2.4701709  1.0510223  0.35034075 0.40858393
## 25 2.2309992  5.4619984 -0.8088277 -0.26960924 1.73242410
```

```
# Graphics using ggplot2
ggplot(plotdata,aes(y))+
geom_histogram()+xlim(-6,12)
```

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

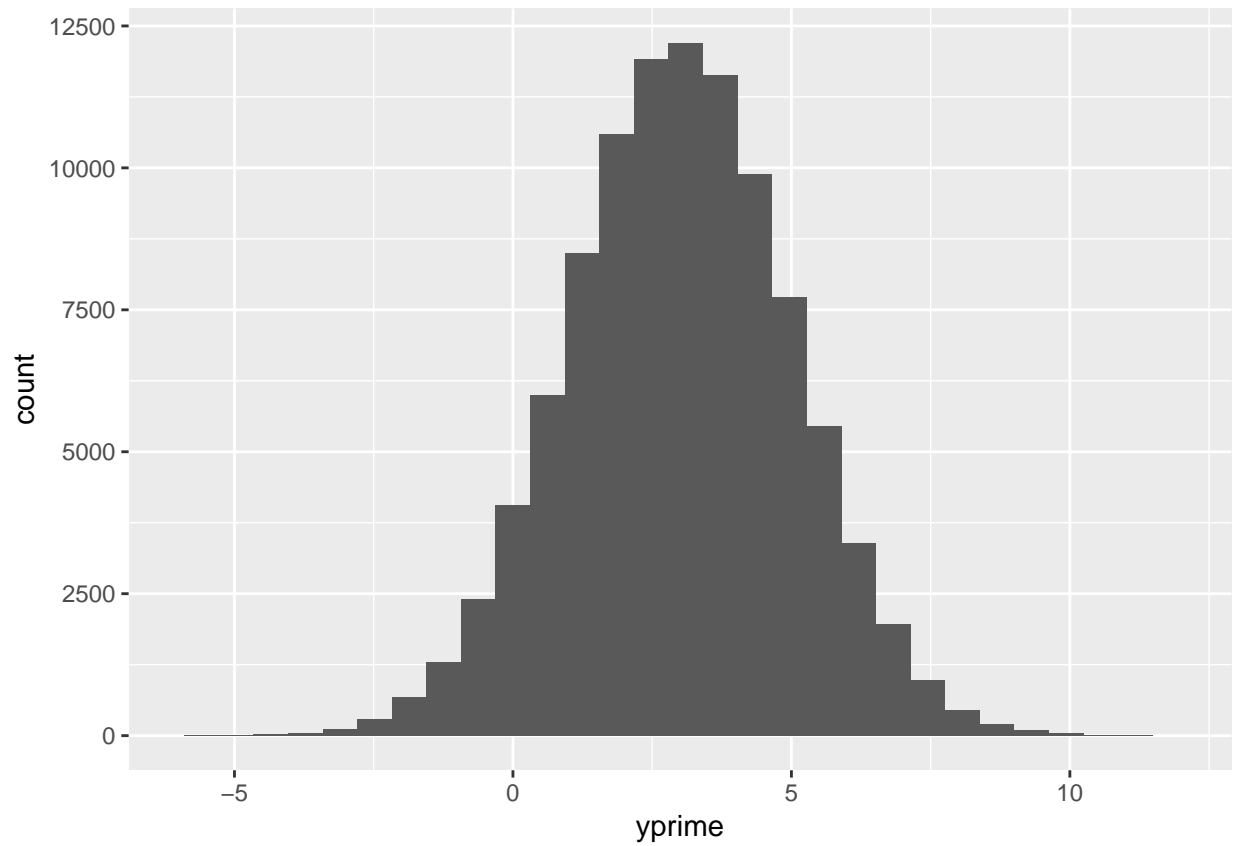
```
## Warning: Removed 1 rows containing missing values (geom_bar).
```



```
ggplot(plotdata,aes(yprime))+  
geom_histogram()+xlim(-6,12)
```

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

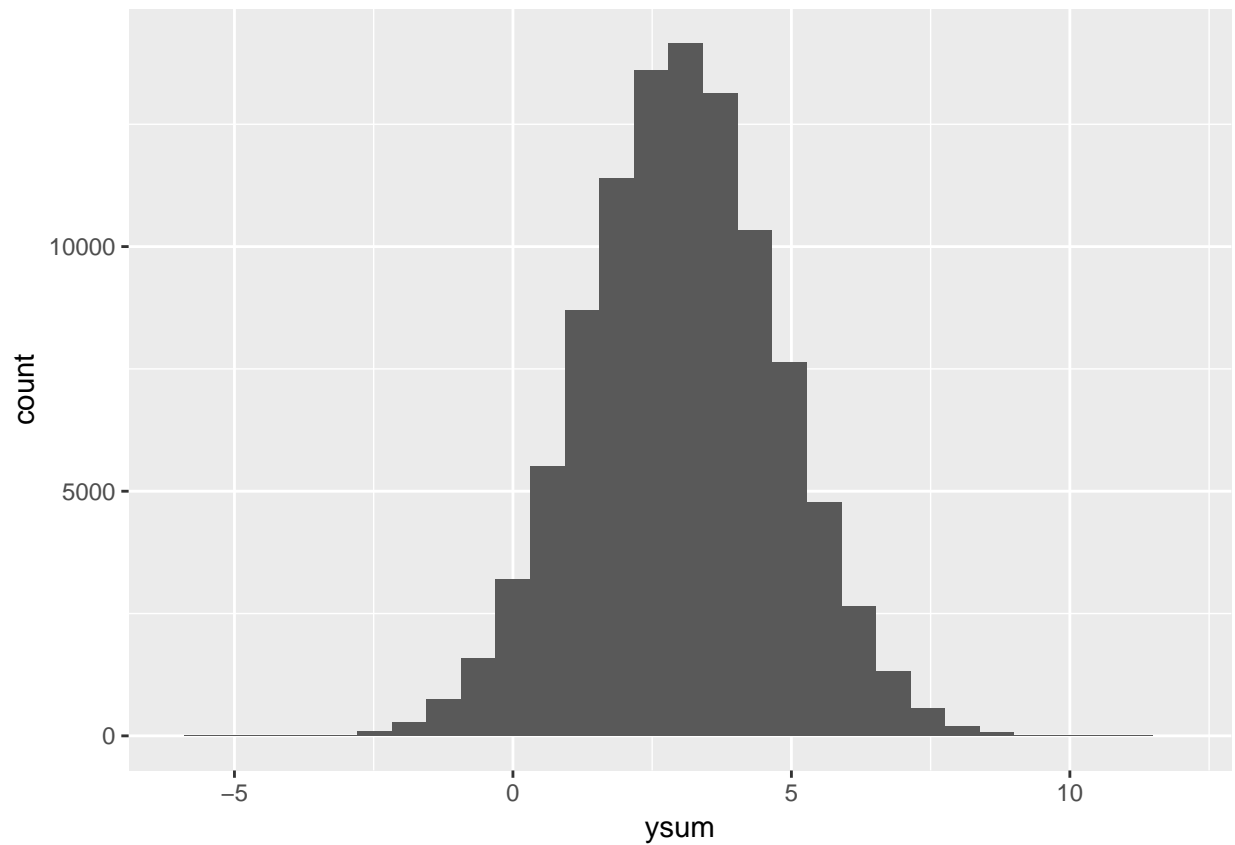
```
## Warning: Removed 1 rows containing missing values (geom_bar).
```



```
ggplot(plotdata,aes(ysum))+  
geom_histogram()+xlim(-6,12)
```

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

```
## Warning: Removed 1 rows containing missing values (geom_bar).
```

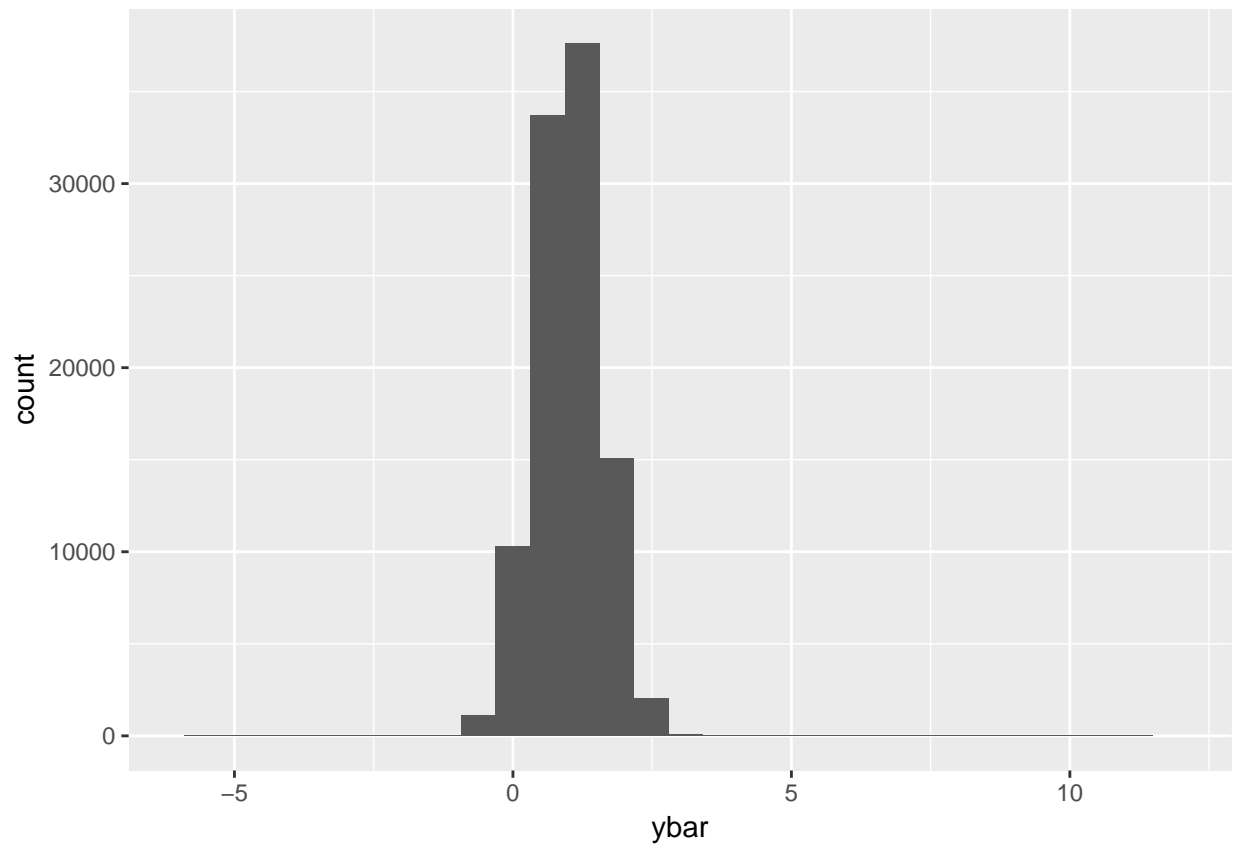


```
ggplot(plotdata,aes(ybar))+  
geom_histogram()+xlim(-6,12)
```

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

```
## Warning: Removed 1 rows containing missing values (geom_bar).
```

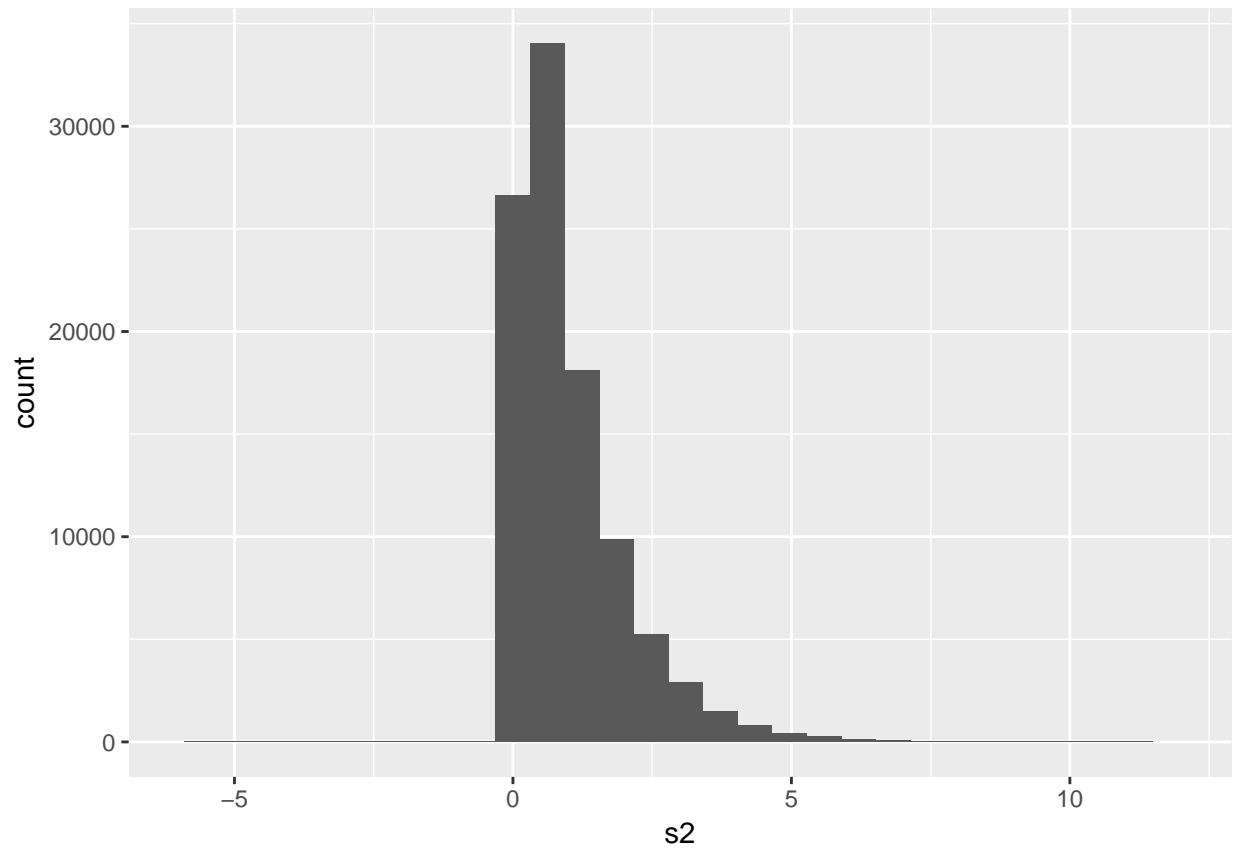




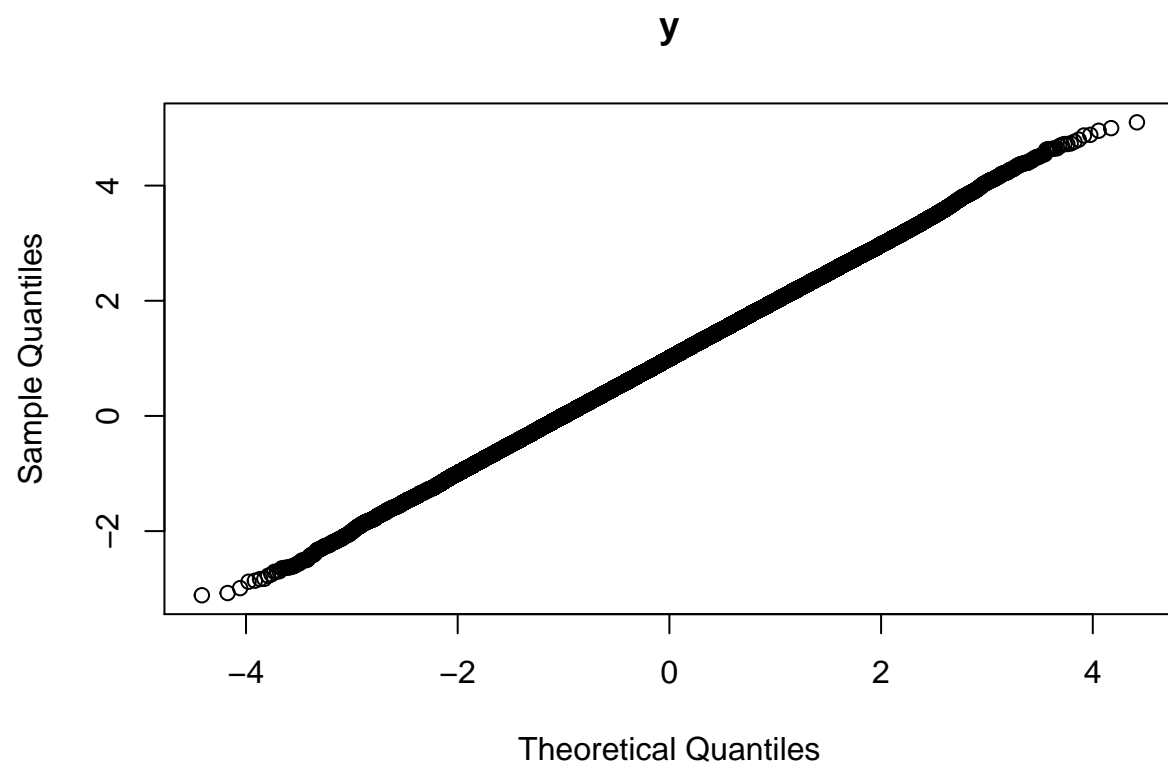
```
ggplot(plotdata,aes(s2))+  
geom_histogram()+xlim(-6,12)
```

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

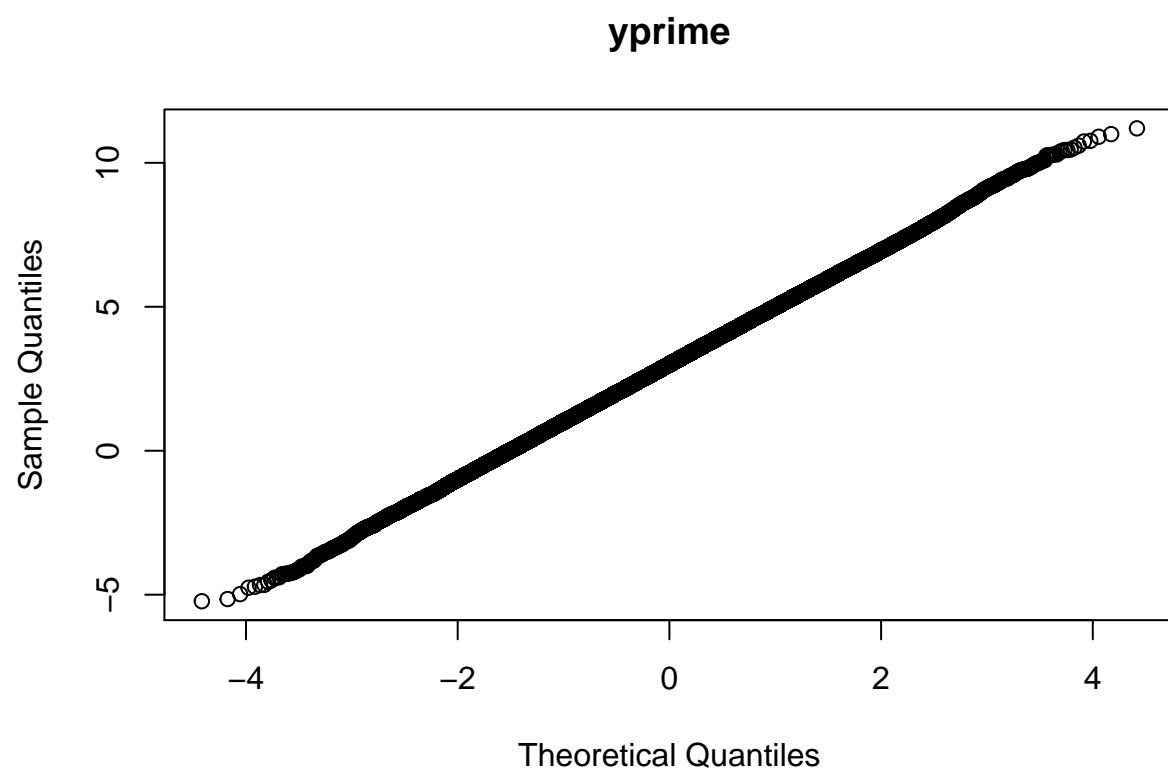
```
## Warning: Removed 1 rows containing missing values (geom_bar).
```



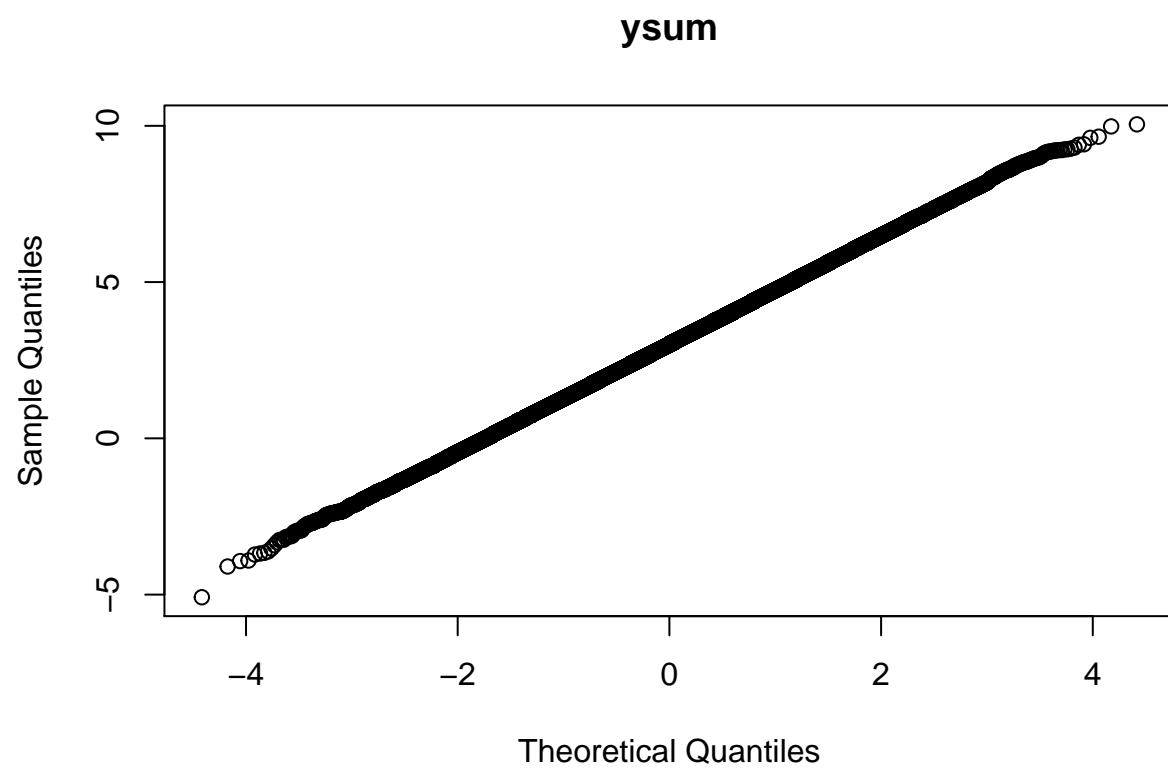
```
# Normal quantile plots  
qqnorm(y,main="y")
```



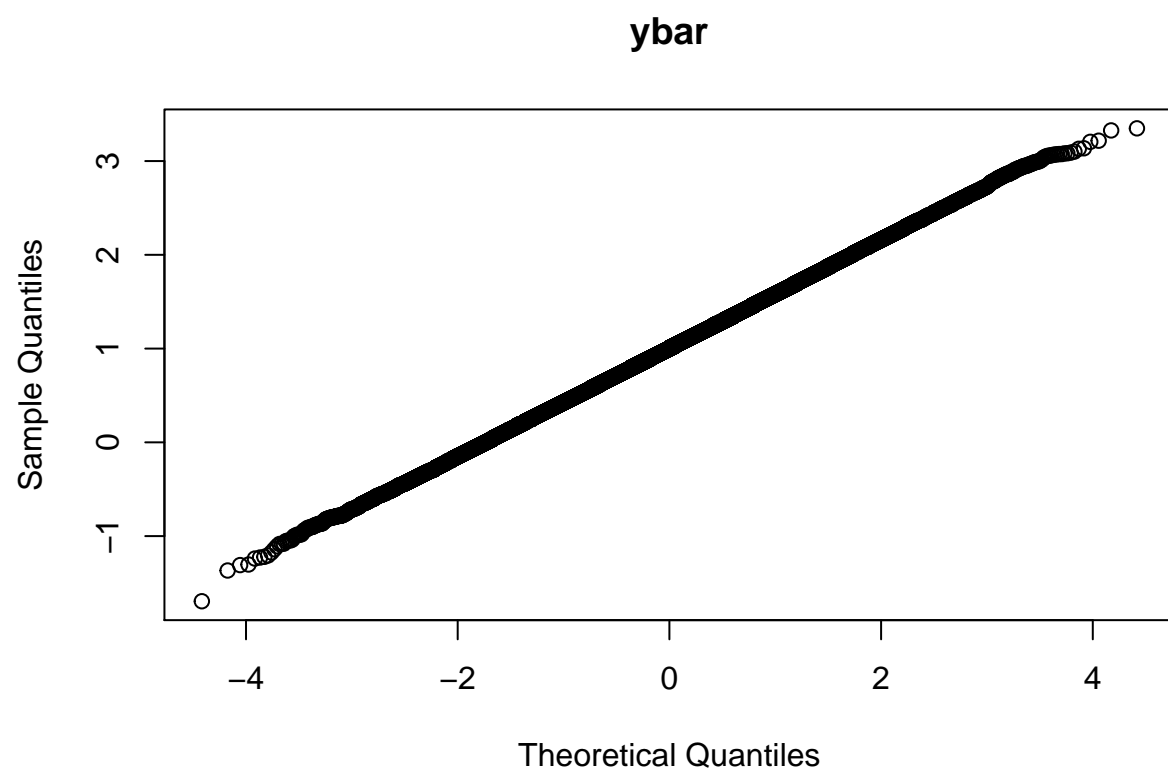
```
qqnorm(yprime,main="yprime")
```



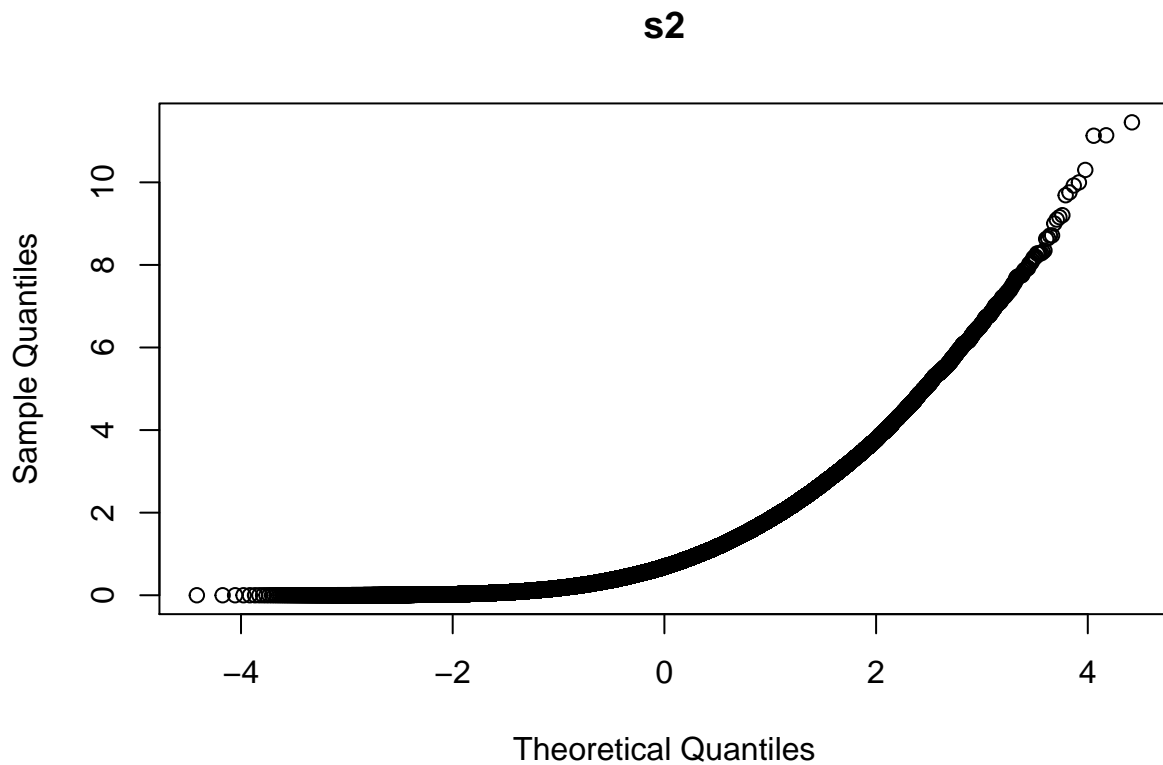
```
qqnorm(ysum,main="ysum")
```



```
qqnorm(ybar,main="ybar")
```



```
qqnorm(s2,main="s2")
```



```
# Descriptive statistics
describe(plotdata)
```

```
##      vars      n mean  sd median trimmed  mad   min   max range  skew
## y         1 1e+05 1.00 1.00   1.00   1.00 1.00 -3.11  5.10  8.21 -0.01
## yprime    2 1e+05 3.00 1.99   3.00   3.00 2.00 -5.23 11.20 16.42 -0.01
## ysum      3 1e+05 3.01 1.73   3.01   3.01 1.73 -5.08 10.05 15.13  0.01
## ybar      4 1e+05 1.00 0.58   1.00   1.00 0.58 -1.69  3.35  5.04  0.01
## s2       5 1e+05 1.00 1.00   0.69   0.83 0.71  0.00 11.45 11.45  1.99
##      kurtosis   se
## y           0.01 0.00
## yprime      0.01 0.01
## ysum        -0.02 0.01
## ybar        -0.02 0.00
## s2           5.87 0.00
```