SDM4 in R: Multiple Regression (Chapter 28)

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Introduction and background

This document is intended to help describe how to undertake analyses introduced as examples in the Fourth Edition of *Stats: Data and Models* (2014) by De Veaux, Velleman, and Bock. More information about the book can be found at http://wps.aw.com/aw_deveaux_stats_series. This file as well as the associated R Markdown reproducible analysis source file used to create it can be found at http://nhorton.people.amherst.edu/sdm4.

This work leverages initiatives undertaken by Project MOSAIC (http://www.mosaic-web.org), an NSF-funded effort to improve the teaching of statistics, calculus, science and computing in the undergraduate curriculum. In particular, we utilize the `mosaic` package, which was written to simplify the use of R for introductory statistics courses. A short summary of the R needed to teach introductory statistics can be found in the mosaic package vignettes (http://cran.r-project.org/web/packages/mosaic). A paper describing the mosaic approach was published in the *R Journal*: https://journal.r-project.org/archive/2017/RJ-2017-024.

Chapter 28: Multiple Regression

Section 28.1: What is multiple regression?

The table on page 818 displays the results from the multiple regression model.

```
library(mosaic)
library(readr)
options(digits = 3)
BodyFat <- read_csv("http://nhorton.people.amherst.edu/sdm4/data/Body_fat_complete.csv")
BodyFatmod <- lm(PctBF ~ waist + Height, data = BodyFat)
msummary(BodyFatmod)
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3.1009     7.6861   -0.40     0.69
## waist         1.7731     0.0716   24.77  < 2e-16 ***
## Height       -0.6015     0.1099   -5.47  1.1e-07 ***
##
## Residual standard error: 4.46 on 247 degrees of freedom
## Multiple R-squared:  0.713,  Adjusted R-squared:  0.711
## F-statistic:  307 on 2 and 247 DF,  p-value: <2e-16
```

We can use this model to generate predicted values.

```
BodyFatfun <- makeFun(BodyFatmod)
BodyFatfun(waist = 0, Height = 0)  # returns intercept
```

```
##    1
## -3.1
```

```
BodyFatfun(waist = 30, Height = 70)
```

```
##    1
## 7.98
```

```
-3.101 + 1.773*30 - 0.602*70
```

```
## [1] 7.95
```

Section 28.2: Interpreting multiple regression coefficients

Figure 28.1 on page 819 displays the scatterplot of percent body fat against height.

```
gf_point(PctBF ~ Height, data = BodyFat) %>%
  gf_lm()
```

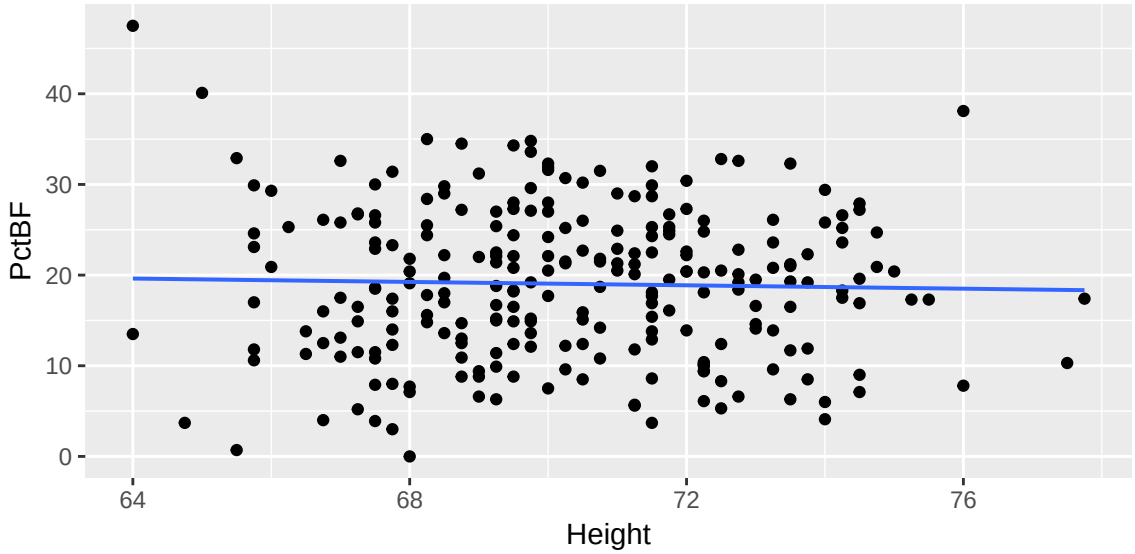


Figure 28.2 (page 820) displays the scatterplot for a subset of the data (men with waist sizes between 36 and 38 inches).

```
gf_point(PctBF ~ Height, data = filter(BodyFat, waist > 36, waist < 38)) %>%
  gf_lm()
```

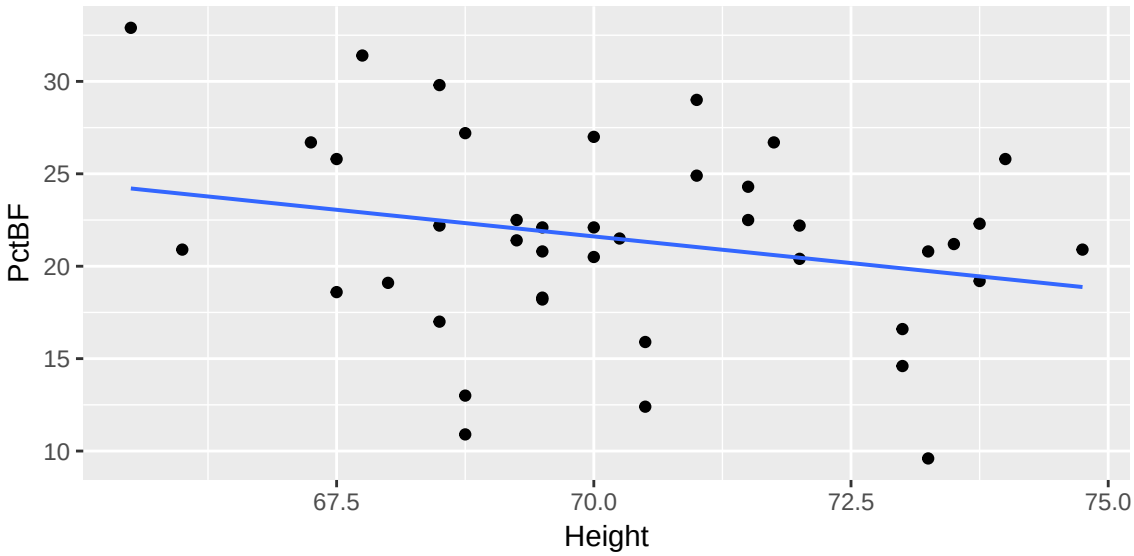
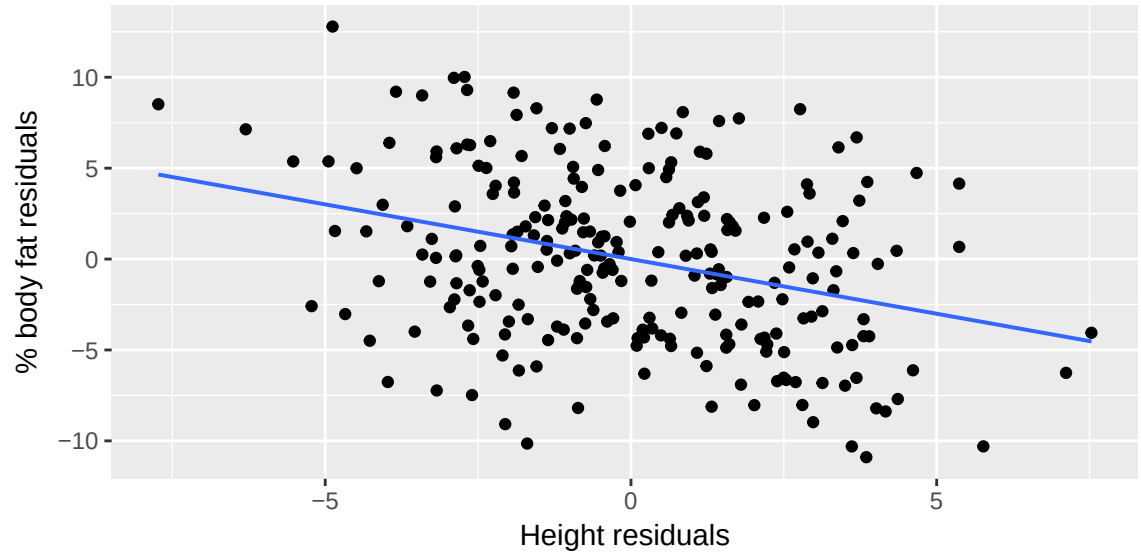


Figure 28.3 (page 820) displays the partial regression plot for weight.

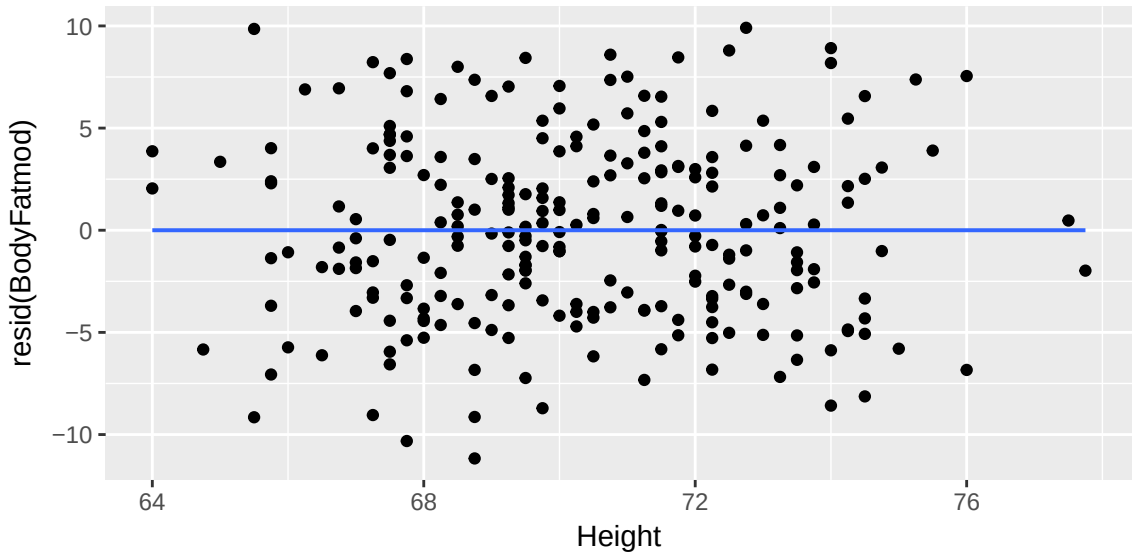
```
BodyFatwaist <- lm(PctBF ~ waist, data = BodyFat)
BodyFatheight <- lm(Height ~ waist, data = BodyFat)

gf_point(resid(BodyFatwaist) ~ resid(BodyFatheight),
       ylab = "% body fat residuals", xlab = "Height residuals") %>%
  gf_lm()
```



Section 28.3: The multiple regression model (assumptions and conditions)

Figure 28.4 (page 822) displays scatterplots of residuals vs. height and waist, respectively.

```
gf_point(resid(BodyFatmod) ~ Height, data = BodyFat) %>%
  gf_lm()
```




```
gf_point(resid(BodyFatmod) ~ waist, data = BodyFat) %>%
  gf_lm()
```

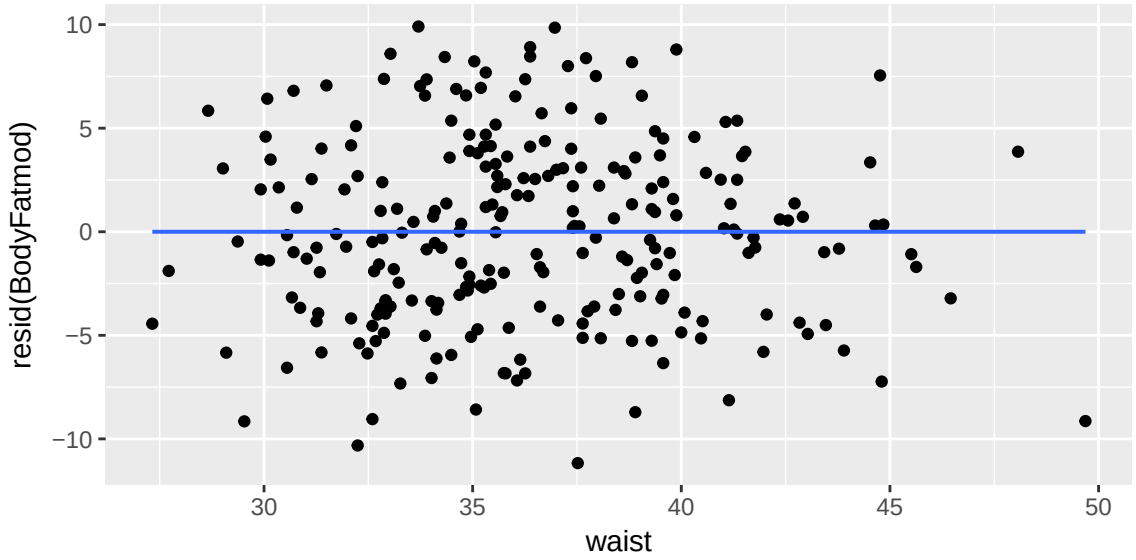
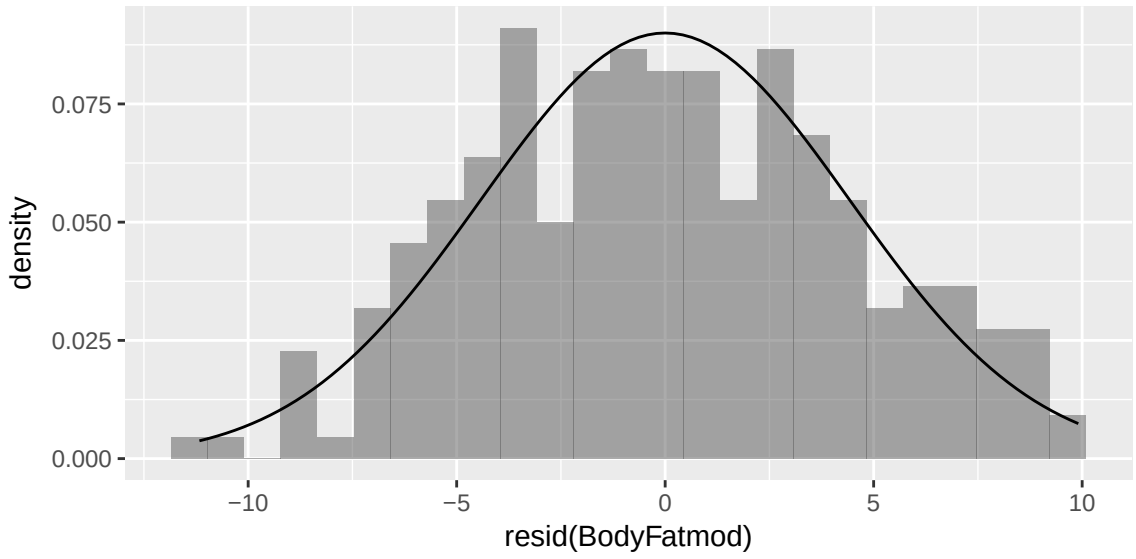
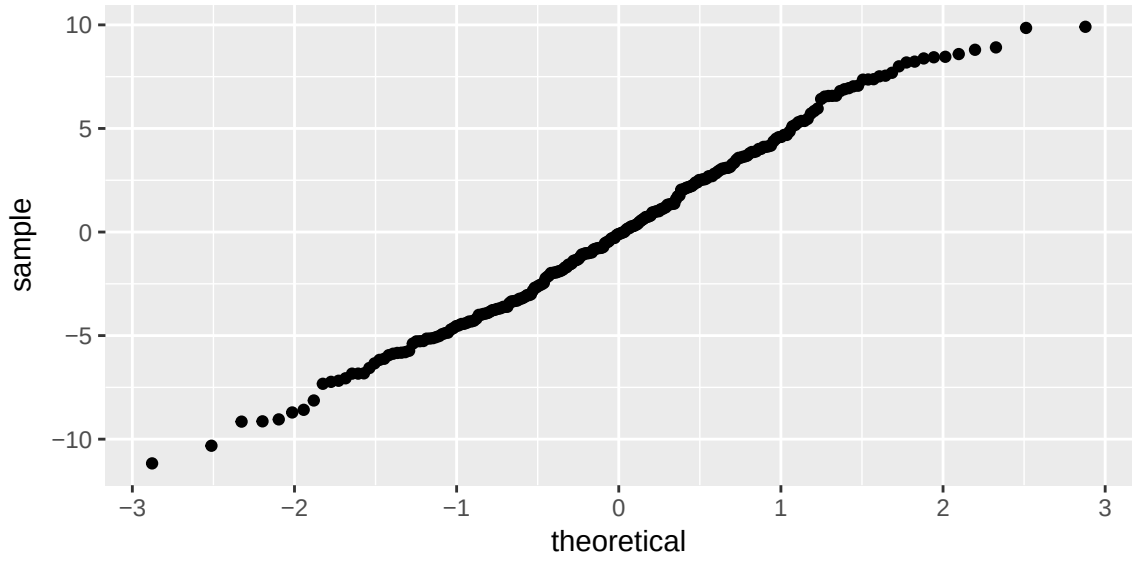


Figure 28.5 (page 823) displays histogram and qq plot of the residuals.

```
gf_dhistogram(~ resid(BodyFatmod), data = BodyFat) %>%
  gf_fitdistr(dist = dnorm)
```



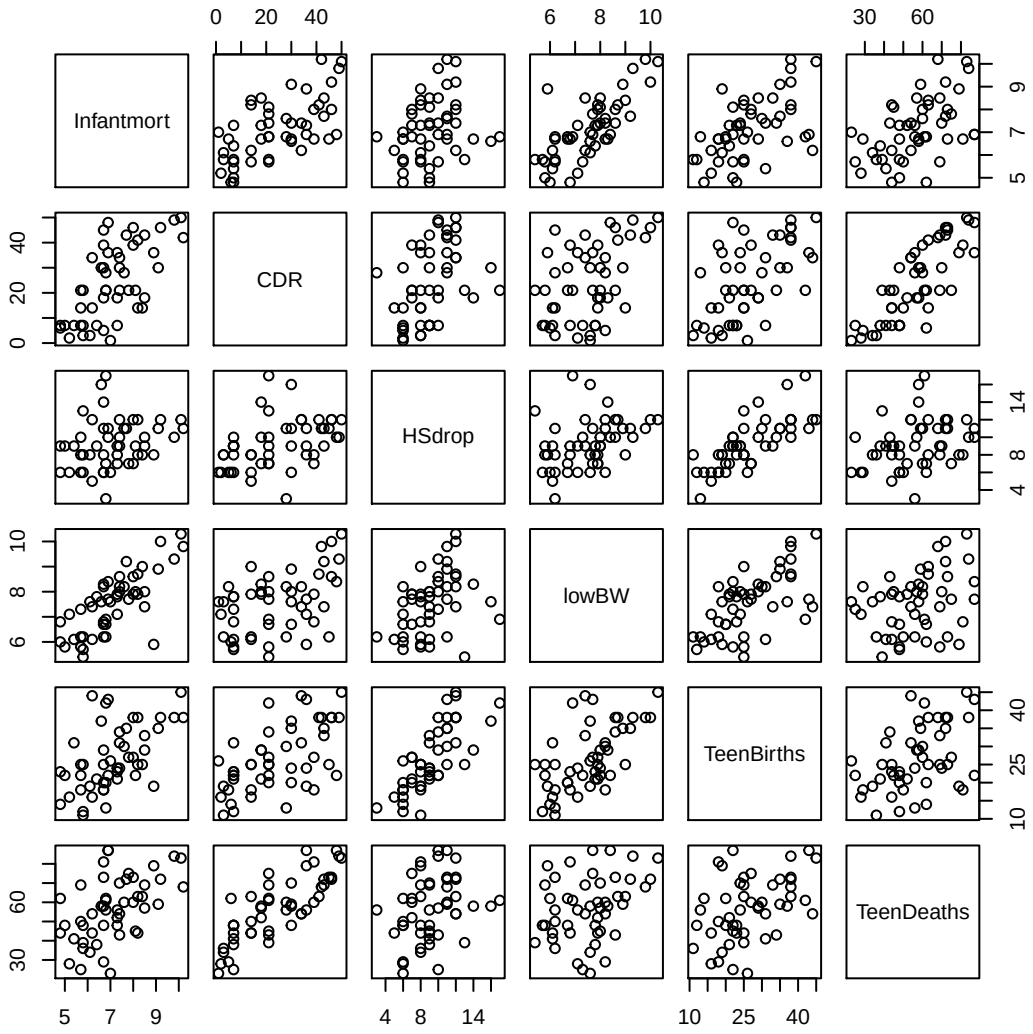

```
gf_qq(~ resid(BodyFatmod))
```



Section 28.4: Multiple regression inference

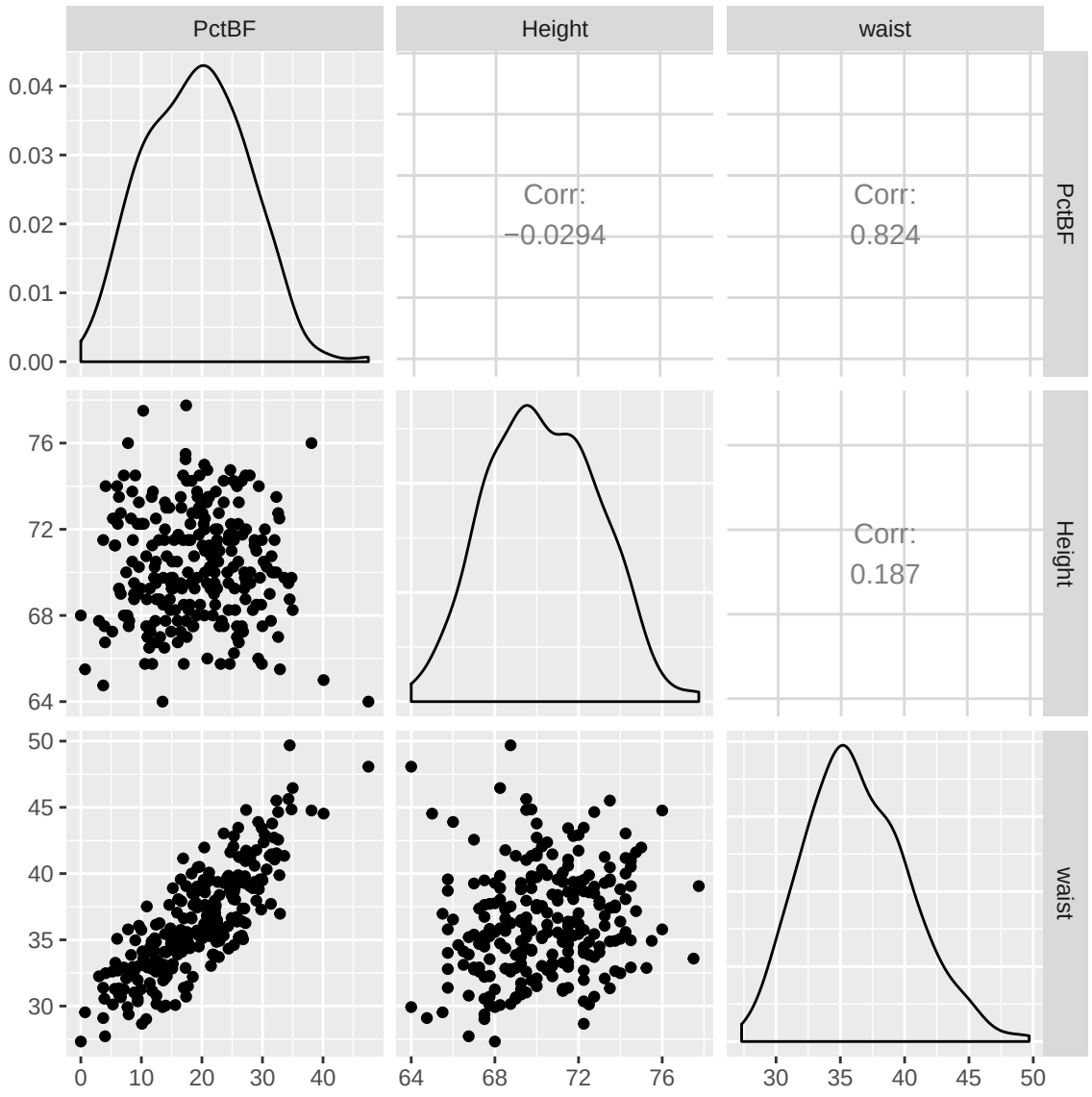
Figure 28.6 (page 829) displays the scatterplot matrix infant mortality data.

```
InfantMortality <- read_csv("http://nhorton.people.amherst.edu/sdm4/data/Infant_Mortality.csv")
pairs(select(InfantMortality, - State))
```



In addition, we display a scatterplot matrix for the motivating example from the chapter (BodyFat) using the `GGally` package.

```
subsetBodyFat <- select(BodyFat, PctBF, Height, waist)
library(GGally)
ggpairs(subsetBodyFat)
```



Section 28.5: Comparing multiple regression models

We may want to compare which of our models provides the most parsimonious fit to these data.

```
msummary(BodyFatheight)
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  65.8864     1.4848   44.37   <2e-16 ***
## waist         0.1216     0.0406    2.99    0.003 **
##
## Residual standard error: 2.58 on 248 degrees of freedom
## Multiple R-squared:  0.0349, Adjusted R-squared:  0.031
## F-statistic: 8.96 on 1 and 248 DF,  p-value: 0.00305
```

```
msummary(BodyFatwaist)
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -42.7341     2.7165   -15.7   <2e-16 ***
## waist         1.7000     0.0743    22.9   <2e-16 ***
##
## Residual standard error: 4.71 on 248 degrees of freedom
## Multiple R-squared:  0.678,  Adjusted R-squared:  0.677
## F-statistic:  523 on 1 and 248 DF,  p-value: <2e-16
```

```
msummary(BodyFatmod)
```

```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  -3.1009     7.6861   -0.40     0.69
## waist         1.7731     0.0716   24.77  < 2e-16 ***
## Height       -0.6015     0.1099   -5.47  1.1e-07 ***
##
## Residual standard error: 4.46 on 247 degrees of freedom
## Multiple R-squared:  0.713,  Adjusted R-squared:  0.711
## F-statistic:  307 on 2 and 247 DF,  p-value: <2e-16
```

The adjusted R-squared value of 0.711 is considerably higher for the model with both predictors (though the model with just waist has an adjusted R-squared value of 0.677).