

Zkouška z MAS02, 7. 9. 2021

Popis situace: U 23 českých profesionálních basketbalistů byly zjišťovány hodnoty těchto proměnných:

vyska ... tělesná výška v cm

hmotnost ... tělesná hmotnost v kg

tuk ... procento tělesného tuku (u basketbalistů by se tyto hodnoty měly pohybovat od 7 % do 13 %)

VO2_max ... aerobní kapacita (maximální množství kyslíku za minutu, které může organismus využít při intenzivním fyzickém zatížení; jedná se o ukazatel tělesné zdatnosti; ideální hodnota by se měla pohybovat kolem 60 ml/kg)

Údaje jsou uloženy v souboru basketbal.csv.

Cíle výzkumu:

1. Pomocí metod korelační analýzy prozkoumat závislosti mezi proměnnými.

2. Sestavit model vícenásobné lineární regrese, který umožní popsat závislost aerobní kapacity na výšce, hmotnosti a procentu tělesného tuku.

Upozornění: Pro ověření vícerozměrné normality dat je použita funkce CM.test z knihovny mvtnorm.

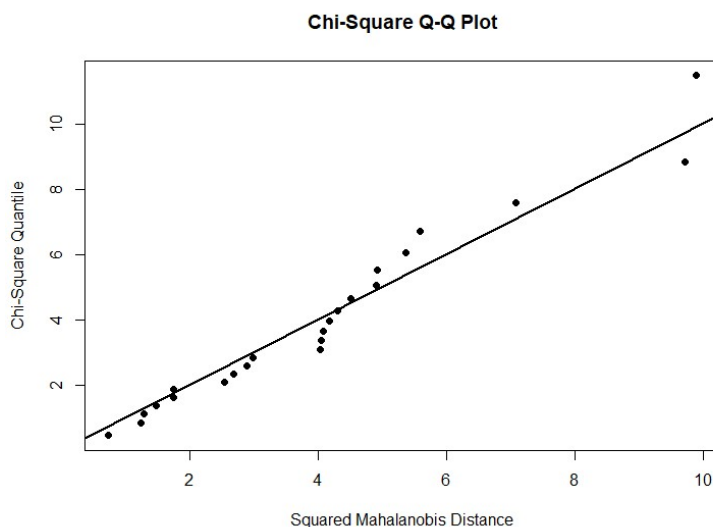
Výstupy ze systému R

```
> library(mvtnorm)
> CM.test(basketbal,qqplot=T)
      Cramer-von Mises test for Multivariate Normality

data : basketbal

CM          : 0.07362245
p-value     : 0.5191481

Result  : Data are multivariate normal (sig.level = 0.05)
```



```
> cor.test(basketbal$VO2_max,basketbal$vyska)
```

Pearson's product-moment correlation

```
data: basketbal$VO2_max and basketbal$vyska
t = -2.7973, df = 21, p-value = 0.01079
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.7682332 -0.1385822
sample estimates:
      cor
-0.5210216
```

```
> cor.test(basketbal$VO2_max,basketbal$hmotnost)
```

Pearson's product-moment correlation

```
data: basketbal$VO2_max and basketbal$hmotnost
t = -10.194, df = 21, p-value = 1.381e-09
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.9624444 -0.8010513
sample estimates:
      cor
-0.9120869
```

```
> cor.test(basketbal$VO2_max,basketbal$tuk)
```

Pearson's product-moment correlation

```
data: basketbal$VO2_max and basketbal$tuk
t = -5.108, df = 21, p-value = 4.646e-05
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.8850136 -0.4791772
sample estimates:
      cor
-0.7443558
```

```
> cor.test(basketbal$vyska,basketbal$hmotnost)
```

Pearson's product-moment correlation

```
data: basketbal$vyska and basketbal$hmotnost
t = 4.0081, df = 21, p-value = 0.0006373
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.3378260 0.8420445
sample estimates:
      cor
0.6583511
```

```
> cor.test(basketbal$vyska,basketbal$tuk)
```

Pearson's product-moment correlation

```
data: basketbal$vyska and basketbal$tuk
t = 1.7241, df = 21, p-value = 0.09939
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 -0.07027838 0.66744879
sample estimates:
      cor
0.3521245
```

```
> cor.test(basketbal$hmotnost,basketbal$tuk)
```

Pearson's product-moment correlation

```
data: basketbal$hmotnost and basketbal$tuk
t = 4.0019, df = 21, p-value = 0.0006467
alternative hypothesis: true correlation is not equal to 0
95 percent confidence interval:
 0.3369272 0.8417491
sample estimates:
      cor
0.657776
```

```
> pcor(basketbal[-1])
```

```
$estimate
      hmotnost      tuk      VO2_max
hmotnost 1.00000000 -0.07721672 -0.8399233
tuk      -0.07721672 1.00000000 -0.4676157
VO2_max  -0.83992326 -0.46761575 1.0000000

$p.value
      hmotnost      tuk      VO2_max
hmotnost 0.000000e+00 0.73269113 1.011868e-06
tuk      7.326911e-01 0.00000000 2.820084e-02
VO2_max 1.011868e-06 0.02820084 0.000000e+00

$statistic
      hmotnost      tuk      VO2_max
hmotnost 0.00000000 -0.3463578 -6.921347
tuk      -0.3463578 0.00000000 -2.365840
VO2_max  -6.9213471 -2.3658399 0.0000000

$n
[1] 23

$gp
[1] 1

$method
[1] "pearson"
```

```
> pcor(basketbal[-2])
```

```
$estimate
      vyska      tuk      VO2_max
vyska 1.00000000 -0.0626353 -0.4142560
tuk   -0.0626353 1.00000000 -0.7020999
VO2_max -0.4142560 -0.7020999 1.0000000

$p.value
      vyska      tuk      VO2_max
vyska 0.00000000 0.7818504001 0.0552699949
tuk   0.78185040 0.0000000000 0.0002701834
VO2_max 0.05526999 0.0002701834 0.0000000000

$statistic
      vyska      tuk      VO2_max
vyska 0.00000000 -0.2806647 -2.035475
tuk   -0.2806647 0.00000000 -4.409467
VO2_max -2.0354755 -4.4094672 0.0000000
```

```
$n
[1] 23
```

```
$gp
[1] 1
```

```
$method
[1] "pearson"
```

```
> pcor(basketbal[-3])
```

```
$estimate
```

	vyska	hmotnost	VO2_max
vyska	1.0000000	0.5233145	0.2574508
hmotnost	0.5233145	1.0000000	-0.8857539
VO2_max	0.2574508	-0.8857539	1.0000000

```
$p.value
```

	vyska	hmotnost	VO2_max
vyska	0.0000000	1.244393e-02	2.473979e-01
hmotnost	0.01244393	0.000000e+00	4.233245e-08
VO2_max	0.24739789	4.233245e-08	0.000000e+00

```
$statistic
```

	vyska	hmotnost	VO2_max
vyska	0.0000000	2.746421	1.191520
hmotnost	2.746421	0.0000000	-8.534241
VO2_max	1.191520	-8.534241	0.0000000

```
$n
[1] 23
```

```
$gp
[1] 1
```

```
$method
[1] "pearson"
```

```
> pcor(basketbal)
```

```
$estimate
```

	vyska	hmotnost	tuk	VO2_max
vyska	1.00000000	0.52105379	-0.02616148	0.2179797
hmotnost	0.52105379	1.00000000	-0.05225222	-0.8132347
tuk	-0.02616148	-0.05225222	1.00000000	-0.4505123
VO2_max	0.21797971	-0.81323473	-0.45051226	1.0000000

```
$p.value
```

	vyska	hmotnost	tuk	VO2_max
vyska	0.0000000	1.543230e-02	0.91037573	3.425065e-01
hmotnost	0.0154323	0.000000e+00	0.82202548	7.399455e-06
tuk	0.9103757	8.220255e-01	0.00000000	4.041368e-02
VO2_max	0.3425065	7.399455e-06	0.04041368	0.000000e+00

```
$statistic
```

	vyska	hmotnost	tuk	VO2_max
vyska	0.0000000	2.6609928	-0.1140743	0.9735625
hmotnost	2.6609928	0.0000000	-0.2280737	-6.0914074
tuk	-0.1140743	-0.2280737	0.0000000	-2.1996000
VO2_max	0.9735625	-6.0914074	-2.1996000	0.0000000

```
$n
```

```
[1] 23
```

```
$gp
```

```
[1] 2
```

```
$method
```

```
[1] "pearson"
```

```
> model<-
```

```
lm(basketbal$VO2_max~basketbal$vyska+basketbal$hmotnost+basketbal$tuk)
```

```
> summary(model)
```

```
Call:
```

```
lm(formula = basketbal$VO2_max ~ basketbal$vyska + basketbal$hmotnost +  
basketbal$tuk)
```

```
Residuals:
```

```
      Min       1Q   Median       3Q      Max  
-2.6811 -1.0552 -0.1376  0.6958  4.0287
```

```
Coefficients:
```

```
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)    79.60140     7.28196  10.931 1.23e-09 ***  
basketbal$vyska  0.04633     0.04759   0.974  0.3425  
basketbal$hmotnost -0.31683     0.05201  -6.091 7.40e-06 ***  
basketbal$tuk    -0.33671     0.15308  -2.200  0.0404 *
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 1.943 on 19 degrees of freedom
```

```
Multiple R-squared:  0.8749, Adjusted R-squared:  0.8551
```

```
F-statistic: 44.29 on 3 and 19 DF, p-value: 9.031e-09
```

```
> model1<-lm(basketbal$VO2_max~basketbal$hmotnost+basketbal$tuk)
```

```
> summary(model1)
```

```
Call:
```

```
lm(formula = basketbal$VO2_max ~ basketbal$hmotnost + basketbal$tuk)
```

```
Residuals:
```

```
      Min       1Q   Median       3Q      Max  
-3.0164 -1.1064 -0.3972  1.1637  4.2497
```

```
Coefficients:
```

```
              Estimate Std. Error t value Pr(>|t|)  
(Intercept)    85.96030     3.21533  26.735 < 2e-16 ***  
basketbal$hmotnost -0.28617     0.04135  -6.921 1.01e-06 ***  
basketbal$tuk     -0.35798     0.15131  -2.366  0.0282 *
```

```
---
```

```
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
Residual standard error: 1.94 on 20 degrees of freedom
```

```
Multiple R-squared:  0.8687, Adjusted R-squared:  0.8555
```

```
F-statistic: 66.14 on 2 and 20 DF, p-value: 1.528e-09
```

```
> anova(model, model1)
```

```
Analysis of Variance Table
```

```
Model 1: basketbal$VO2_max ~ basketbal$vyska + basketbal$hmotnost +  
basketbal$tuk
```

```
Model 2: basketbal$VO2_max ~ basketbal$hmotnost + basketbal$tuk
```

```

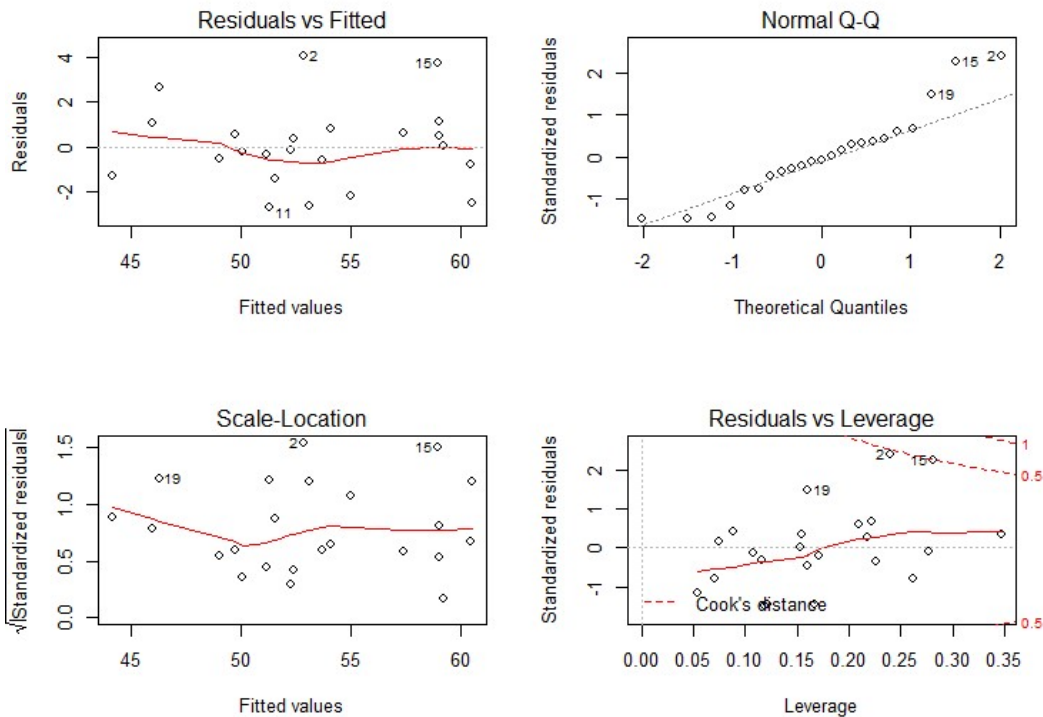
Res.Df    RSS Df Sum of Sq    F Pr(>F)
1      19 71.694
2      20 75.271 -1    -3.5765 0.9478 0.3425

```

```

> par(mfrow=c(2,2))
> plot(model1)

```



```

> shapiro.test(model1$residuals)

```

Shapiro-wilk normality test

```

data: model1$residuals
W = 0.96952, p-value = 0.6774

```

```

> library(car)
> durbinwatsonTest(model1)
lag Autocorrelation D-w Statistic p-value
1 0.02514025 1.927389 0.73
Alternative hypothesis: rho != 0

```

```

> confint(model1)
                2.5 %      97.5 %
(Intercept)  79.2532493 92.66735262
basketbal$hmotnost -0.3724219 -0.19992679
basketbal$tuk    -0.6736194 -0.04234917

```

```

> vif(model1)
basketbal$hmotnost    basketbal$tuk
1.76264              1.76264

```

```

> (MAPE<-100 * mean(abs(model1$residuals/basketbal$VO2_max)))
[1] 2.753056

```