MATH 204 - ASSIGNMENT 2: SOLUTIONS

(a) Fitting the simple linear regression model to each of the variables in turn yields the following results: we look at t-tests for the individual coefficients, and the ANOVA-F test statistics.

Variable		T-test				ANOVA		Conclusion
		$\widehat{\beta}$	$s_{\widehat{\beta}}$	t	p	F	p	
age		4.055	1.088	3.726	0.001	13.380	0.001	**INFLUENTIAL**
height		0.932	0.260	3.590	0.002	12.885	0.002	**INFLUENTIAL**
weight		1.187	0.301	3.944	0.001	15.559	0.001	**INFLUENTIAL**
bmp		0.639	0.565	1.131	0.270	1.279	0.270	NOT INFLUENTIAL
fev1		1.354	0.555	2.439	0.023	5.951	0.023	MARGINALLY INFLUENTIAL
rv		-0.123	0.077	-1.595	0.124	2.543	0.124	NOT INFLUENTIAL
frc		-0.319	0.145	-2.202	0.038	4.847	0.038	MARGINALLY INFLUENTIAL
tlc		-0.358	0.404	-0.886	0.385	0.785	0.385	NOT INFLUENTIAL
sex	0	19.045	13.176	1.445	0.162	2.089	0.162	NOT INFLUENTIAL
	1	98.455	9.860	9.985	0.000			

The variables declared as Marginally Influential are not significant at the $\alpha = 0.05$ significance level once a multiple testing correction is introduced; we are performing 9 tests, so we should test each hypothesis at the $\alpha = 0.05/9 = 0.0056$ significance level.

Note that the coefficient estimates for **sex** are baseline level (in the subgroup with **sex**=1), and difference from baseline (in the subgroup with **sex**=0). The fact that baseline subgroup coefficient is significantly different from zero does **not** mean that this variable is influential in predicting y.

It is possible to fit the model to the log-transformed response variable. This was not asked for, but is an acceptable approach. For the log-transformed data, the results are as follows;

Variable		T-test				ANOVA		Conclusion
		$\widehat{\beta}$	$s_{\widehat{\beta}}$	t	p	F	p	
age		0.033	0.009	3.515	0.002	12.355	0.002	**INFLUENTIAL**
height		0.008	0.002	3.498	0.002	12.234	0.002	**INFLUENTIAL**
weight		0.010	0.003	3.656	0.001	13.364	0.001	**INFLUENTIAL**
bmp		0.005	0.005	0.943	0.356	0.888	0.356	NOT INFLUENTIAL
fev1		0.011	0.005	2.207	0.038	4.872	0.038	MARGINALLY INFLUENTIAL
rv		-0.001	0.001	-1.595	0.124	2.543	0.124	NOT INFLUENTIAL
frc		-0.003	0.001	-2.151	0.042	4.625	0.042	MARGINALLY INFLUENTIAL
tlc		-0.003	0.003	-0.830	0.415	0.689	0.415	NOT INFLUENTIAL
sex	0	0.154	0.113	1.366	0.185	1.865	0.185	NOT INFLUENTIAL
	1	4.566	0.074	54.137	0.000			

Overall, inspecting the R^2 values, it seems that the prediction of y rather than $\log(y)$ is better, but the difference is marginal.

Thus, on the basis of simple linear regression one variable at a time, only **age**, **height** and **weight** are influential variables in the model predicting y.

10 Marks

(b) The results of the multiple regression analysis, with all variables included in linear form without interaction, as specified by the model

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_9 x_9 + \epsilon$$

can be found on pages 19-22 of the printout.

The following results can be discerned (only the first is needed for full marks)

- No variables are individually influential - all the p-values for the coefficients and in the componentwise ANOVA tests are greater than 0.05 - which contradicts the results from (a).

5 Marks

- However, we can go further. Using the ANOVA table, we can construct a global test of the hypothesis

$$\begin{aligned} H_0 &: \beta_1 = \beta_2 = \ldots = \beta_8 = \beta_9^{(0)} = 0 \\ H_a &: \text{At least one } \beta_j \neq 0 \end{aligned}$$

to assess whether the variables are worth including at all, or whether the null model described by H_0 fits as well. Here $\beta_9^{(0)}$ is the coefficient for the **sex**=0 subgroup.

We construct the test statistic F by

$$F = \frac{MSR}{MSE} = \frac{(SS - SSE)/k}{SSE/(n-k-1)}$$

where $k = 9$ is the total number of predictors, and MSR is the mean square due to the regression - recall that

$$SS = SSR + SSE.$$

Here, for the original scale data

$$F = \frac{(26832.64 - 9371.250)/9}{9371.250/15} = 3.105$$

In the usual way for ANOVA, we compare this with the Fisher-F$(9, 15)$ distribution. We find that

$$F_{0.95}(9, 15) = 2.587$$

so H_0 is rejected; hence it is worth fitting the collection of variables, as this model fits better than the model with all variables excluded. This type of analysis is sometimes called "ANCOVA", ANOVA with covariates. We also have

$$R^2 = 1 - \frac{SSE}{SS} = 1 - \frac{9731.250}{26832.64} = 0.637$$

$$\text{Adjusted } R^2 = 1 - \frac{SSE/(n-k-1)}{SS/(n-1)} = 1 - \frac{9731.250/15}{26832.64/24} = 0.420$$

so the overall explanatory power is not very good.

(c) The correlation table (page 23) indicates that a lot of the variables are strongly correlated. In particular, **age**, **height** and **weight** have correlations above 0.9, so are strongly positively correlated.

3 Marks

(d) The results in (c) partly explain those in (a) and (b) as the strong positive correlation between the apparently influential variables **age**, **height** and **weight** makes the results of the multiple regression hard to interpret. In the multiple regression, we are **not** truly observing the effect of each variable manifested through the estimated coefficient. The variables are borrowing strength from each other in the prediction of the response; when they are fitted together, the influence of each covariate is diluted.

2 Marks

Regression for pemax

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.613	.376	.349	26.974

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10098.478	1	10098.478	13.880	.001
	Residual	16734.162	23	727.572		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	50.408	16.657		3.026	.006	15.950	84.866
	Age in years	4.055	1.088	.613	3.726	.001	1.803	6.306

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.599	.359	.331	27.345

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	9634.636	1	9634.636	12.885	.002
	Residual	17198.004	23	747.739		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-33.276	40.044		-.831	.415	-116.114	49.563
	Height (cm)	.932	.260	.599	3.590	.002	.395	1.469

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.635	.404	.378	26.380

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10827.159	1	10827.159	15.559	.001
	Residual	16005.481	23	695.890		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	63.546	12.702		5.003	.000	37.270	89.821
	Weight (kg)	1.187	.301	.635	3.944	.001	.564	1.809

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.230	.053	.011	33.244

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1413.464	1	1413.464	1.279	.270
	Residual	25419.176	23	1105.182		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	59.080	44.744		1.320	.200	-33.481	151.641
	Body mass percentage (% of normal)	.639	.565	.230	1.131	.270	-.530	1.809

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.453	.206	.171	30.444

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5515.438	1	5515.438	5.951	.023
	Residual	21317.202	23	926.835		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	62.114	20.208		3.074	.005	20.309	103.918
	Forced expiratory volume	1.354	.555	.453	2.439	.023	.206	2.502

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.316	.100	.060	32.411

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2671.777	1	2671.777	2.543	.124
	Residual	24160.863	23	1050.472		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	140.423	20.671		6.793	.000	97.662	183.185
	Residual volume	-.123	.077	-.316	-1.595	.124	-.282	.036

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.417	.174	.138	31.041

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4670.553	1	4670.553	4.847	.038
	Residual	22162.087	23	963.569		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	158.706	23.363		6.793	.000	110.377	207.035
	Functional residual capacity	-.319	.145	-.417	-2.202	.038	-.619	-.019

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.182	.033	-.009	33.588

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	885.055	1	885.055	.785	.385
	Residual	25947.585	23	1128.156		
	Total	26832.640	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	149.919	46.550		3.221	.004	53.623	246.215
	Total lung capacity	-.358	.404	-.182	-.886	.385	-1.194	.478

Regression for log(pemax)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.591	.349	.321	.23457

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.680	1	.680	12.355	.002
	Residual	1.266	23	.055		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.170	.145		28.788	.000	3.870	4.470
	Age in years	.033	.009	.591	3.515	.002	.014	.053

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.589	.347	.319	.23497

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.675	1	.675	12.234	.002
	Residual	1.270	23	.055		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	3.460	.344		10.054	.000	2.748	4.171
	Height (cm)	.008	.002	.589	3.498	.002	.003	.012

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.606	.368	.340	.23129

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.715	1	.715	13.364	.001
	Residual	1.230	23	.053		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.281	.111		38.445	.000	4.051	4.512
	Weight (kg)	.010	.003	.606	3.656	.001	.004	.015

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.193	.037	-.005	.28536

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.072	1	.072	.888	.356
	Residual	1.873	23	.081		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.294	.384		11.179	.000	3.499	5.088
	Body mass percentage (% of normal)	.005	.005	.193	.943	.356	-.005	.015

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.418	.175	.139	.26419

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.340	1	.340	4.872	.038
	Residual	1.605	23	.070		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.283	.175		24.422	.000	3.920	4.645
	Forced expiratory volume	.011	.005	.418	2.207	.038	.001	.021

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.316	.100	.060	.27596

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.194	1	.194	2.544	.124
	Residual	1.752	23	.076		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	4.918	.176		27.945	.000	4.554	5.282
	Residual volume	-.001	.001	-.316	-1.595	.124	-.002	.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.409	.167	.131	.26536

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.326	1	.326	4.625	.042
	Residual	1.620	23	.070		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	5.066	.200		25.365	.000	4.653	5.479
	Functional residual capacity	-.003	.001	-.409	-2.151	.042	-.005	.000

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.171	.029	-.013	.28656

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.057	1	.057	.689	.415
	Residual	1.889	23	.082		
	Total	1.945	24			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	4.978	.397		12.534	.000	4.156	5.800
	Total lung capacity	-.003	.003	-.171	-.830	.415	-.010	.004

General Linear Model Analysis for pemax

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10098.478	1	10098.478	13.880	.001
Intercept	6663.073	1	6663.073	9.158	.006
age	10098.478	1	10098.478	13.880	.001
Error	16734.162	23	727.572		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	50.408	16.657	3.026	.006	15.950	84.866
age	4.055	1.088	3.726	.001	1.803	6.306

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	9634.636	1	9634.636	12.885	.002
Intercept	516.320	1	516.320	.691	.415
height	9634.636	1	9634.636	12.885	.002
Error	17198.004	23	747.739		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	-33.276	40.044	-.831	.415	-116.114	49.563
height	.932	.260	3.590	.002	.395	1.469

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10827.159	1	10827.159	15.559	.001
Intercept	17417.813	1	17417.813	25.030	.000
weight	10827.159	1	10827.159	15.559	.001
Error	16005.481	23	695.890		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	63.546	12.702	5.003	.000	37.270	89.821
weight	1.187	.301	3.944	.001	.564	1.809

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1413.464	1	1413.464	1.279	.270
Intercept	1926.820	1	1926.820	1.743	.200
bmp	1413.464	1	1413.464	1.279	.270
Error	25419.176	23	1105.182		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	59.080	44.744	1.320	.200	-33.481	151.641
bmp	.639	.565	1.131	.270	-.530	1.809

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	5515.438	1	5515.438	5.951	.023
Intercept	8756.129	1	8756.129	9.447	.005
fev1	5515.438	1	5515.438	5.951	.023
Error	21317.202	23	926.835		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	62.114	20.208	3.074	.005	20.309	103.918
fev1	1.354	.555	2.439	.023	.206	2.502

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2671.777	1	2671.777	2.543	.124
Intercept	48477.536	1	48477.536	46.148	.000
rv	2671.777	1	2671.777	2.543	.124
Error	24160.863	23	1050.472		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	140.423	20.671	6.793	.000	97.662	183.185
rv	-.123	.077	-1.595	.124	-.282	.036

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4670.553	1	4670.553	4.847	.038
Intercept	44466.107	1	44466.107	46.147	.000
frc	4670.553	1	4670.553	4.847	.038
Error	22162.087	23	963.569		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	158.706	23.363	6.793	.000	110.377	207.035
frc	-.319	.145	-2.202	.038	-.619	-.019

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	885.055	1	885.055	.785	.385
Intercept	11701.531	1	11701.531	10.372	.004
tlc	885.055	1	885.055	.785	.385
Error	25947.585	23	1128.156		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	149.919	46.550	3.221	.004	53.623	246.215
tlc	-.358	.404	-.886	.385	-1.194	.478

Between-Subjects Factors

		Value Label	N
Sex of patient	0	Male	14
	1	Female	11

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2234.413	1	2234.413	2.089	.162
Intercept	287280.013	1	287280.013	268.614	.000
sex	2234.413	1	2234.413	2.089	.162
Error	24598.227	23	1069.488		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	98.455	9.860	9.985	.000	78.057	118.852
[sex=0]	19.045	13.176	1.445	.162	-8.212	46.303
[sex=1]	0	.	.	.	.	.

General Linear Model Analysis for log(pemax)

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.680	1	.680	12.355	.002
Intercept	45.600	1	45.600	828.753	.000
age	.680	1	.680	12.355	.002
Error	1.266	23	.055		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.170	.145	28.788	.000	3.870	4.470
age	.033	.009	3.515	.002	.014	.053

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.675	1	.675	12.234	.002
Intercept	5.581	1	5.581	101.082	.000
height	.675	1	.675	12.234	.002
Error	1.270	23	.055		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	3.460	.344	10.054	.000	2.748	4.171
height	.008	.002	3.498	.002	.003	.012

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.715	1	.715	13.364	.001
Intercept	79.069	1	79.069	1478.054	.000
weight	.715	1	.715	13.364	.001
Error	1.230	23	.053		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.281	.111	38.445	.000	4.051	4.512
weight	.010	.003	3.656	.001	.004	.015

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.072	1	.072	.888	.356
Intercept	10.177	1	10.177	124.980	.000
bmp	.072	1	.072	.888	.356
Error	1.873	23	.081		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.294	.384	11.179	.000	3.499	5.088
bmp	.005	.005	.943	.356	-.005	.015

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.340	1	.340	4.872	.038
Intercept	41.627	1	41.627	596.425	.000
fev1	.340	1	.340	4.872	.038
Error	1.605	23	.070		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.283	.175	24.422	.000	3.920	4.645
fev1	.011	.005	2.207	.038	.001	.021

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.194	1	.194	2.544	.124
Intercept	59.471	1	59.471	780.917	.000
rv	.194	1	.194	2.544	.124
Error	1.752	23	.076		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.918	.176	27.945	.000	4.554	5.282
rv	-.001	.001	-1.595	.124	-.002	.000

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.326	1	.326	4.625	.042
Intercept	45.305	1	45.305	643.374	.000
frc	.326	1	.326	4.625	.042
Error	1.620	23	.070		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	5.066	.200	25.365	.000	4.653	5.479
frc	-.003	.001	-2.151	.042	-.005	.000

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.057	1	.057	.689	.415
Intercept	12.902	1	12.902	157.112	.000
tlc	.057	1	.057	.689	.415
Error	1.889	23	.082		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	4.978	.397	12.534	.000	4.156	5.800
tlc	-.003	.003	-.830	.415	-.010	.004

Between-Subjects Factors

		Value Label	N
Sex of patient	0	Male	14
	1	Female	11

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	.146	1	.146	1.865	.185
Intercept	531.076	1	531.076	6788.253	.000
sex	.146	1	.146	1.865	.185
Error	1.799	23	.078		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

					95% Confidence Interval	
Parameter	B	Std. Error	t	Sig.	Lower Bound	Upper Bound
Intercept	4.566	.084	54.137	.000	4.391	4.740
[sex=0]	.154	.113	1.366	.185	-.079	.387
[sex=1]	0	.	.	.	.	.

Multiple regression for pemax

Between-Subjects Factors

		Value Label	N
Sex of patient	0	Male	14
	1	Female	11

Tests of Between-Subjects Effects

Dependent Variable: Maximum expiratory pressure (cm water)

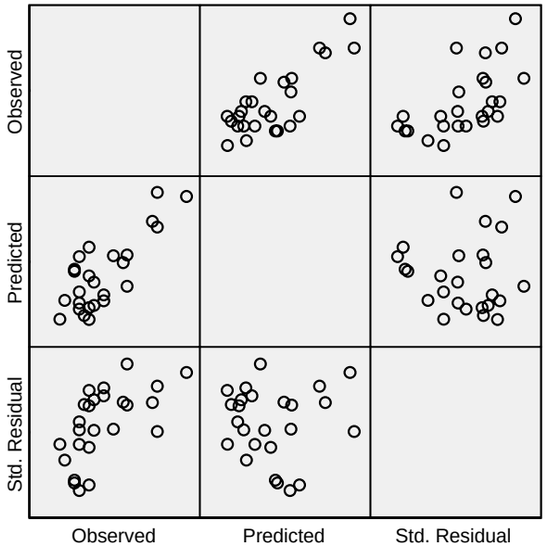
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	17101.390	9	1900.154	2.929	.032
Intercept	396.750	1	396.750	.612	.446
age	181.813	1	181.813	.280	.604
height	158.317	1	158.317	.244	.628
weight	1441.213	1	1441.213	2.222	.157
bmp	1480.123	1	1480.123	2.281	.152
fev1	648.450	1	648.450	1.000	.333
rv	653.775	1	653.775	1.008	.331
frc	254.552	1	254.552	.392	.540
tlc	92.404	1	92.404	.142	.711
sex	37.902	1	37.902	.058	.812
Error	9731.250	15	648.750		
Total	324512.000	25			
Corrected Total	26832.640	24			

Parameter Estimates

Dependent Variable: Maximum expiratory pressure (cm water)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	172.321	219.821	.784	.445	-296.215	640.858
age	-2.542	4.802	-.529	.604	-12.777	7.693
height	-.446	.903	-.494	.628	-2.372	1.479
weight	2.993	2.008	1.490	.157	-1.287	7.273
bmp	-1.745	1.155	-1.510	.152	-4.207	.717
fev1	1.081	1.081	1.000	.333	-1.223	3.385
rv	.197	.196	1.004	.331	-.221	.615
frc	-.308	.492	-.626	.540	-1.358	.741
tlc	.189	.500	.377	.711	-.877	1.254
[sex=0]	3.737	15.460	.242	.812	-29.215	36.689
[sex=1]	0	.	.	.	.	.

Dependent Variable: Maximum expiratory pressure (cm water)



Model: Intercept + age + height + weight + bmp + fev1 + rv + frc + tlc + sex

Multiple regression for log(pemax)

Tests of Between-Subjects Effects

Dependent Variable: log(pemax)

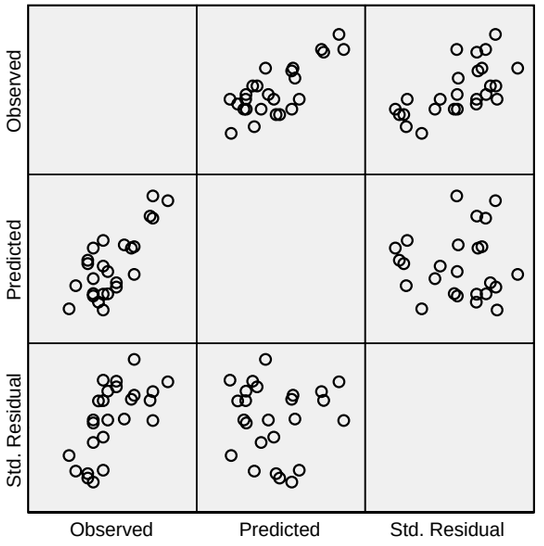
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.142	9	.127	2.370	.067
Intercept	.367	1	.367	6.857	.019
age	.021	1	.021	.394	.540
height	.005	1	.005	.097	.760
weight	.104	1	.104	1.933	.185
bmp	.127	1	.127	2.364	.145
fev1	.036	1	.036	.670	.426
rv	.030	1	.030	.558	.466
frc	.015	1	.015	.279	.605
tlc	.006	1	.006	.114	.740
sex	.003	1	.003	.049	.828
Error	.803	15	.054		
Total	542.926	25			
Corrected Total	1.945	24			

Parameter Estimates

Dependent Variable: log(pemax)

Parameter	B	Std. Error	t	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Intercept	5.283	1.997	2.646	.018	1.027	9.540
age	-.027	.044	-.628	.540	-.120	.066
height	-.003	.008	-.311	.760	-.020	.015
weight	.025	.018	1.390	.185	-.014	.064
bmp	-.016	.010	-1.537	.145	-.039	.006
fev1	.008	.010	.818	.426	-.013	.029
rv	.001	.002	.747	.466	-.002	.005
frc	-.002	.004	-.528	.605	-.012	.007
tlc	.002	.005	.338	.740	-.008	.011
[sex=0]	.031	.140	.221	.828	-.268	.330
[sex=1]	0	.	.	.	.	.

Dependent Variable: log(pemax)



Model: Intercept + age + height + weight + bmp + fev1 + rv + frc + tlc + sex

(c) Correlation matrix for continuous covariates, response and log response

Correlations

		Age in years	Height (cm)	Weight (kg)	Body mass percentage (% of normal)	Forced expiratory volume	Residual volume	Functional residual capacity	Total lung capacity	Maximum expiratory pressure (cm water)	log(pemax)
Age in years	Pearson Correlation	1	.926**	.906**	.378	.294	-.552**	-.639**	-.469*	.613**	.591**
	Sig. (2-tailed)		.000	.000	.063	.153	.004	.001	.018	.001	.002
	N	25	25	25	25	25	25	25	25	25	25
Height (cm)	Pearson Correlation	.926**	1	.921**	.441*	.317	-.570**	-.624**	-.457*	.599**	.589**
	Sig. (2-tailed)	.000		.000	.027	.123	.003	.001	.022	.002	.002
	N	25	25	25	25	25	25	25	25	25	25
Weight (kg)	Pearson Correlation	.906**	.921**	1	.673**	.449*	-.622**	-.617**	-.418*	.635**	.606**
	Sig. (2-tailed)	.000	.000		.000	.024	.001	.001	.037	.001	.001
	N	25	25	25	25	25	25	25	25	25	25
Body mass percentage (% of normal)	Pearson Correlation	.378	.441*	.673**	1	.546**	-.582**	-.434*	-.365	.230	.193
	Sig. (2-tailed)	.063	.027	.000		.005	.002	.030	.073	.270	.356
	N	25	25	25	25	25	25	25	25	25	25
Forced expiratory volume	Pearson Correlation	.294	.317	.449*	.546**	1	-.666**	-.665**	-.443*	.453*	.418*
	Sig. (2-tailed)	.153	.123	.024	.005		.000	.000	.027	.023	.038
	N	25	25	25	25	25	25	25	25	25	25
Residual volume	Pearson Correlation	-.552**	-.570**	-.622**	-.582**	-.666**	1	.911**	.589**	-.316	-.316
	Sig. (2-tailed)	.004	.003	.001	.002	.000		.000	.002	.124	.124
	N	25	25	25	25	25	25	25	25	25	25
Functional residual capacity	Pearson Correlation	-.639**	-.624**	-.617**	-.434*	-.665**	.911**	1	.704**	-.417*	-.409*
	Sig. (2-tailed)	.001	.001	.001	.030	.000	.000		.000	.038	.042
	N	25	25	25	25	25	25	25	25	25	25
Total lung capacity	Pearson Correlation	-.469*	-.457*	-.418*	-.365	-.443*	.589**	.704**	1	-.182	-.171
	Sig. (2-tailed)	.018	.022	.037	.073	.027	.002	.000		.385	.415
	N	25	25	25	25	25	25	25	25	25	25
Maximum expiratory pressure (cm water)	Pearson Correlation	.613**	.599**	.635**	.230	.453*	-.316	-.417*	-.182	1	.989**
	Sig. (2-tailed)	.001	.002	.001	.270	.023	.124	.038	.385		.000
	N	25	25	25	25	25	25	25	25	25	25
log(pemax)	Pearson Correlation	.591**	.589**	.606**	.193	.418*	-.316	-.409*	-.171	.989**	1
	Sig. (2-tailed)	.002	.002	.001	.356	.038	.124	.042	.415	.000	
	N	25	25	25	25	25	25	25	25	25	25

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).