Inflammatory Markers in Dependence on the Plasma Concentration of 37 Fatty Acids After the Coronary Stent Implantation

Jiří Handl, Milan Meloun and Vladimíra Mužáková
University of Pardubice,
532 10 Pardubice, Czech Republic

Goal of article

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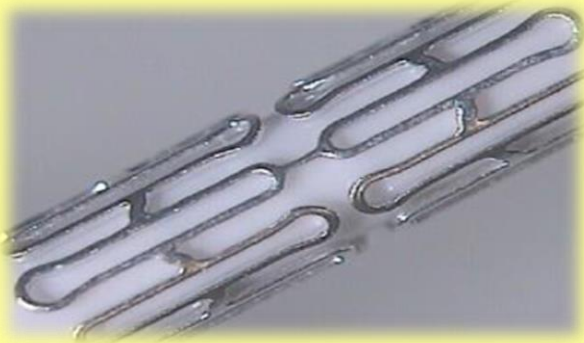
Using the regression model building the relations between the concentration of 37 fatty acids of blood plasma phospholipids of 41 patients with coronary artery disease after coronary stent implantation, and the inflammatory response and oxidative stress markers were estimated.

Highlights

➢ Regression testifies the strength of positive/negative relationship of the fatty acid on markers.

➢ Selected markers were C-reactive protein, interleukin-6, malondialdehyde and serum amyloid A.

➢ Factor analysis and cluster analysis separated 37 fatty acids into clusters of similar properties.

➢ The box plot revealed in fatty acids the largest concentration variation in phospholipid fraction.

The Box-and-whisker plot tests the variability of the concentration of 37 fatty acids examined.
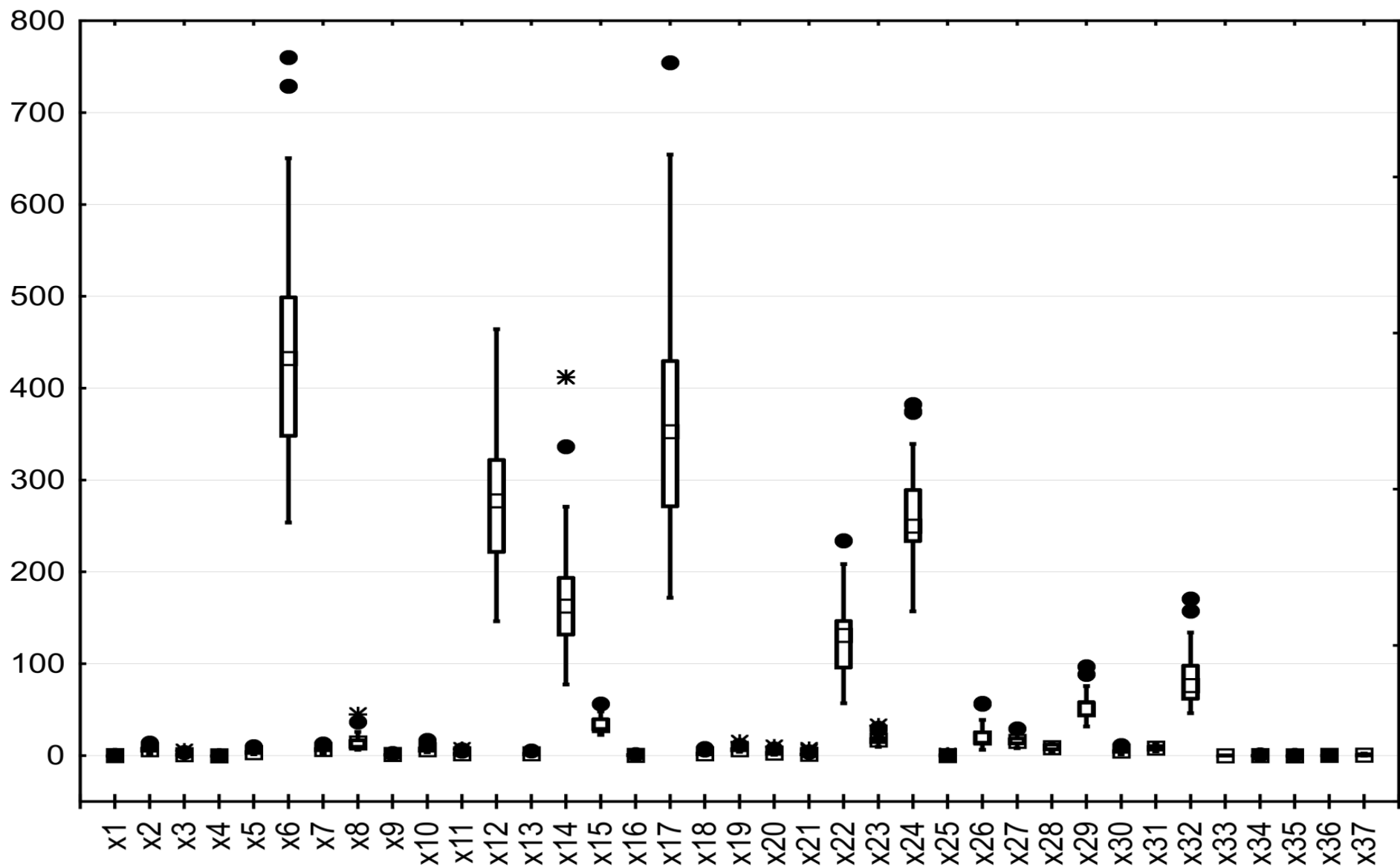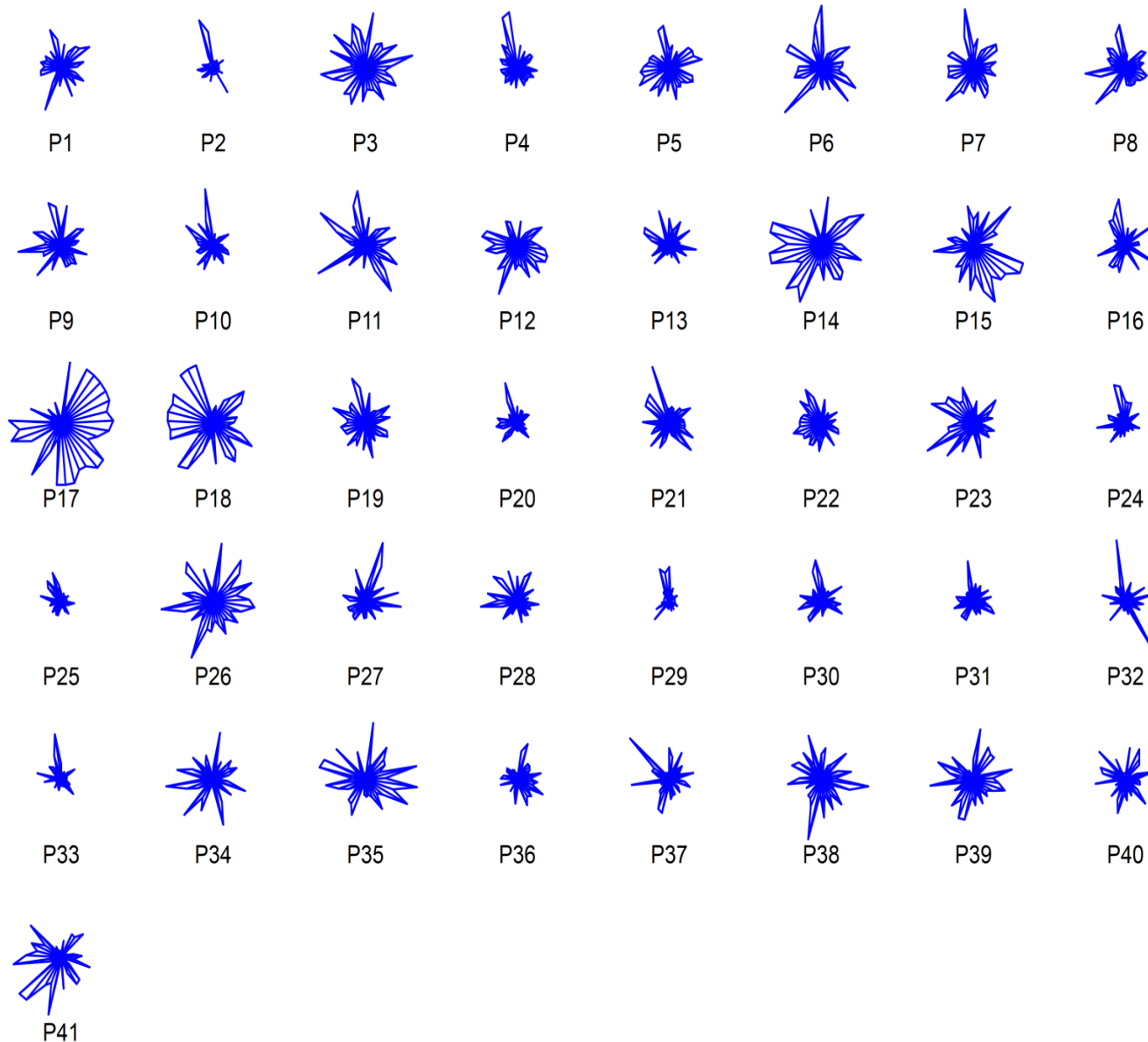
Estimated concentration [µmol/l] of 37 fatty acids in 41 patients

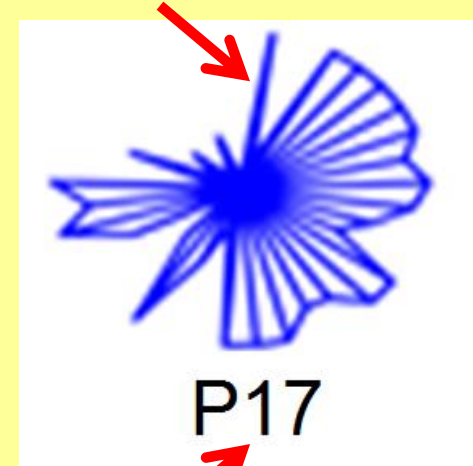| ID	Molecular	$s(e)$	Median				
				x_{19}	C20:0	2,08	**6,81**
x_1	12-Me C13:0	0,06	**0,16**	x_{20}	C18:3 N3	1,72	**3,12**
x_2	C14:0	2,86	**6,64**	x_{21}	C18:4 N3	1,44	**1,85**
x_3	13-Me C14:0	0,87	**1,34**	x_{22}	C20:3 N6	42,70	**131,07**
x_4	12-Me C14:0	0,06	**0,09**	x_{23}	C22:0	4,61	**17,10**
x_5	C15:0	1,69	**3,34**	x_{24}	C20:4 N6	52,60	**250,01**
x_6	C16:0	115,51	**432,39**	x_{25}	C20:4 N3	0,15	**0,16**
x_7	C16:1 N10	2,15	**6,91**	x_{26}	C20:5 N3	11,24	**19,51**
x_8	C16:1 N7-cis	7,81	**13,97**	x_{27}	C24:0	4,60	**15,58**
x_9	14-Me C16:0	0,38	**1,40**	x_{28}	C22:4 N6	2,97	**8,82**
x_{10}	C17:0	2,38	**6,78**	x_{29}	C24:1 N9	12,92	**50,24**
x_{11}	16-Me C17:0	1,53	**2,27**	x_{30}	C22:5 N6	1,97	**5,07**
x_{12}	C18:0	65,86	**277,43**	x_{31}	C22:5 N3	2,39	**8,24**
x_{13}	C18:1 N7, trans	1,11	**2,24**	x_{32}	C22:6 N3	28,79	**76,51**
x_{14}	C18:1 N9	62,13	**163,04**	x_{33}	C26:0	0,09	**0,11**
x_{15}	C18:1 N7, cis	7,33	**33,00**	x_{34}	C24:4 N6	0,18	**0,31**
x_{16}	C19:0	0,20	**0,54**	x_{35}	C24:5 N6	0,07	**0,12**
x_{17}	C18:2 N6	119,19	**352,91**	x_{36}	C24:5 N3	0,20	**0,61**
x_{18}	C18:3 N6	1,60	**2,19**	x_{37}	C24:6 N3	0,67	**0,74**

Stars

test the concentration of 37 fatty acids, *i.e.* here the beam-length in 41 patients studied.

P1 P2 P3 P4 P5 P6 P7 P8
P9 P10 P11 P12 P13 P14 P15 P16
P17 P18 P19 P20 P21 P22 P23 P24
P25 P26 P27 P28 P29 P30 P31 P32
P33 P34 P35 P36 P37 P38 P39 P40
P41

The length of a beam

P17

The index of patient

Polygons

test concentration of 37 fatty acids, *i.e.* here the beam-length in 41 patients.

Factor analysis provides the plot of factor loadings after varimax rotation forming clusters of the concentration of fatty acids. The factors are named according to fatty acids located near factor axes.
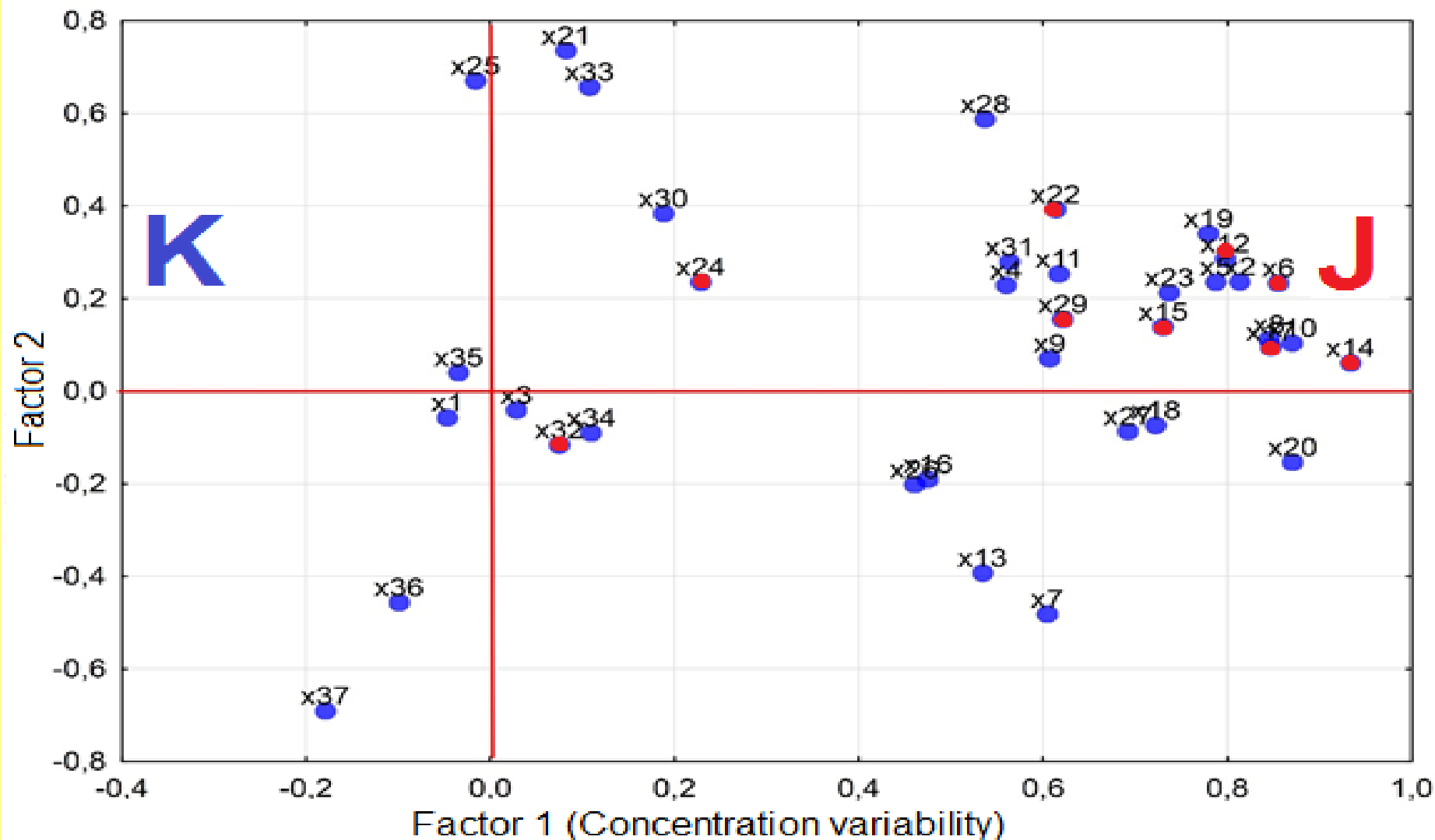
Cluster Analysis Dendrogram of variables (i.e. the concentration of fatty acids) shows clusters of similar variables.
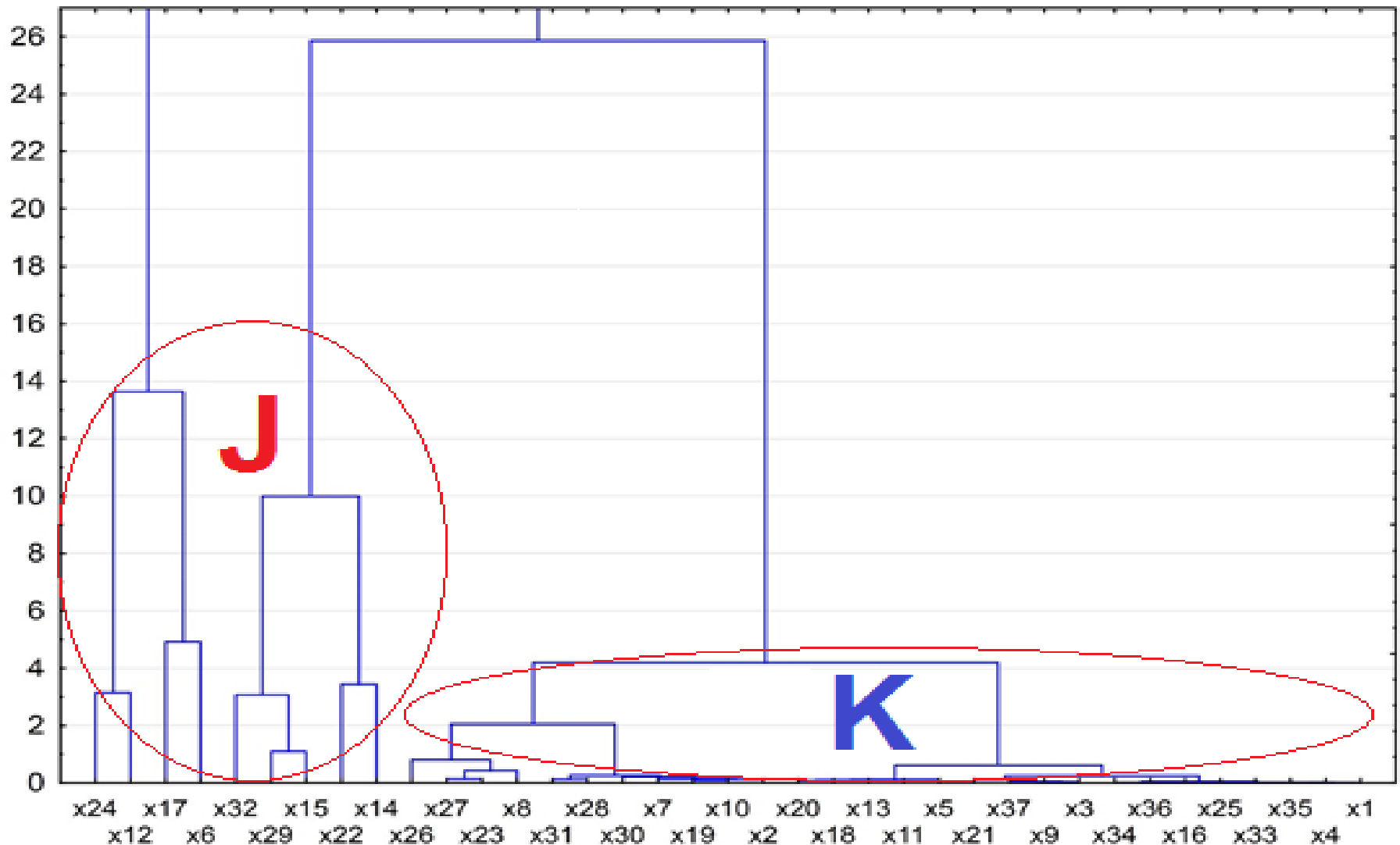
Factor Analysis The plot of factor scores explaines 37 features concerning a similarity of all patients classified in clusters.
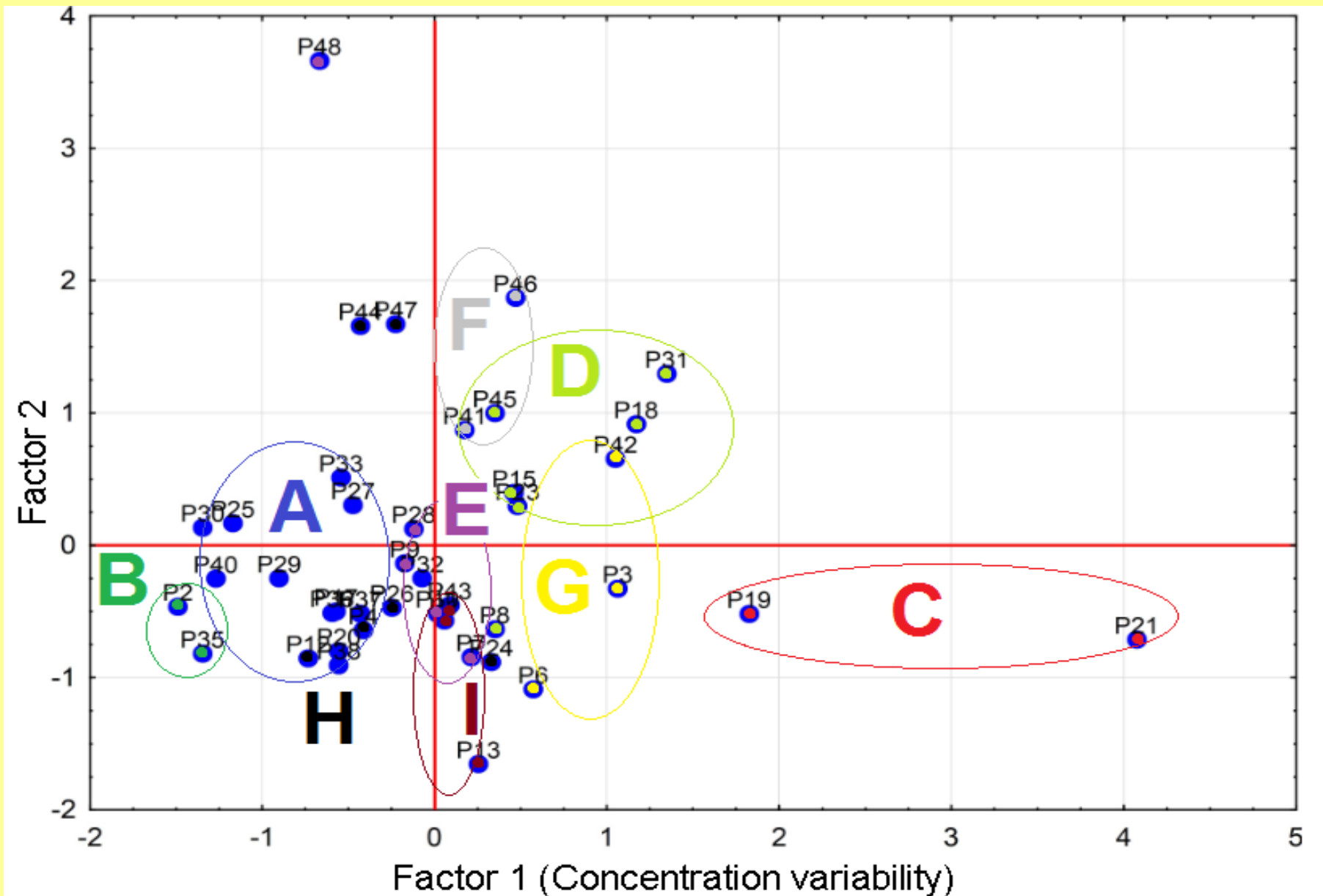
Cluster Analysis

The dendrogram of clusters scores explaines 37 features concerning all patients. The similarity of 41 patients are examined using clusters of similar objects.

Regression model ΔCRP:

The linear regression model building and testing forms the regression model

$$\Delta CRP = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots + \beta_{37} x_{37}$$

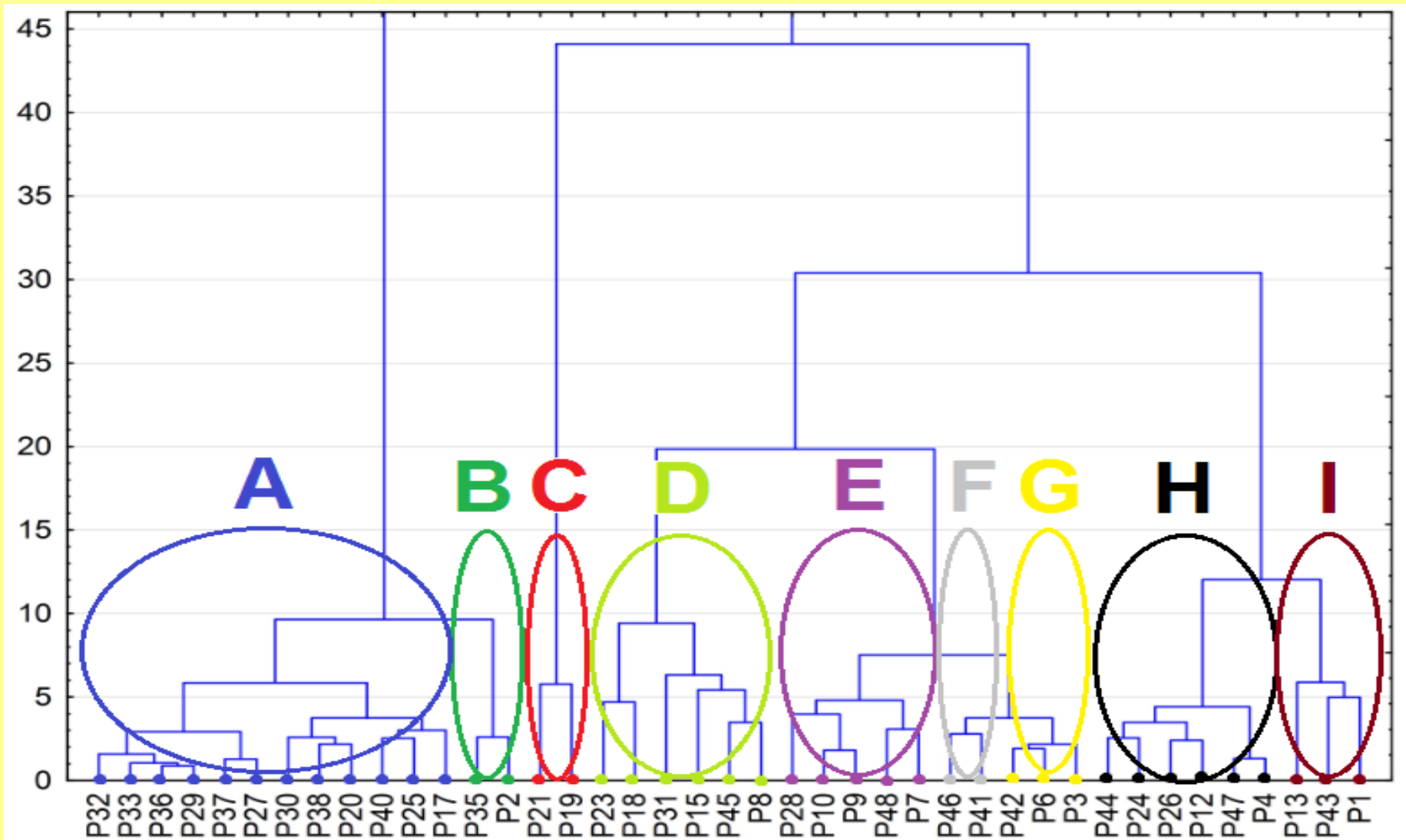concerning a dependence of ΔCRP on the concentration of each of 37 fatty acids. The fatty acids are present in table according to their significant slope β.

Fatty acid	Estimate β (s)	p (α=0,05)	Concentration variability (μmol/l)	
			Min	Max
Cerotic acid	140.4 (04)	1.96E-04	0.02	0.36
n-3 Tetracosapentaenoic acid	40.0 (01)	1.95E-04	0.15	1.00
Eicosatetraenoic acid	-144.4 (03)	1.28E-04	0.06	0.92
Nonadecanoic acid	-82.8 (02)	1.42E-04	0.24	1.13
12-Methyltridecanoic acid	-78.8 (03)	2.54E-04	0.03	0.30

Regression model ΔMDA:

The linear regression model building and testing forms the regression model

$$\Delta\mathbf{MDA} = \boldsymbol{\beta}_0 + \boldsymbol{\beta}_1\, x_1 + \boldsymbol{\beta}_2\, x_2 \ldots + \boldsymbol{\beta}_{37}\, x_{37}$$

concerning a dependence of ΔMDA on the concentration of each of 37 fatty acids. The fatty acids are present in table according to their significant slope $\boldsymbol{\beta}$.

Fatty acid	Estimate β (s)	$p\ (\alpha=0{,}05)$	Concentration variability (µmol/l)	
			Min	Max
Cerotic acid	8.0 (08)	6.22E-03	0.02	0.36
12-Methyltridecanoic acid	6.0 (06)	5.93E-03	0.09	0.42
Tetracosatetraenoic acid	-2.7 (04)	9.89E-03	0.08	0.98
Nonadecanoic acid	-2.7 (03)	7.10E-03	0.24	1.13
Pentadecanoic acid	-1.1 (01)	8.65E-03	1.60	9.84

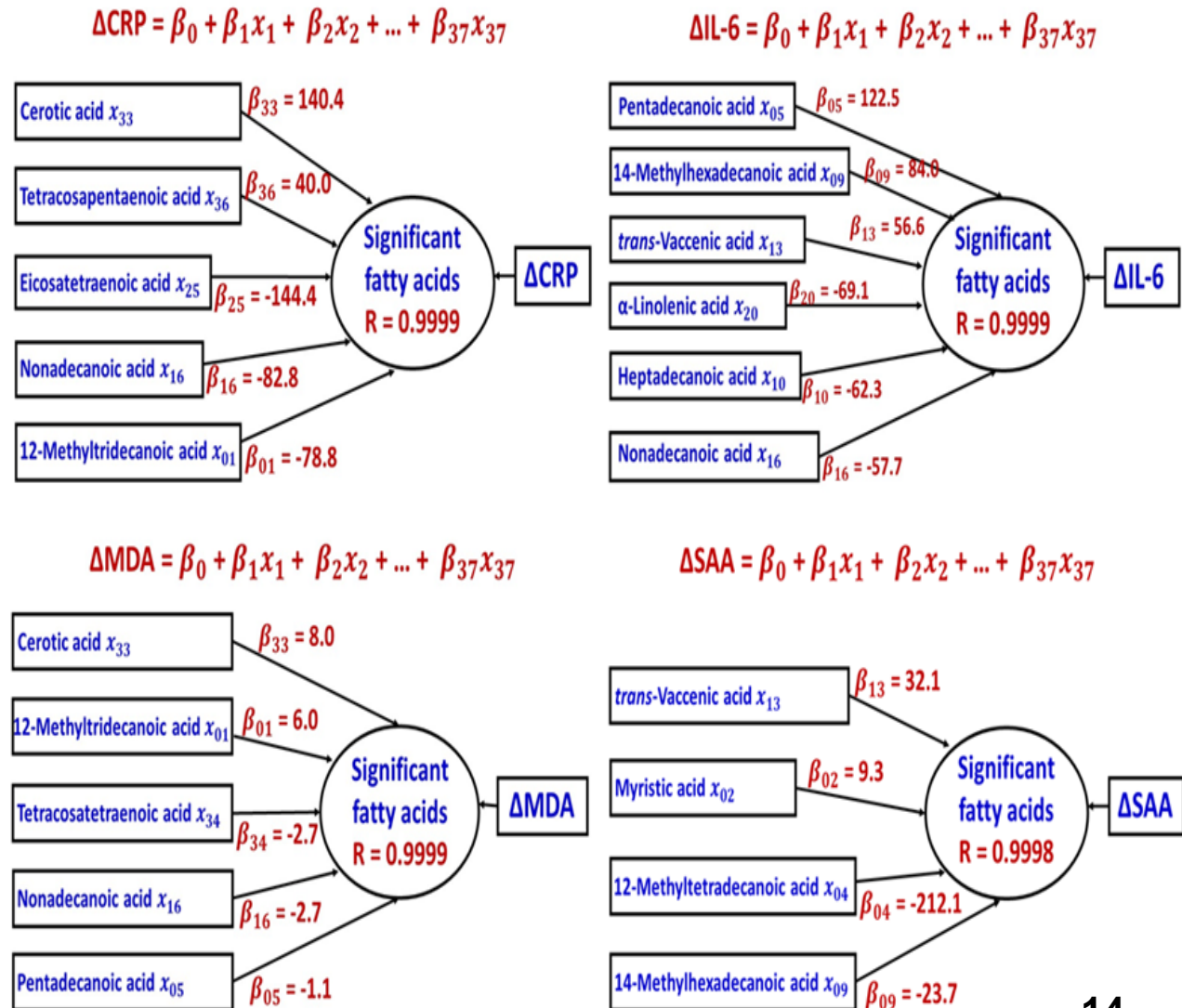# Conclusion The following diagram of dependence was found.

The strength of 37 fatty acid concentration on the concentration of 4 selected markers

Markers:
C-reactive protein (ΔCRP),
Interleukin-6 (ΔIL-6)
Malondialdehyde (ΔMDA),
Serum amyloid A (ΔSAA)

Parameter $\beta > 0$: the fatty acid increases the concentration of the marker.

Parameter $\beta < 0$: the fatty acid decreases the concentration of the marker.

$$\Delta CRP = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_{37} x_{37}$$

Cerotic acid x_{33} — $\beta_{33} = 140.4$
Tetracosapentaenoic acid x_{36} — $\beta_{36} = 40.0$
Eicosatetraenoic acid x_{25} — $\beta_{25} = -144.4$
Nonadecanoic acid x_{16} — $\beta_{16} = -82.8$
12-Methyltridecanoic acid x_{01} — $\beta_{01} = -78.8$

Significant fatty acids R = 0.9999 → ΔCRP

$$\Delta IL\text{-}6 = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_{37} x_{37}$$

Pentadecanoic acid x_{05} — $\beta_{05} = 122.5$
14-Methylhexadecanoic acid x_{09} — $\beta_{09} = 84.0$
trans-Vaccenic acid x_{13} — $\beta_{13} = 56.6$
α-Linolenic acid x_{20} — $\beta_{20} = -69.1$
Heptadecanoic acid x_{10} — $\beta_{10} = -62.3$
Nonadecanoic acid x_{16} — $\beta_{16} = -57.7$

Significant fatty acids R = 0.9999 → ΔIL-6

$$\Delta MDA = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_{37} x_{37}$$

Cerotic acid x_{33} — $\beta_{33} = 8.0$
12-Methyltridecanoic acid x_{01} — $\beta_{01} = 6.0$
Tetracosatetraenoic acid x_{34} — $\beta_{34} = -2.7$
Nonadecanoic acid x_{16} — $\beta_{16} = -2.7$
Pentadecanoic acid x_{05} — $\beta_{05} = -1.1$

Significant fatty acids R = 0.9999 → ΔMDA

$$\Delta SAA = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_{37} x_{37}$$

trans-Vaccenic acid x_{13} — $\beta_{13} = 32.1$
Myristic acid x_{02} — $\beta_{02} = 9.3$
12-Methyltetradecanoic acid x_{04} — $\beta_{04} = -212.1$
14-Methylhexadecanoic acid x_{09} — $\beta_{09} = -23.7$

Significant fatty acids R = 0.9998 → ΔSAA

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Related articles

J. Handl, M. Meloun and V. Mužáková, *The Canonical Correlation of Biomarkers in Relation to the Concentration of 37 Fatty Acids of Erythrocyte Membranes after Coronary Stent Implantation*, **Journal of Molecular and Applied Bioanalysis (Open Access 2017), 16 Aug 2017.**

Canonical association of selected fatty acids with the most negative values on five original markers