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Bio- Mathematical Variations in Paralysis Using Flame Atomic Absorption Spectroscopy

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Abstract

We have tried to see the impact of trace elements in paralytic patients. A detailed statistical analysis was applied to the data in the present work. It is found that the data available with the flame atomic absorption spectroscopy method are higher in paralytic patients in comparison to the normal healthy controls. We have also evaluated the correlations between two elements and regression equations with regression coefficients also. Different pattern was seen in all the trace elements.

Keywords: Regression equations; Regression coefficientsand paralytic patients.

1. Introduction

Trace elements belong, like the vitamins, the essential amino acids and essential fatty acids to the elements human beings. These are in need to function properly and the human system is unable to produce from food. These elements are crucial parts of many kinds of biochemical conversions in the body like co-enzyme reactions. Excess and deficiency of elements can lead to a malfunctioning of several organsystems of human body as a whole. Some other elements and toxic metals can influence the need for a traceelement. Consequently ratios are sometimes also important.

Minerals are important to our health. These are inorganic chemicals and are not attached with carbon atom. Minerals and trace minerals can be differentiated easily. These trace minerals are called trace elements. If the cellular body requires less than 100 mg of eleven minerals is labeled a trace element and if accepts more than this level is labeled a mineral.

Trace elements are required in quantities of few milligrams or micrograms per day. A study of relationships of minerals with human health is very necessary and important. A balance of the level for minerals in every organ, tissue and cell of the human body may lead to a good health.

Minerals comprise only a fraction of total body weight. These are crucial for many functions of the human body. These include transporting oxygen, normalizing the central nervous system (CNS) and simulating growth, maintenance and repair of tissues and bones [1].

Human body contains lot of element out of 25 are divided into mainly three categories such as major, minor components and trace elements. A brief description but elements is given here. Zumkley [2], stated that clinical experimental and epidemiological studies indicate that a large number of trace elements may be involved in the etiology of different human body disorders. Both increased levels of any trace element or reverse of this can influence the development of disease. On an average, a young person requires one hundred to one hundred fifty milligram of copper daily. Copper in higher concentration is found in liver, hair, muscle and lung [3]. The binding of zinc to amino acids and serum protein was studied by Prasad and Oberleas [4]. McCance and Widdowson [5], have concluded from their research and have reported that once the iron was absorbed by the human body, its excretion was very minimal and was not controlled either by gastrointestinal tract or the kidneys. McCance and Widdowson [5], have studied the magnesium content in human body and found a range of magnesium, which stated from 22.7 to 35.0 meq/ kg weight of tissues. Magnesium reaches us in many forms. Many authors [6-8] have reported that the ingested calcium mixes with digestive juice calcium in the proximal small intestine from where it is absorbed by a mechanism Human body contains electrolytes. The balance of the electrolytes is essential for function of cells and organs of human beings. Main electrolytes which are measured in the blood by the doctors are sodium, potassium, chloride and bicarbonate.

2. Materials and Methods

Blood sample of paralytic patients along with normal healthy control were collected from the Department of Neurology, Safdarjang Hospital, New Delhi-110016 after the approval of ethical committee of the hospital. 10 ml freshly drawn blood from each patient was collected in clean and dry test tube without any anti-coagulant. The test tube was kept for 45 minutes at room temperature (22 ± 2^{o}C) for the formation of clot. Sera of different patients were separated by centrifugation at 1500 r.p.m. upto15 minutes and were collected in screw capped test tubes.

The atomic absorption spectral estimation of the serum samples from normal persons and paralytic patients were carried out on atomic absorption spectrophotometer Model No. AA- 6300 of Shimadzu Japan, at Deptt. of Environmental study University of Delhi 110007.

3. Mathematical and Statistical Formulation

We would like to add here that simple formulae of statistics and mathematics have been used in the present work. We used different types of mathematical and statistical software for multiple and partial correlation coefficients in the study. We have calculated all multiple correlations with the help of determinant theory only [9].

Yule's Notation: If we consider a distribution involving 'n' random variables $X_1, X_2, X_3, \ldots, X_n$. Then the equation of the plane of regression of X_1 on $X_2, X_3, \ldots, X_n$ is given by

$$X_1 = b_{12.34...n}X_2 + b_{13.24...n}X_3 + ... + b_{1n.23....(n-1)}X_n \quad \text{..........[1]}$$

The constants b' in Equation (1) are determined by the principle of least squares , i.e. ,by minimizing the sum of the squares of the residuals ,viz.,

The sum of the squares of residuals is given by

$$S = \sum X_{1.23......n}^2 = \sum \left[X_1 - b_{12.34...n}X_2 + b_{13.24...n}X_3 + ... + b_{1n.23....(n-1)}X_n \right]^2 \quad \text{..........[2]}$$

The summation being extended to the given values (N in number) of the variables.

Here we make N observations on each of the variables X_1 on $X_2, X_3, \ldots, X_n$.

The normal equations for estimating $b_{12.34...n}$ and $b_{13.24...n}$

Using the principle of least squares, the normal equations for estimating the (n-1) ,b's are :

$$\frac{\partial S}{\partial b_{12.34...n}} = 0 = -2\sum X_2 \left(X_1 - b_{12.34...n}X_2 + b_{13.24...n}X_3 + ... + b_{1n.23....(n-1)}X_n \right) \quad \text{........[3]}$$

$$\frac{\partial S}{\partial b_{13.24...n}} = 0 = -2\sum X_3 \left(X_1 - b_{12.34...n}X_2 + b_{13.24...n}X_3 + ... + b_{1n.23....(n-1)}X_n \right) \quad \text{........[4]}$$

$$\frac{\partial S}{\partial b_{1n.23...(n-1)}} = 0 = -2\sum X_n \left(X_1 - b_{12.34...n}X_2 + b_{13.24...n}X_3 + ... + b_{1n.23....(n-1)}X_n \right) \quad \text{....[5]}$$

i.e., $$\sum X_i X_{1.23........n} = 0, (i = 2, 3, ..., n) \quad \text{..........[6]}$$

which on simplification give

$$r_{12}\sigma_1\sigma_2 = b_{12.34...n}\sigma_2^{\ 2} + b_{13.24...n}r_{23}\sigma_2\sigma_3 + ... + b_{1n.23....(n-1)}r_{2n}\sigma_2\sigma_n \quad \text{..........[7]}$$

$$r_{13}\sigma_1\sigma_3 = b_{12.34...n}r_{23}\sigma_2\sigma_3 + b_{13.24...n}\sigma_3^{\ 2} + ... + b_{1n.23....(n-1)}r_{3n}\sigma_3\sigma_n \quad \text{..........[8]}$$

$$r_{1n}\sigma_1\sigma_n = b_{12.34...n}r_{2n}\sigma_2\sigma_n + b_{13.24...n}r_{3n}\sigma_3\sigma_n + ... + b_{1n.23....(n-1)}\sigma_n^{\ 2} \quad \text{..........[9]}$$

Hence the eliminant of b's between Eqn.[1] ,Eqn.[[7] ,Eqn.[[8] andEqn.[[9] is

$$\begin{vmatrix} X_1 & X_2 & X_3 & \ldots\ldots & X_n \\ r_{12}\sigma_1\sigma_2 & \sigma_2{}^2 & r_{23}\sigma_2\sigma_3 & \ldots\ldots\ldots & r_{2n}\sigma_2\sigma_3 \\ r_{13}\sigma_1\sigma_3 & r_{23}\sigma_2\sigma_3 & \sigma_3{}^2 & \ldots\ldots\ldots\ldots & r_{3n}\sigma_3\sigma_n \\ \vdots & \vdots & \vdots & & \vdots \\ r_{1n}\sigma_1\sigma_n & r_{2n}\sigma_1\sigma_n & r_{3n}\sigma_3\sigma_n & \ldots\ldots\ldots & \sigma_n^2 \end{vmatrix} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[10]$$

Dividing $C_{1,}C_{1,}C_{1,}........,C_n$ by $\sigma_1,\sigma_2,......\sigma_n$ respectively and $R_1,R_1,.......R_n$ by $\sigma_2,\sigma_3,......\sigma_n$ respectively , we get.

$$\begin{vmatrix} \dfrac{X_1}{\sigma_1} & \dfrac{X_2}{\sigma_2} & \dfrac{X_3}{\sigma_3} & \ldots\ldots & \dfrac{X_n}{\sigma_n} \\ r_{12} & 1 & r_{32} & \ldots. & r_{2n} \\ r_{13} & r_{23} & 1 & \ldots.. & r_{3n} \\ \vdots & \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & r_{n3} & \ldots.. & 1 \end{vmatrix} = 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[11]$$ if we write

$$\omega = \begin{vmatrix} 1 & r_{12} & r_{13} & \ldots\ldots & r_{1n} \\ r_{21} & 1 & r_{32} & \ldots. & r_{2n} \\ r_{31} & r_{32} & 1 & \ldots.. & r_{3n} \\ \vdots & \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & r_{n3} & \ldots.. & 1 \end{vmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[12]$$

and ω_{ij} is the cofactor of the element in the ith row and jth column of ω , we get from Eqn. [11]

$$\frac{X_1}{\sigma_1}\omega_{11} + \frac{X_2}{\sigma_2}\omega_{12} + \frac{X_3}{\sigma_3}\omega_{13} + \frac{X_4}{\sigma_4}\omega_{14} + \ldots\ldots + \frac{X_n}{\sigma_n}\omega_{1n} = 0 \ldots\ldots\ldots\ldots\ldots\ldots[13]$$

Equation [13] is the required equation of the plane of regression of X_1 on X_2, X_3 ......, X_n

Equation [11] can be written as :

$$X_1 = -\frac{\sigma_1}{\sigma_2}.\frac{\omega_{12}}{\omega_{11}}X_2 - \frac{\sigma_1}{\sigma_3}.\frac{\omega_{13}}{\omega_{11}}X_3 - \ldots\ldots - \frac{\sigma_1}{\sigma_n}.\frac{\omega_{1n}}{\omega_{11}} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[14]$$

ComparingEqn. [13] with Eqn. [1],we get

$$\begin{aligned} b_{12.34....n} &= -\frac{\sigma_1}{\sigma_2}.\frac{\omega_{12}}{\omega_{11}} \\ b_{13.24....n} &= -\frac{\sigma_1}{\sigma_3}.\frac{\omega_{13}}{\omega_{11}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots[15] \\ &\vdots \\ b_{1n.23...(n-1)} &= -\frac{\sigma_1}{\sigma_n}.\frac{\omega_{1_n}}{\omega_{11}} \end{aligned}$$

4. Results

Table-1. Trace elemental determinations from plasma of paralytic patients and normal controls

S.N.	FACTOR	Zn in ppm	Cu in ppm	Fe in ppm	Na in ppm	K in ppm	Ca in ppm	Mg in ppm
1	P	4.379	0.227	4.775	143.00	3.79	2.36	0.26
2	P	2.346	0.019	0.225	145.00	5.19	3.03	0.35
3	P	1.392	0.149	1.093	132.00	5.39	3.95	3.92
4	P	2.850	0.164	0.164	141.00	5.38	2.17	1.24
5	P	0.534	0.167	6.184	142.00	3.89	3.17	2.51
6	P	3.871	0.202	0.282	144.00	3.69	4.38	0.31
7	P	0.531	0.208	2.598	128.00	4.19	4.62	3.10
8	P	0.902	0.112	0.548	138.00	3.99	4.86	2.79
9	P	0.524	0.093	0.117	139.00	4.29	4.40	2.49
10	P	0.776	0.104	2.776	140.00	3.99	4.41	1.49
11	P	0.547	0.162	0.295	143.00	4.19	4.62	3.49
12	P	0.332	0.122	0.237	140.00	3.89	3.96	3.79
13	P	0.894	0.216	0.956	144.00	4.29	2.39	1.99
14	P	1.455	0.193	0.789	143.00	4.19	3.99	1.35
15	P	4.379	0.113	2.132	139.0	4.79	3.62	2.19
16	N	1.493	0.125	0.702	135.00	3.59	2.47	0.49
17	N	0.801	0.073	1.142	131.00	3.79	2.46	0.59
18	N	2.134	0.125	1.145	137.00	3.71	2.97	0.60
19	N	0.571	0.112	0.451	136.00	3.61	2.79	0.75
20	N	0.584	0.117	0.162	141.00	3.91	1.92	0.79
21	N	0.847	0.115	0.058	142.00	3.71	4.59	0.54
22	N	1.286	0.156	0.612	137.00	3.81	4.56	0.62
23	N	0.023	0.158	5.788	135.00	3.61	4.53	0.73
24	N	1.491	0.208	0.586	137.00	3.62	4.29	0.84

Table-2. Mean and standard deviationsin normal and paralytic patients

ELEMENT	(Mean±s.d) For **paralysis**	(Mean±s.d) For **Normal**
Zn	1.6076 ± 1.272	1.025 ± 0.598
Cu	0.150 ± 0.054	0.132 ± 0.035
Fe	1.54 ± 1.78	1.182 ± 1.665
Na	140.06 ± 4.49	136.77 ± 3.08
K	4.34 ± 0.551	3.706 ± 0.104
Ca	3.72 ±0.867	3.39 ± 1.017
Mg	2.08 ±1.18	0.6611 ± 0.113

Table-3. Regression c equations of trace elements in normal controls

Zn= -0.122749456 Cu+ 3.455056498 Mg- 1.111363848·10^{-2} Ca- 2.20821668·10^{-3} Fe+ 2.099284772·10^{-1} Na- 6.147789476·10^{-2} K+ 7.64806502·10^{-2}
Cu= 16.68819082 Mg- 0.171807372 Ca- 3.66940813·10^{-2} Fe+ 5.342786305·10^{-1} Na- 2.528407205·10^{-1} K- 3.817045778 Zn+ 5.44521922
Mg= 3.832067636·10^{-3} Cu+ 1.321879048·10^{-3} Fe-6.197427003·10^{-2} Na+ 1.729654479·10^{-2} K+ 1.946154288·10^{-1} Zn+ 3.022898595·10^{-2} Cu- 4.194125922·10^{-2}
Ca= -0.223195912 Fe-9.523792534·10^{-1} Na+ 1.209076357·10^{-1} K- 3.62305649 Zn- 1.801162277 Cu+ 22.17838366Mg+ 36.14288887
Fe= 8.436242872 Na+ 0.604444228 K- 3.476492121 Zn- 1.857752224 Cu+ 36.94614822 Mg- 1.077871426 Ca+ 104.0512515
Na= 1.320701459·10^{-2} K+ 4.109606214·10^{-1} Zn+ 3.363480124·10^{-2} Cu- 2.153863417 Mg- 5.718997936·10^{-3} Ca+ 1.049006948·10^{-2} Fe + 2.212113012
K= -5.874253067 Zn- 7.769139008·10^{-1} Cu + 29.34072946 Mg+ 3.543794695·10^{-2} Ca+ 3.668515315·10^{-2} Fe + 6.446284504·10^{-1} Na - 3.247211922

Table-4. Regression equations of trace elements in paralysis

Zn= -6.134659462·10^{-1} Cu+ 3.757697369 Mg- 2.261481115·10^{-2} Ca- 7.450389233·10^{-2} Fe + 3.716497609·10^{-1} Na+ 1.681523712·10^{-1} K+ 10.73647994
Cu= 6.573949664 Mg + 9.060178901·10^{-3} Ca- 1.279464174·10^{-2} Fe + 6.442408358·10^{-1} Na + 5.982430704·10^{-2} K - 8.562195211·10^{-1}Zn + 1.163320738
Mg= -6.35390668·10^{-3} Ca- 6.318568338·10^{-3} Fe- 8.627021799·10^{-2} Na - 4.557614174·10^{-2}K + 1.396812679·10^{-2}Zn + 1.750846518·10^{-2} Cu + 1.532218107
Ca= -2.571958092·10^{-1}Fe- 2.711071288 Na - 1.705683729 K - 9.431309118·10^{-2}Zn + 2.707204865·10^{-2}Cu - 7.128587394 Mg + 56.92535167
Fe= -5.638771478 Na- 3.657361698 K- 1.259088853 Zn - 1.549212103·10^{-1} Cu - 28.72630293 Mg - 1.04222693 Ca + 186.9857094
Na= -0.484812983 K+ 7.651382081·10^{-2} Zn + 9.50297564·10^{-2} Cu - 4.778048563 Mg - 1.338344614·10^{-1} Ca- 6.869309898·10^{-2} Fe+ 16.3834748
K= 8.592785463·10^{-2} Zn+ 2.190352357·10^{-2}Cu - 6.265448469 Mg- 2.090020114·10^{-1}Ca - 1.105914287·10^{-1} Fe - 1.203370006 Na+ 25.4934185

Table-5. Regression coefficients in paralytic patients and controls

S.N.	FORMULA	PARALYSIS	CONTROL
1	$b_{ZnCu.MgCaFeNaK} = -\frac{\sigma_1}{\sigma_2} \times \frac{\omega_2}{\omega_{11}}$	-10.29	-18.195
2	$b_{ZnMg.CaFeNaKCu} = -\frac{\sigma_1}{\sigma_3} \times \frac{\omega_3}{\omega_{11}}$	1.506	-2.310
3	$b_{Zn.CaCuMgFeNaK} = -\frac{\sigma_1}{\sigma_4} \times \frac{\omega_{14}}{\omega_{11}}$	-0.2830	0.1183
4	$b_{ZnFe.CuMgCaNaK} = -\frac{\sigma_1}{\sigma_5} \times \frac{\omega_{15}}{\omega_{11}}$	1.68	0.5301
5	$b_{ZnNa.CuMgCaFeK} = -\frac{\sigma_1}{\sigma_6} \times \frac{\omega_{16}}{\omega_{11}}$	-0.00785	-0.2255
6	$b_{ZnK.CuMgCaFeNa} = -\frac{\sigma_1}{\sigma_7} \times \frac{\omega_{17}}{\omega_{11}}$	-0.330	-1.987

Table-6. Correlation coefficients in paralytic and controls

S.N.	*Correlation Coefficient*	Value of the Correlation in Paralysis	Value of the Correlation in Control
1	r_{ZnCu}	0.2144	0.1896
2	r_{ZnMg}	-0.7555	-0.3341
	r_{ZnCa}	-0.4263	-0.0727
4	r_{ZnFe}	0.0991	0.4814
5	r_{ZnNa}	0.2909	0.0128
6	r_{ZnK}	0.1673	-0.0576
7	r_{CuZn}	0.2144	0.1896
8	r_{CuMg}	-0.0494	0.5086
9	r_{CuCa}	-0.1984	0.6224
10	r_{CuFe}	0.3201	0.2159
11	r_{CuNa}	-0.0697	0.1926
12	r_{CuK}	-0.3838	-0.3532

13	r_{MgZn}	-0.7555	-0.3341
14	r_{MgCu}	-0.0494	0.5086
15	r_{MgCa}	0.4637	0.0506
16	r_{MgFe}	-0.1042	0.1536
17	r_{MgNa}	-0.6033	0.1437
18	r_{MgK}	0.0521	0.0433
19	r_{CaZn}	-0.4263	-0.0727
20	r_{CaCu}	0.3201	0.6224
21	r_{CaMg}	0.4637	0.0506
22	r_{CaFe}	-0.2614	0.3362
23	r_{CaNa}	-0.4252	0.2080
		-0.3434	-0.2873
25	r_{FeZn}	0.0991	-0.4814
26+	r_{FeCu}	0.3201	0.2159
27	r_{FeMg}	-0.1042	0.1536
28	r_{FeCa}	-0.2614	0.3362
29	r_{FeNa}	-0.0718	-0.3674
30	r_{FeK}	-0.3437	-0.3441
31	r_{NaZn}	0.2909	0.0128
32	r_{NaCu}	-0.0697	0.1926
33	r_{NaMg}	-0.6033	0.1437
34	r_{NaCa}	-0.4252	0.208
35	r_{NaFe}	-0.0718	-0.3674
36	r_{NaK}	-0.1955	0.2935
37	r_{KZn}	0.1673	-0.0576
38	r_{KCu}	-0.3838	-0.3532
39	r_{KMg}	0.0521	0.0433
40	r_{KCa}	-0.3434	-0.2873
41	r_{KFe}	-0.3437	-0.3441
42	r_{KNa}	-0.1955	0.2935
43	r_{ZnZn}	1	1
44	r_{CuCu}	1	1
45	r_{MgMg}	1	1
46	r_{CaCa}	1	1
47	r_{FeFe}	1	1
48	r_{NaNa}	1	1
49	r_{KK}	1	1

5. Discussion and Conclusion

All the trace elements were higher in paralytic samples compared to normal healthy controls .On the basis of statistical analysis we have measured regression and correlation coefficients between different trace elements like Na, K, Ca, Mg, Zn, Cu and Fe in normal samples .Fluctuations in correlations between two elements were also seen .It is suggested that more precisely observations are required for furtherinvestigations .We have tried to give a brief idea of regression equations between all 7 elements and a good support is in the direction of implementing these data in manufacturing medicines in the present work.

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