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Evaluation of serum trace element, biochemical and hematological data of a healthy elderly group residing in São Paulo city, Brazil

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Abstract In this study, blood serum trace elements, biochemical and hematological parameters were obtained to assess the health status of an elderly population residing in São Paulo city, SP, Brazil. Results obtained showed that more than 93% of the studied individuals presented most of the serum trace element concentrations and of the hematological and biochemical data within the reference values used in clinical laboratories. However, the percentage of elderly presenting recommended low density lipoprotein (LDL) cholesterol concentrations was low (70%). The study indicated positive correlation between the concentrations of Zn and LDL-cholesterol ($p < 0.06$).

Keywords Blood serum · Trace elements · Biochemical analysis · Hematological analysis

Introduction

The aging population has gone through a rapid increase throughout the world. As in developed nations, the group of the population in Brazil that most increases is that of the elderly, according to the Nation's Official Census [1]. This population could represent 13% of the total population in the next 20 years. Consequently, it is of great importance to identify factors that affect physical ageing, as well as geriatric disease development and chronic diseases in order to establish criteria for a healthy life style and ultimately achieve a better quality of life. So, the evaluation of serum trace element levels, biochemical and hematological parameters of an elderly population is of particular interest.

The objective of this study was to evaluate blood serum trace element, biochemical and hematological parameters of a healthy elderly population living in São Paulo city, SP. Results obtained in these analyses were compared with reference intervals used in clinical laboratories to assess the health status of this population. In addition, correlation studies between concentrations of some trace element and biochemical parameters were performed.

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Experimental

Sampling and sample preparation

Procedures for blood sample collection and about sample contamination are described in our previous study [2]. The study population consisted of elderly considered healthy and participating of a "Successful Ageing" program of the São Paulo University Medical School. The elderly were selected following the guidelines of the SENIEUR protocol admission criteria [3]. This research project was approved by the Ethics Committees of institutions involved. Fasting blood samples were collected from 87 elderly individuals (63 females and 24 males) aged 60–91 and mean age of 72 ± 7 years.

Serum Ca, Fe, Rb, Se and Zn concentrations were obtained by neutron activation analysis (NAA). For these analyses, part of blood was centrifuged after completely clotted. Aliquots of 3.0 mL of serum were frozen for transportation to the Neutron Activation Analysis Laboratory, IPEN-CNEN/SP. For NAA, the sera were freeze-dried at −54 °C for about 10 h. The weight loss during this freeze-drying process was about 90.9 ± 0.5%.

Biochemical analyses (Cu, K, Mg, Na, P, ferritin, glucose, urea, creatinine, total cholesterol, high density lipoprotein (HDL) cholesterol triglycerides, uric acid, total protein and albumin were carried out on Roche/Hitachi MODULAR ANALYTICS PP (Roche Diagnostics GmbH, Mannheim, Germany), using specific kits from Roche Diagnostics, too. The levels of low density lipoprotein (LDL) cholesterol were calculated using the Friedewald equation. The erythrocyte count, hemoglobin concentration, hematocrit, leukocytes and platelets were determined on SYSMEX XT2000i (Roche's Diagnostics Division, Basel, Switzerland). The Central Laboratory Division of the Hospital das Clínicas, FMUSP is certified by ISO 9001:2000 standards.

Standards preparation

The synthetic standards were prepared by pippeting 50 µL of elemental standard solutions onto sheets of Whatman No. 40 filter paper. These solutions containing one or more elements were prepared using certified standard solutions provided by Spex Certiprep Chemical, USA. All pippetors and volumetric flasks were calibrated before use. The filter sheets were dried at room temperature inside a desiccator and then placed into clean polyethylene envelopes, which were sealed. In these standards, the quantities of each element, in µg (in parentheses) were the following: Ca (1000), Fe (280), Rb(4.0), Se (40) and Zn (35.0).

Instrumental neutron activation analysis

Neutron activation analysis of serum was performed as described in the previous study [2]. Briefly the procedure consists of irradiating aliquots of about 200 mg of serum weighed in polyethylene envelopes in the IEA-R1 nuclear reactor along with the synthetic standards of the elements. Sixteen-hour irradiations under a thermal neutron flux of $\sim 5 \times 10^{12}$ n cm^{-2} s^{-1} were performed for Ca, Fe, Rb, Se and Zn determinations. After adequate decay times, the irradiated samples and standards were measured by a hyperpure Ge detector Model GX2020 coupled to a gamma ray spectrometer. The radioisotopes measured were identified according to their half-lives and gamma-ray energies. The concentrations of elements were calculated by a comparative method. The radioisotopes used in serum analyses were: ^{47}Ca, ^{59}Fe, ^{86}Rb, ^{75}Se and ^{65}Zn.

To evaluate the precision and accuracy of the results, certified reference materials NIST 1566b Oyster Tissue and IAEA-A-13 Animal Blood were analyzed. The results showed good precision and accuracy (relative standard deviations and relative errors <10%).

Results and discussion

The serum element concentrations of Ca, Cu, K, Fe, Mg, P, Rb, Se, Na and Zn obtained are presented in Table 1 together with the data used as reference intervals in clinical laboratories [4], for comparison. Our results indicated that more than 93% of the group presented trace elements within

Table 1 Mean and intervals for serum trace element concentrations

Elements	This study				Reference intervals used in clinical laboratory [4]
	n	Mean ± SD	Interval	Healthy individuals, %	
Ca (mg dL^{-1})	87	9.59 ± 0.89	7.68–12.24	93	8.8–10.2
Cu (µg dL^{-1})	52	88.7 ± 19.8	34–151	93	70–1 60
K (mmol L^{-1})	78	4.5 ± 0.3	3.6–5.6	98.7	3.5–5.0
Fe (µg dL^{-1})	22(M), 60(F)	128 ± 32 (M), 108 ± 25 (F)	80–221 (M), 60–175 (F)	95 (M), 100 (F)	65–175 (M), 50–170 (F)
Mg (mEq L^{-1})	72	2.0 ± 0.3	1.5–2.8	73.6	1.23–1.98
P (mg dL^{-1})	70	3.5 ± 0.5	2.2–5.0	98.5	2.3–4.6
Rb (µg L^{-1})	87	330.7 ± 58.9	194–520	100	80–560
Se (µg L^{-1})	87	74.9 ± 24.0	40.6–185.6	97.7	46–143
Na (mmol L^{-1})	78	140 ± 3	131–153	98.6	135–145
Zn (µg dL^{-1})	87	98.1 ± 13.6	66.6–139.7	100	70–120

Mean concentration is given with standard deviation (SD) and *n* is number of individuals

M Male, *F* Female

Table 2 Concentration means and standard deviations (SD) obtained for a group of *n* individuals and reference intervals of biochemical and hematological data

Parameters	This study				Reference intervals used in clinical laboratory [4]
	n	Mean ± SD	Maximum and minimum values	Healthy individuals, %	
Ferritin (μg L^{-1})	20 (M), 52 (F)	283 ± 196 (M), 104 ± 33 (F)	56–722 (M), 28–220 (F)	75.0 (M), 71.0 (F)	25–300 (M), 10–125 (F)
Glucose (fasting) (mg dL^{-1})	81	93 ± 11	66–135	95.0	70–100
Urea (mg dL^{-1})	79	36 ± 12	14–106	94,9	10–45
Creatinine(mg dL^{-1})	81	0.8 ± 0.2	0.5–1.2	95.9	0.6–1.4
Total cholesterol (mg dL^{-1})	81	213 ± 38	129–328	96.0	<200 (Recommended); 200–239 (borderline high); >240 (high)
HDL-cholesterol(mg dL^{-1})	80	61 ± 14	34–103	96.2	>40
LDL-cholesterol (mg dL^{-1})$^{-}$	80	129 ± 33	52–208	70.0	<100 (Optimal); 100–129 (near optimal); 130–159 (borderline high); 160–189 (high); ≥190 (very high)
Triglycerides (mg dL^{-1})	80	119 ± 53	41–266	83.71	<150 (Normal); 150–200 (borderline high); 200–499 (high), >500 (very high)
Uric acid (mg dL^{-1})	20 (M), 49 (F)	5.8 ± 1.8 (M), 4.6 ± 1.1 (F)	0.3–9.8 (M), 2.7 7.6 (F)	85.0 (M), 71.0 (F)	3.4–7.0 (M), 2.4–4.7 (F)
Total protein (g dL^{-1})	68	7.3 ± 0.5	5.3–8.6	98.6	6.0–8.0
Albumin (g dL^{-1})	76	4.4 ± 0.4	2.9–5.3	98.6	3.5–5.0
Globulin (g dL^{-1})	76	2.9 ± 0.5	1.4–4.6	82.9.	2.5–3.0
Hemoglobin (g dL^{-1})	23 (M), 60 (F)	15.0 ± 0.9 (M) 13.7 ± 0.9 (F)	12.7–17.0 (M), 11.2–16.4 (F)	100 (M), 100 (F)	13–18 (M), 12–16 (F)
Hematocrit (%)	23 (M), 60(F)	45.0 ± 2.7 (M), 40.7 ± 4.4 (F)	39.3–50.3 (M), 13.4 –47.3 (F)	100 (M), 98.7 (F)	40–52 (M), 35–47 (F)
Erythrocyte (×10^6 mm^{-3})	23 (M), 60 (F)	4.9 ± 2.7 (M), 4.6 ± 0.4 (F)	4.3–5.3 (M), 3.8 –5.8 (F)	100 (M), 100 (F)	4.4–5.9 (M), 4.0–5.4 (F)
Leukocytes (×10^3 mm^{-3})	83	6.3 ± 1.9	3.0–12.9	97.4	4.0–11.0
Platelets (×10^3 mm^{-3})	83	224 ± 46	134–365	98.7	140–450

M Male, *F* Female

the reference intervals with the exception of Mg. For Mg, about 73.6% of the elderly showed recommended values.

The results obtained in the biochemical and hematological tests (Table 2) indicate that more than 95% of the elderly presented concentrations of glucose, urea, creatinine, total cholesterol, HDL-cholesterol, total protein, erythrocytes, hemoglobin, hematocrit, leucocytes and platelets within the recommended values. However, only about 70% presented recommended concentrations of ferritin and LDL-cholesterol concentrations. In the case of uric acid concentrations, only 85% of males and 71% of females presented data within the reference intervals. For triglycerides, 83.7% of the group presented recommended value. Our biochemical and hematological data did not show correlation with the age of the individuals. However, serum Se concentrations from elderly group aged 60–74 years were significantly higher than those found for the group of 75–91 years [5].

Some authors [6–9] have investigated the relationships between serum Cu and Zn concentrations and cardiovascular risk factors such as cholesterol and triglyceride levels. Our results showed no correlation between serum Cu concentrations and total cholesterol, HDL-cholesterol, LDL-cholesterol and triglyceride concentrations ($p < 0.1$). Besides, correlations between concentrations of HDL-cholesterol and triglycerides and Zn were also not found ($p < 0.1$). However, serum Zn concentrations were positively related to LDL-cholesterol (correlation coefficient $r = 0.21$, $p < 0.06$) (Fig. 1). Furthermore, the ratios of [HDL-cholesterol]/[LDL-cholesterol] as can be seen in Fig. 2, were negatively correlated with Zn concentrations ($r = -0.234$, $p < 0.04$). In Figs. 1 and 2, regression lines were drawn through the scatter plots to summarize the relationship between the studied parameters. According to Fasmile [10], ingestion of Zn supplements can cause toxic

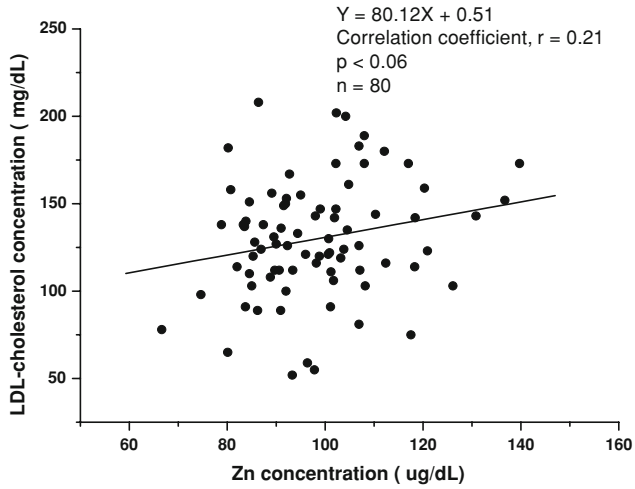

Fig. 1 Relationship between serum Zn and LDL cholesterol concentrations

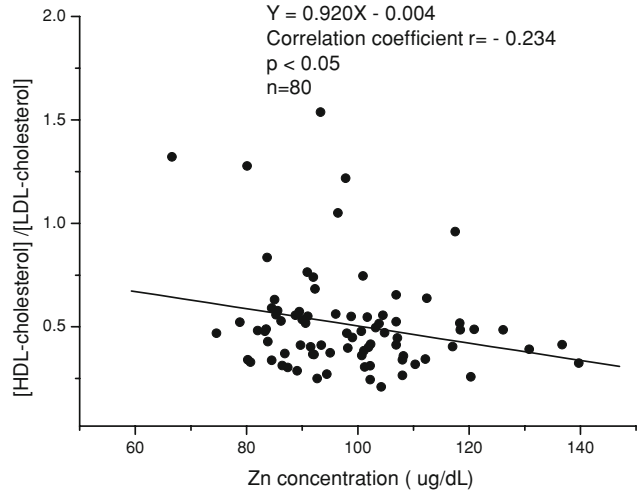

Fig. 2 Relationship between serum Zn concentrations and the ratios [HDL-cholesterol]/[LDL-cholesterol]

manifestations. This element can interfere in the utilization of other nutrients, to impair immune functions and negatively affect lipoprotein profile.

The effect of serum zinc on lipoproteins is a controversial subject. The mechanism of zinc effect on lipoproteins has not been clarified. Besides, serum elemental data for elderly are scarce for comparison. Goodwin et al. [9] found an increase of HDL-cholesterol, a decrease of LDL-cholesterol and an improvement in the HDL-cholesterol and LDL-cholesterol ratios in a healthy elderly population when Zn supplementation was stopped. On the other hand, Back et al. [11] suggest that Zn supplements lower serum HDL cholesterol levels.

Conclusions

Most of serum trace element concentrations obtained for an elderly group of São Paulo city are within the reference intervals established for general population and in use in clinical laboratories. The positive correlation found between the concentrations of serum Zn and LDL-cholesterol indicates the possible effect of this element in serum lipoprotein profiles. Therefore, these findings suggest more investigations on Zn supplementation in elderly subjects with cardiovascular diseases.

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