2007 International Nuclear Atlantic Conference - INAC 2007
Santos, SP, Brazil, September 30 to October 5, 2007
ASSOCIAÇÃO BRASILEIRA DE ENERGIA NUCLEAR - ABEN
ISBN: 978-85-99141-02-1

THE REFERENCE VALUE FOR BLOOD SODIUM IN INHABITANTS OF BRAZIL: HARMONIZATION OF STATISTICAL TREATMENT

Laura C. Oliveira[1], Cibele B. Zamboni[1], Guilherme S. Zahn[1], and Marco A. Maschio[1]

[1] Instituto de Pesquisas Energéticas e Nucleares (IPEN / CNEN - SP)
Av. Professor Lineu Prestes 2242
05508-000 São Paulo, SP
laura@ipen.br

ABSTRACT

The objective of this study is the establishment of reliable sodium reference value in whole blood of Brazilians, living in two regions (Northeast and Southeast) using NAA, with emphasis on the statistical treatment. These results included: mean Na levels (1.77 g/l), the standard deviation (0.29 g/l), median (1.75 g/l), mode (2.05 g/l) and also the reference intervals - for general population (1.48 – 2.06 g/l), for male (1.47 – 2.05 g/l) and for female (1.53 – 2.07 g/l). Also, the influence of sex and age on Na in blood was evaluated by the analyse of variance between males and females and considering several range for age (18-20, 21-30, 31-40, 41-50, ≥ 51 years). These results show small differences when a comparison is performed in function of age, sex and geographic occupation.

1. INTRODUCTION

Knowledge of the concentration of trace elements in body fluids of persons without occupational exposure is a fundamental data to establish trace element reference values for evaluation of the intensity of exposure and uptake in human being. In many countries these data have been evaluated, but the absence of established harmonized statistical treatment makes their compare to difficult. Based on it, in this work we performed measurements of sodium in whole blood of Brazilians using NAA and, the result is presented following a descriptive statistics procedure which includes the evaluation of mean, standard deviation, median and mode. These statistical treatments make possible the comparison with data derived for different population groups from Brasil.
The element sodium was selected because it is relevant for biochemistry analyses in clinical practice and for which date of reference value was not established for Brazilian population.

2. MATERIAL AND METHODS

For this study the population group was established considering the sex, age and also the habits (influence or not of alcohol consumption and/or smokers, nom-smokers). To facility the volunteers selection a questionnaire was completed by each donor at the time of sample collection providing all these information.

The volunteers for this study were selected from Blood Bank at São Paulo and Recife cities. Subjects suffering from obesity, stress as well as pregnant woman were not considered from this study. All sample collections were performed by trained technical staff of the medical

centers located within the selected regions with the ethical approval from Regional Ethics Committee of the Blood Blanks involved.

The samples were collected in a vacuum plastic tube attached to the donor's arm. Immediately after the collection exactly 100μl of whole blood was transferred to the filter paper using a calibrated pipette. After that, each sample was dried for few minutes using an infrared lamp.

In this context, sodium was measured in 283 Brazilian subjects using NAA specifically a variant of k_0 – NAA [1], where the neutron flux can be evaluated using the Cadmium Ratio Technique [2], eliminating the use of standards. In this experimental procedure, Au foils (<1mg), both bare and Cd covered (1mm thick), are irradiated together with the whole blood sample (100 μl) in the IEA-R1 nuclear reactor at IPEN/SP (IEA-R1, 2-4MW, pool type), for few minutes, allowing the simultaneous activation of these materials under the exact same irradiation conditions. Using this procedure the γ-ray activities induced in the Au foils by both the thermal and epithermal neutrons were obtained as well as the activation of biological sample. A γ-spectrometer system with a semiconductor detector connected to an ADCAM multichannel analyzer and to a PC computer were then used to measure the induced γ-ray activity. The detector (HPGe) was calibrated for energy and efficiency through the measurements of standard sources of ^{56}Co and ^{152}Eu [3]. All gamma spectra analysis evaluations were performed using the IDF computer code [4], which locates peak position, identify the energies and calculate net areas. The concentration of each element was then obtained by using an in-house software [5], which correlated the measured parameters, i.e, neutron flux, net area and efficiency of the selected γ- ray with the constants physics involved (the decay constant, the atomic mass, the Avogadro's number, the cross section for the selected capture reaction, the isotopic fraction and the intensity of the gamma ray). In a running of the software, the isotope that will be analyzed must be selected by the user and all the physical constants are previously defined. After that, the user needs to input data about: irradiation time, counting time and waiting time (the time elapsed between the end of the irradiation and the start of the counting) and the sample mass as well as the measured parameters.

3. RESULTS

The results relate to the statistical treatment applied for sodium determination in whole blood using NAA, *i.e.*, mean (M), standard deviation (SD), median (Md), mode and also the reference intervals for all population as well as for male and for female, are presented in Table 1.

The relationship of the variable Na in whole blood in function of age was also investigated considering several range for age (18-20, 21-30, 31-40, 41-50, ≥ 51years) and the results are presented in Figure 1.

In Table 2 the Na reference value in whole blood of males and females were compared with data derived for different regions (Southeast and Northeast) of Brazil.

Table 1. The statistical treatment results for blood sodium concentration in inhabitants of Brazil using NAA.

Na (gl^{-1})	M	SD (68%)	Md	Mode	Reference intervals
All n = 283	1.77	0.29	1.75	2.05	1.48 – 2.06
Male n = 150	1.76	0.29	1.74	1.57	1.47 – 2.05
Female n = 133	1.80	0.27	1.79	2.05	1.53 – 2.07

n: number of samples analyzed in duplicate

Table 2. Tentative reference intervals for sodium in blood in population groups living in different Brazilians region.

Group of subjects Na (gl^{-1})	São Paulo city (Southeast region) n = 141	Recife city (Northeast region) n = 142
All	1.48 – 1.90	1.50 – 2.10
Male	1.45 – 1.89	1.49 – 2.09
Female	1.56 – 1.92	1.52 – 2.16

n: number of samples analyzed in duplicate

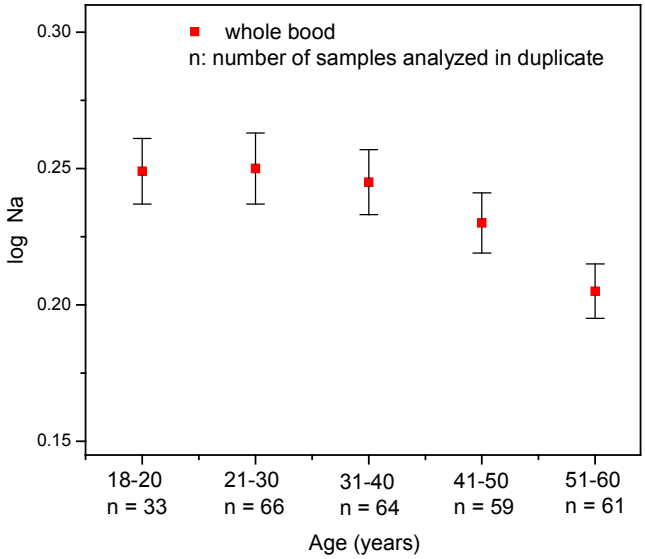

Figure 1. Blood-sodium levels as function of age

4. DISCUSSION

Standardization of statistical treatment are very important to perform comparison of data on trace elements in biological materials (fluids, tissues and organs) of the general population living in different regions of Brazil. In this context, sodium has been evaluated in the whole blood of 283 Brazilian inhabitants living in two distinct regions, Southeast (São Paulo city) and Northeast (Recife city). These cities are select because they present some similarities, such as, high concentration people living in an industrialized center with urban and suburban populations, suggesting that these volunteers have a similar history of occupational exposure.

The results shown in Figure 1, indicate that the sodium concentration decreases with age. The data in Table 1 shows that the sodium concentration is slightly greater in women than in men, and this could be a consequence of the fact that women retain more body fluids than men (these ions are strongly linked to the hidric balance). Relate to geographic occupation (Northeast and Southeast region studied), the evaluation presented in Table 2 shows an increase in the sodium concentration in the population from Recife (Northeast), when compared to the São Paulo population (Southeast); it could be related to the fact that Recife is a coastal city and that the local population has a greater intake of sea food but, studies related to nutrition habits must be performed in order to subside this discussion.

5. CONCLUSIONS

The establishment of reliable sodium reference value in whole blood of Brazilians, with emphasis on the statistical treatment becomes possible the comparison of data in function of age, sex and geographic distribution. Of course, this procedure can be extended to others regions (cities) as well as to others elements in blood, permitting to study in more details the frequency of the distribution of the elements in this body fluids.

REFERENCES

1. F. de Corte, A. Simonits, "Recommended nuclear data for use in the k_0 standardization of neutron activation analysis," *Atomic Data and Nuclear Data Tables*, **85**, pp.47-67 (2003).
2. L. C. Oliveira, C. B. Zamboni, F. A. Genezini, A. M. G. Figueiredo, G. S. Zahn, "Use of Thermal Neutrons to Perform Clinical Analyses in Blood and Urine Samples," *Journal of Radioanalytical and Nuclear Chemistry,* **236**, pp.783-786 (2005).
3. International Atomic Energy Agency, *X-Ray and Gamma-Ray Standards for detector calibration,* Viena, IAEA – TECDOC – 619 (1991).
4. P. Gouffon, *Manual do Programa Idefix,* IFUSP, São Paulo, Brasil (1987).
5. J. A. G. Medeiros, *Software ATIVAÇÃO*, Instituto de Pesquisas Energéticas e Nucleares, São Paulo, Brasil (2003).