Available online at www.sciencedirect.com
SCIENCE DIRECT®
Environmental Research 97 (2005) 322–329
Environmental Research
www.elsevier.com/locate/envres

Efficient antioxidant capacity against lipid peroxide levels in healthy elderly of Mexico City

Martha A. Sánchez-Rodríguez[a], Raquel Retana-Ugalde[a], Mirna Ruíz-Ramos[a], José Luis Muñoz-Sánchez[b], Luis Alberto Vargas-Guadarrama[c], Víctor Manuel Mendoza-Núñez[a,*]

[a]*Unidad de Investigación en Gerontología, Facultad de Estudios Superiores Zaragoza, Universidad Nacional Autónoma de México (UNAM), Fuerte de Loreto, Col. Ejercito de Oriente, Batalla 5 de mayo s/n, esq. 09230 Mexico City, Mexico*
[b]*Departamento de Bioquímica, Escuela Nacional de Ciencias Biológicas, Instituto Politécnico Nacional (IPN), Mexico City, Mexico*
[c]*Instituto de Investigaciones Antropológicas, UNAM, Mexico City, Mexico*

Received 22 December 2003; received in revised form 20 April 2004; accepted 4 May 2004
Available online 20 July 2004

Abstract

We evaluated antioxidant activity against lipid peroxide levels (LPO) in healthy elderly and adults of Mexico City in comparison with a population of a rural area. The study included free-living subjects: 38 adults aged <60 years and 129 older subjects aged $\geqslant 60$ years of urban Mexico City in addition to 37 adults aged <60 years and 88 older subjects aged $\geqslant 60$ years of rural area (Actopan, Hidalgo State, Mexico). LPO were observed as higher in adults and elderly of the urban area than among rural subjects ($P<0.01$), although LPO levels were similar in rural adults and elderly ($P>0.05$); conversely, in urban area levels were higher in the elderly than in adults ($P<0.01$). On the other hand, the superoxide dismutase in urban elderly was higher than that in rural elderly ($P<0.05$) but similar between urban adults and urban elderly ($P>0.05$). Total oxidant status in urban elderly was higher than that in rural elderly ($P<0.01$). Our findings allow us to conclude that the urban elderly (residents of Mexico City) have higher oxidative stress than the rural-dwelling elderly, though the urban elderly have efficient antioxidant capacity as a response to elevated LPO.

Keywords: Lipid peroxides; Total antioxidants; Elderly; Urban; Rural; Pollution

1. Introduction

Oxidative stress (OxS) is a serious imbalance between the reactive oxygen species (ROS) produced and the effective action of the antioxidant system. It is a factor that contributes to aging and the development, among other diseases, of diabetes mellitus, chronic obstructive lung disease, atherosclerosis, Parkinson's disease, Alzheimer's disease, rheumatoid arthritis, and some types of cancer (Harman, 1998; Finkel and Holbrook, 2000; Knight, 1999). Several factors affect the antioxidant status in favor of OxS, such as an antioxidant-deficient diet, strenuous exercise, smoking, alcoholism, exposure to air pollutants, genetic alterations, and aging (Joseph et al., 2000; Mastaloudis et al., 2001; Panda et al., 2000; Cederbaum, 2001, Cotovio et al., 2001).

There is abundant experimental and observational evidence that supports the idea that aging is the sum of all free radical reactions throughout all cells and tissues or that they are at least a major contributor to it (Harman, 1998; Finkel and Holbrook, 2000; Knight, 1999).

The inhabitants of Mexico City are exposed most of the time to high levels of air pollutants, which have been associated with an increase in the incidence of mortality in children and the elderly (Loomis et al.,

*Corresponding author. Fax: +52-55-5773-6332.
E-mail address: mendovic@servidor.unam.mx (V.M. Mendoza-Núñez).

0013-9351/$ - see front matter © 2004 Elsevier Inc. All rights reserved.
doi:10.1016/j.envres.2004.05.006

1999; Téllez-Rojo et al., 2000). In such regard, it has been demonstrated that newly arrived subjects to Mexico City (1–8 days) present greater lipoperoxidation concomitant with a greater production of Cu/Zn-superoxide dismutase (SOD), in comparison with permanent residents (Hicks et al., 1996). In this sense, it has also been demonstrated in adults recently arrived in Mexico City that the activity of SOD decreased after 16 weeks in comparison with the values obtained the first week; at the same time the inhibitory capacity of serum against induced in vitro lipoperoxidation increased by 22% as an adaptive response (Medina-Navarro et al., 1997). However, it has not been demonstrated that this adaptive response is conserved in healthy elderly.

For this reason, the purpose of this study was to evaluate antioxidant activity against lipid peroxide levels in healthy elderly and adults of Mexico City in comparison with a population of the rural area.

2. Materials and methods

2.1. Subjects

The study included free-living subjects with residence in the urban or rural areas for 10 years or more: 38 adults aged <60 years (mean 34 ± 6.2 years) and 129 older subjects aged $\geqslant60$ years (mean 68 ± 7 years) of urban Mexico City (altitude 2260 m above sea level); in addition, the study included 37 adults aged <60 years (33 ± 6.4 years) and 88 older subjects aged $\geqslant60$ years (mean 70 ± 8.3 years) from the rural area (Actopan, Hidalgo State, Mexico, to 130 km away from Mexico City and 2069 m above sea level). None of the subjects studied had been taking antioxidant supplementation (vitamins or minerals) for at least 6 months previously and none smoked or had acute or chronic diseases or were receiving prescription medications. All groups were healthy (without arterial hypertension, diabetes mellitus, or cancer) and well nourished. Older subjects had BMI of 23.1–27 kg/m^2, their Mini Nutritional Assessment score was >23.5, their caloric intake was between 2000 and 2500 kcal per day, their alimentation had the nutrient requirements (protein, fat, carbohydrate, vitamins, and minerals) consistent with the recommended dietary allowance (RDA) measured by 24-h dietary recalls, and their serum albumin was >35 g/L. Adult subjects had BMI of 22.1–25 kg/m^2, their caloric intake was between 2200 and 2800 kcal per day, their alimentation had the nutrient requirements (protein, fat, carbohydrate, vitamins, and minerals) consistent with the RDA measured by 24-h dietary recalls, and their serum albumin was >35 g/L (Vellas et al., 2000; Ervin, 1998; Barrocas et al., 1995). The physical activity was similar between groups of older subjects and adult subjects; this was measured with a physical activity scale for the elderly (Washburn et al., 1999).

The subjects agreed to participate in the study after giving their informed consent. The Ethics Committee of the Universidad Nacional Autónoma de México Zaragoza Campus approved the research protocol for this study.

2.2. Air pollutants monitoring

No personal monitoring was performed. Annual mean of ozone air in Mexico City was 0.155 ± 0.046 ppm and in Actopan, Hidalgo State 0.070 ± 0.010 ppm ($P<0.0001$); PM10 in Mexico City was 122 ± 27 μg/m^3 and in Actopan, Hidalgo State was 104 ± 24 μg/m^3 ($P=0.064$) (CENICA, 2000).

2.3. Blood sampling and preparation

Blood samples were collected after a 12-h fasting period by venopuncture and placed in vacutainer/siliconized test tubes containing a separating gel and no additives. Heparin was employed as anticoagulant agent. Blood samples containing heparin were analyzed using a complete hemoglobin test protocol (including hemoglobin, hematocrit, and leukocyte counts). The following serum quantifications were conducted: glucose, urea, creatinine, urate, albumin, cholesterol, triglycerides, and cholesterol high-density lipoproteins (HDL). These tests were used as screening measurements for diagnosis of clinically healthy subjects.

2.4. Blood sampling and biochemical analyses

Hemoglobin levels were measured by cyanomethahemoglobin reaction procedure (cutoff points: in males, 12.17–17.26 g/dL, and in females, 11.48–16.25 g/dL). Hematocrit levels were assessed by microhematocrit procedure (cutoff points: males, 38–52%, females, 36–51%). Leukocyte count was done using the Newbauer chamber procedure (cutoff points: 3500–10,650/mm^3).

Glucose, urea, creatinine, urate, albumin, cholesterol, triglyceride, and HDL levels were determined using an Eclipse autoanalyzer (Merck, México). Specifically, glucose levels were measured with the glucose oxidase method (cutoff points: 63–120 mg/dL), urea levels were measured with the Berthelot urease method (cutoff points: 9.5–47.0 mg/dL), creatinine levels were measured with the Jaffe method without deproteinization (cutoff points: males, 0.3–1.5 mg/dL, females, 0.3–1.3 mg/dL), and urate levels were measured with the uricase colorimetric method (cutoff points: males, 2.9–8.88 mg/dL, females, 2.5–8.7 mg/dL). Albumin levels were measured with the bromocresol green technique (3.23–4.03 g/dL).