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Correlation of lipid and glycaemic profile with oxidative stress in the elderly with or without nontransmissible chronic diseases

Correlação do perfil lipídico e glicêmico com estresse oxidativo em idosos com ou sem doenças crônicas não transmissíveis

Correlación del perfil lipídico y glucémico con el estrés oxidativo en ancianos con o sin enfermedades crónicas no transmisibles

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Abstract

Objectives: This study set out to determine whether there are any correlations between lipid and glucose levels and oxidative stress presented by elderly patients with and without nontransmissible chronic diseases (NTCDs). Methods: Serum biochemical concentrations of lipoproteins, glucose and oxidative stress markers (malondialdehyde and nitric oxide) were determined in 44 elderly patients (22 elderly people without NTCDs and 22 elderly people with NTCDs), aged between 60 and 81 years old. Results: The elderly people with NTCDs showed higher LDL concentrations, glucose, and oxidative stress markers than those without NTCDs. There was a positive and significant correlation between the levels of malondialdehyde with the abnormal lipid profile of the elderly without NTCDs and hyperglycaemia presented by elderly people with NTCDs. The total trolox equivalent antioxidant capacity had a negative correlation with the levels of malondialdehyde in the elderly without NTCDs. Another negative correlation was observed between the levels of nitric oxide and malondialdehyde in elderly people with NTCDs. Conclusion: Once oxidative stress and abnormal lipid profile have occurred in both groups, it is suggested that the hyperglycemia present in the group with chronic diseases has been determinant for the increase of the oxidative stress found in this group.

Keywords: Oxidative stress; Aging; Lipids.

Resumo

Objetivos: O objetivo deste estudo foi verificar se há correlação entre os níveis de lipídeos e glicose e o estresse oxidativo em idosos com e sem doenças crônicas não transmissíveis (DCNT). Métodos: Concentrações bioquímicas séricas de lipoproteínas, glicose e marcadores de estresse oxidativo (malondialdeído e óxido nítrico) foram determinadas em 44 pacientes idosos (22 idosos sem DCNT e 22 idosos com DCNT), com idades entre 60 e 81 anos. Resultados: Os idosos com DCNT apresentaram maiores concentrações de LDL, glicose e marcadores de estresse oxidativo do que aqueles sem DCNT. Houve correlação positiva e significativa entre os níveis de malondialdeído com o perfil lipídico anormal de idosos sem DCNT e a hiperglicemia apresentada por idosos com DCNT. A capacidade antioxidante total

equivalente a trolox apresentou correlação negativa com os níveis de malondialdeído em idosos sem DCNT. Outra correlação negativa foi observada entre os níveis de óxido nítrico e malondialdeído em idosos com DCNT. Conclusão: Uma vez que o estresse oxidativo e o perfil lipídico anormal ocorreram em ambos os grupos, sugere-se que a hiperglicemia presente no grupo com doenças crônicas tenha sido determinante para o aumento do estresse oxidativo encontrado neste grupo.

Palavras-chave: Estresse oxidativo; Lipídeos; Envelhecimento.

Resumen

Objetivos: Este estudio se propuso determinar si existen correlaciones entre los niveles de lípidos y glucosa y el estrés oxidativo que presentan los pacientes ancianos con y sin enfermedades crónicas no transmisibles (ECNT). Métodos: Se determinaron las concentraciones séricas de lipoproteínas, glucosa y marcadores de estrés oxidativo (malondialdehído y óxido nítrico) en 44 pacientes ancianos (22 ancianos sin ECNT y 22 ancianos con ECNT), con edades comprendidas entre 60 y 81 años. Resultados: Los ancianos con ECNT mostraron concentraciones de LDL, glucosa y marcadores de estrés oxidativo más altos que aquellos sin ECNT. Hubo una correlación positiva y significativa entre los niveles de malondialdehído con el perfil lipídico anormal de los ancianos sin ECNT y la hiperglucemia que presentan los ancianos con ECNT La capacidad antioxidante total equivalente de trolox tuvo una correlación negativa con los niveles de malondialdehído en los ancianos sin ECNT. Se observó otra correlación negativa entre los niveles de óxido nítrico y malondialdehído en personas mayores con ECNT. Conclusión: Una vez ocurrido estrés oxidativo y perfil lipídico anormal en ambos grupos, se sugiere que la hiperglucemia presente en el grupo con enfermedades crónicas ha sido determinante para el aumento del estrés oxidativo encontrado en este grupo.

Palabras clave: Estrés oxidativo; Lípidos; Envejecimiento.

1. Introduction

Nontransmissible chronic diseases (NTCDs) are the leading cause of morbidity and mortality in the world. Among the most prevalent NTCDs are hypertension, or high blood pressure (HBP), and diabetes mellitus (DM). These diseases tend to present significantly with aging and usually when associated with comorbidities, they lead to decreased autonomy and reduced quality of life (Gottieb, Morassutti, & Cruz, 2011). The NTCDs have multifactorial

causes linked to heredity and the modern lifestyle, such as high consumption of sodium, a high calorie diet, physical inactivity and stress. Causes related to the pathogenesis of NTCDs include changes in lipid and oxidative metabolism, leading to an imbalance between the generation of reactive species (free radicals; FRs) and the ability of antioxidant defences, culminating in cell and tissue damage that have been associated with the aetiology and progression of these diseases (Gottieb, *et al.*, 2011).

The biological aging of the human being is a phenomenon that is associated with changes in the activity of cells, tissues and organs, as well as the reduced effectiveness of a number of physiological processes. During the aging process, metabolic modifications and changes in lipid metabolism are the most affected, resulting in higher serum concentrations of low density lipoprotein (LDL) and very low density lipoprotein (VLDL) and low levels of high density lipoprotein (HDL). All cell structures are susceptible to attack by FRs, but the cell membranes are the most affected and the decomposition of polyunsaturated fatty acids in the lipid layer of the membrane leads to the formation of reactive carbonyl compounds, such as malondialdehyde (MDA), which is elevated in several diseases. In hyperglycaemia, which is another metabolic disorder commonly found in aging, increased production of oxygen FRs by the autoxidation of glucose occurs, also exerting cytotoxic effects on phospholipids and contributing to the formation of MDA (Nasser, Dourado, Manjate, Carlos, & César, 2011; Valko, *et al.*, 2007).

Neither the causes nor the molecular mechanisms involved in the endogenous production of oxidants are yet fully known. General theories of aging suggest that the oxidative process is a crucial contributory factor to cellular aging. Aging has been attributed to the gradual accumulation of structural and functional changes in macromolecules and cell membranes caused by the harmful effects of FRs and other reactive oxygen species (ROS), which form spontaneously in the mitochondria as a consequence of oxidative metabolism. Under oxidative stress, ROS escape part of the antioxidant defences and react with cellular macromolecules such as lipids, proteins and both mitochondrial and nuclear DNA. The consequences of oxidative attack include the diminished endogenous reserves of non-enzymatic antioxidants and the alteration of the structure of lipids and cellular proteins, causing changes in the function of enzymes, transport and cell signalling, as well as changes and mutations in the genetic material (Mecocci, *et al.*, 1999). The changes in antioxidant cell systems and excess ROS are generated both by the aging of cells and the pathological mechanisms relating to the more than 100 possible frequent chronic conditions in older

people, such as cardiovascular diseases, Parkinson's disease, Alzheimer's disease, amyotrophic lateral sclerosis and cancer (Harman, 2011).

FRs are atoms or molecules that have one or more unpaired electron in their outer shell. These radicals may be produced by normal physiological oxidative metabolism, biological dysfunction, or environmental influences that could be altered in aging. When in excess, FRs result in harmful events, such as lipid peroxidation and protein, DNA and carbohydrate damage. Antioxidant compounds are the main defence for protecting the body from the attack of ROS and reactive nitrogen species (RNS). Antioxidant compounds include endogenous and exogenous substances that have the ability to reduce, delay, or repair oxidative damage. Endogenous molecules include the enzymes glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD), while exogenous substances include carotenoids and vitamin C (Barreiros, David, David, 2006; Simões, 2003).

The superoxide anion ($O^{\cdot}_2$), the hydroxyl radical (•OH), peroxynitrite (ONOO-) and hydrogen peroxide (H_2O_2) are major reactive species that can damage biomolecules. Nitric oxide (NO) has protective physiological functions in the vascular endothelium, but under oxidative stress conditions generates reactive species such as peroxynitrite, a potent oxidant involved in tissue destruction (Barreiros, David, David, 2006; Khazan & Hdayati, 2014; Yamaguchi, *et al.*, 2006).

Thus the aim of this study was to correlate the lipid and glycaemic profile with oxidative stress in elderly patients, with or without chronic diseases.

2. Methods

The research in na experimental typeof quantitative nature (Pereira, et al, 2018)

2.1 Population and experimental design

A cross-sectional study was performed to evaluate the lipid and glycaemic profile and serum levels of oxidative stress markers in 44 elderly patients of both sexes and aged at least 60 years old. The elderly were assessed by the Clinical Analysis Laboratory of the Faculty of Pharmacy from the Federal University of Pará (Belém, PA, Brazil) and were divided into two groups of 22 individuals:

Group 1: elderly who did not have NTCDs, with a mean age of 67.2 ± 5.8 years.

Group 2: elderly with NTCDs (such as DM and arterial systemic hypertension [ASH]) with a mean age of 67.6 ± 6.4 years and treated with specific medications such as anti-hypertensive, oral hypoglycaemic agents, etc.

The first stage of the research included the completion of a form providing details of the elderly patient's characteristics. After the patient had agreed to participate in the study, a biological sample was collected by venipuncture following fasting for 12 hours. The serum was obtained after 5 minutes of centrifugation at 3,000 rpm and the samples were divided into aliquots to determine MDA, NO, glucose and the lipid profile, such as total cholesterol (TC), fractions (LDL, VLDL, HDL) and triglycerides (TG).

2.2 Ethical aspects

In compliance with the legal and ethical aspects of research on human beings, the project was submitted to the Ethics and Research Committee of the Federal University of Pará and was approved under number 405 193. All individuals who agreed to participate signed or made a fingerprint impression on a form to indicate free and clear consent according to Resolution CNS 466/12.

2.3 Determination of glucose and serum lipoproteins

The determination of glucose, TC, TG and HDL was performed in a semi-automated Microlab 300 analyser (ELITech, France) using enzymatic colourimetric kits from the same brand and following the specific protocols for their determinations. LDL cholesterol was obtained as the difference between TC and the sum of HDL cholesterol and VLDL cholesterol. The VLDL cholesterol was calculated by dividing the plasma levels of TG by 5 (i.e. TG/5) for TG up to 400 mg/dl. The reference values used for these biochemical parameters followed the criteria of the Guidelines of the Brazilian Society of Diabetes 2013–2014 and the V Brazilian Guidelines for Dyslipidaemia and Prevention of Atherosclerosis (Grisham, Johnson, Lancaster, 1996; Percário, 2004).

2.4 Determination of MDA

Lipid peroxidation was assessed by measuring thiobarbituric acid reactive substances (TBARS) in the serum. This method consists of the reaction of MDA and other aldehydes with two molecules of thiobarbituric acid (TBA) to form a pink colour complex of TBA-MDA-TBA that can be read on a spectrophotometer at a wavelength of 535 nm. The results were expressed in nmol/ml (Re, *et al.,* 1999).

2.5 Determination of NO

The production of NO in the serum samples was determined indirectly by measuring nitrite levels through the Griess method. The absorbance of the reaction was measured on a microplate reader at a wavelength of 550 nm. Levels of NO were expressed in µM (Diretrizes da Sociedade Brasileira de Diabetes, 2014).

2.6 Total Evaluation of Trolox Equivalent Antioxidant Capacity (TEAC)

The total antioxidant status (TAS) is a sensitive and reliable marker to detect *in vivo* oxidative stress changes that may not be detectable through the measurement of a single specific antioxidant. The TAS was evaluated by Trolox (6-hidroxi-2,5,7,8-tetrametilcromono-2carboxilic acid; Sigma-Aldrich) equivalent antioxidant capacity assay from samples of the serum and peritoneal lavage. In this assay, 2,2-azino-bis (3-ethylbenzothiazoline, 6-sulfonate) (ABTS) is incubated with potassium persulfate (K2S2O8; Sigma Aldrich, Saint Louis, MO, USA) to produce ABTS•+, which is a green/blue chromophore. Antioxidants present in the sample cause a reduction in absorption proportional to their concentration. The antioxidant capacities of the samples are expressed as TEAC using a calibration curve plotted with different amounts of Trolox, and their absorbance measured at 740 nm (Re *et al.*, 1999). Data were expressed as µmol/L.

2.7 Statistical analysis

The results are expressed as mean ± standard deviation using the program GraphPadPrism 6. For parametric variables, we used Student's *t*-test, while Fisher's exact test was used for nonparametric variables. Correlation studies were made through the Spearman or

Pearson tests, depending on their distribution. In all the analyses performed, the analysed parameters were considered statistically significant at $p < 0.05$.

3. Results

The general characteristics of the elderly are summarized in Table 1. The majority of the elderly were female (59%) in each group. The age distribution is shown in Table 1 and the mean age was calculated as 67 years old for both groups.

Table 1. General characteristics of the elderly patients.

Variables	*Group 1 *n* = 22 (%)	**Group 2 *n* = 22 (%)
Gender		
Female	13 (59 %)	13 (59%)
Male	9 (41%)	9 (41%)
Age		
60–70	*17 (77.3%)*	13 (59%)
71–80	4 (18.2%)	9 (41%)
81+	1 (4.5%)	0 (0%)

*seniors not suffering from nontransmissible chronic diseases;
** elderly patients with nontransmissible chronic diseases.
Source: Authors.

The means and standard deviations of TC, LDL, HDL and TG of the elderly participants are shown in Table 2. Although no significant differences ($p > 0.05$) were observed between the groups, most of the elderly in both groups did not reach the recommended lipid profiles (desirable), with the TC and LDL levels being increased. In addition, the group of elderly patients with NTCDs (Group 2) had lower HDL levels compared to the elderly without NTCDs (Group 1).

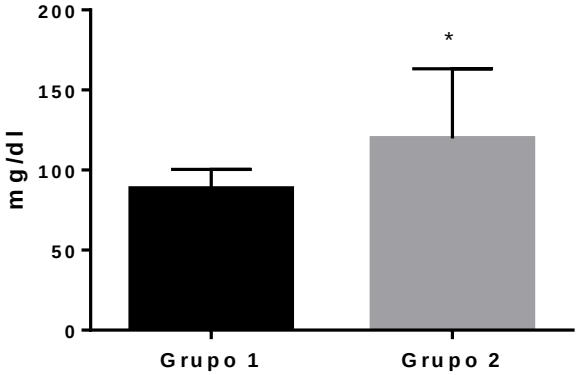
Table 2. Concentration of serum lipoproteins and classification of the lipid profile from the evaluated elderly.

Variables	Mean (*n* = 44)	Group 1 Mean ± SD *n* = 22(%)	Group 2 Mean ± SD *n* = 22 (%)	*p-value*
Triglycerides (mg/dL)	115.2 ± 10.58	112.0 ± 12.46	118.5 ± 8.70	0.5738
Desirable	36 (81.8%)	17 (77.3%)	19 (86.4%)	
Limitrophe	4 (9.1%)	2 (9.1%)	2 (9.1%)	
High	4 (9.1%)	3 (13.6%)	1 (4.5%)	
Total cholesterol (mg/dL)	275.7 ± 11.9	275.7 ± 11.85	275.8 ± 11.96	0.6820
Desirable	3 (6.8%)	1 (4%)	2 (9.1%)	
Limitrophe	10 (22.7%)	6 (28%)	4 (18.2%)	
High	31 (70.5%)	15 (68.2%)	16 (72.7%)	
LDL-c (mg/dL)	211.0 ± 10.94	209.5 ± 10.74	212.6 ± 11.14	0.0801
Great	1 (2.3%)	1 (4.6%)	0 (0%)	
Desirable	2 (4.5%)	0 (0%)	2 (9.1%)	
Limitrophe	2 (4.5%)	0 (0%)	2 (9.1%)	
High	12 (27.3%)	9 (40.9%)	3 (13.6%)	
Very high	27 (61.4%)	12 (54.5%)	15 (68.2%)	
HDL-c (mg/dL)	41.7 ± 2.45	43.8 ±2.57	39.6 ± 2.34	0.8854
High	5 (11.3%)	3 (13.6%)	2 (9.1%)	
Normal	16 (36.4%)	8 (36.4%)	8 (36.4%)	
Low	23 (52.3%)	11 (50%)	12 (54.5%)	

* Fisher's exact test. Group 1: seniors not suffering from nontransmissible chronic diseases; Group 2: elderly patients with nontransmissible chronic diseases. HDL-c: high density lipoprotein cholesterol; LDL-c: low density lipoprotein cholesterol.
Source: Authors.

The glucose concentration in elderly patients without NTCDs (Group 1) was significantly lower than that of the elderly with NTCDs (Group 2) (p = 0.0022), with a mean ± standard deviation of 88.4 ± 2.57 mg/dl and 119.8 ± 9.27 mg/dl, respectively (Figure 1). Hyperglycaemia was therefore evident in elderly patients with NTCDs.

Figure 1. Glucose concentrations of the evaluated groups. Group 1 refers to elderly patients without nontransmissible chronic diseases and Group 2 refers to elderly patients with nontransmissible chronic diseases. The results are expressed as mean ± SD.



* *p = 0.0022, Student's* t-*test.*
Source: Authors.

As shown in Table 3, the evaluation of oxidative stress revealed that the elderly with NTCDs (Group 2) had higher levels of oxidative stress markers such as MDA and NO compared to subjects without diseases. MDA in Group 1 was 1.19 ± 0.09 nmol/ml and in Group 2 was 1.83 ± 0.11 nmol/ml (p <0.0001), while the NO levels in Group 1 were 2.72 ± 0.57 μM and in Group 2 were 4.70 ± 1.21 μM (p 0.0011).

Table 3. Oxidative stress levels among evaluated elderly patients.

Parameters	**Group 1 Mean ± SD (n = 22)**	**Group 2 Mean ± SD (n = 22)**	***p*-value**
MDA (nmol/ml)	1.19 ± 0.09	1.83 ± 0.11*	< 0.0001
NO (μM)	2.72 ± 0.57	4.70 ± 1.21*	0.0011*

Student's t-test and Fisher's exact test*. Group 1: seniors not suffering from nontransmissible chronic diseases; Group 2: elderly patients with nontransmissible chronic diseases; MDA: malondialdehyde; NO: nitric oxide.
Source: Authors.

Analysis of the correlation between lipid profile and oxidative stress revealed that there was a positive correlation between TG/MDA (r = 0.7693, p = < 0.0001), TC/MDA (r = -0.6824, p = 0.0005) and LDL/MDA (r = 0.5951, p = 0.0035), but only among Group 1.

Looking at the oxidative stress markers, we observed a negative correlation between the levels of MDA/NO (r = -0.4742, p = 0.0258) in Group 2.

4. Discussion

Currently, chronic diseases are the leading cause of death worldwide, accounting for 60% of all deaths. They are characterized by slow development and are related to aging, lifestyle and intense oxidative stress. FRs contribute to the onset and progression of these diseases, particularly in the elderly, who are more susceptible because of reduced functional capacity (Gottieb *et al.*, 2011; Valko *et al.*, 2007). Phenomena caused by FRs include the disruption of cell membranes, leading to changes in ion pumps, gene mutations, oxidation of LDL, the formation of chemical residues such as MDA and the engagement of different extracellular matrix components. All these events contribute to the disorganization of the body's homeostasis resulting from aging (V Diretriz Brasileira de Dislipidemias e Prevenção da Aterosclerose, 2013). Patients with NTCDs often have comorbidities and the lipid profile is an important measure related to metabolic disorders in various pathological processes, including hypertension, DM and cardiovascular diseases (Salmon, Richardson, & Perez, 2010).

This study showed that the mean concentrations of TC and LDL were high and very high, respectively, in the two groups, regardless of the presence of chronic disease. It is known that during human aging, physiological changes occur, such as alterations in lipid metabolism, resulting in high serum concentrations of lipoproteins (Isaacs, *et al.*, 2013; Lawrence, 2010; Millar *et al.*, 1995). This result confirms and explains the presence of hypercholesterolaemia and the high LDL concentrations found in our elderly patients.

Another lipid metabolism-related change was the lower HDL levels of elderly people with NTCDs compared with the group of elderly patients without NTCDs. HDL is a lipoprotein with a cardioprotective function due to its ability to transport cholesterol esters from peripheral tissues to the liver, an effect known as reverse cholesterol transport, and its antioxidant capacity, represented by the paraoxonase enzyme (Batista, *et al.*, 2009). Most of the seniors in this study had diabetes as a chronic disease and the reduction in HDL cholesterol levels in diabetics is due to decreased synthesis by the lower activity of lipoprotein lipase and also by the increase in its clearance due to greater activity of hepatic lipase. This may explain the lower values of this lipoprotein found in the group of elderly patients with chronic diseases (Casella Filho, 2011; Rabelo & Martinez, 2017).

Only the elderly patients with NTCD exhibited hyperglycaemia. Glucose is the main energy source used by cells to perform biological functions and is essential to maintain homeostasis and the proper functioning of the central nervous system. However, hyperglycaemia promotes the endogenous formation of advanced glycation end products (AGEs), causing metabolic and vascular complications affecting the kidneys, eyes and blood vessels (Taskien & Borén, 2015).

NTCDs are characterized by the increased generation of FRs, in a similar fashion to the human aging process, which has also been associated with increased production of FRs. Harman's free radical theory proposes that aging is caused by an imbalance between the generation of FRs and antioxidant defence capacity, which will result in lifelong damage to biomolecules (Ferreira, Saviolli, Valenti, & Abreu, 2011; Hardman, D. 1956).

In this work, we also determined some of the markers of oxidative stress, such as MDA, NO and total trolox equivalent antioxidant capacity (TEAC) in in all elderly patients. MDA is one of the products generated by the oxidation of polyunsaturated lipids and can be used to quantify the extent of lipid peroxidation under oxidative stress conditions (Bonnes & Guérin, 1992). In this research, the average MDA concentration was high in the elderly with and without NTCDs. These results corroborate the study by Suresh et al that also showed higher MDA concentrations in the elderly, regardless of the presence of disease (Suresh, Sendil, Annam, & Hamsaveena, 2010).

Lipid peroxidation is high in pathological processes such as inflammation, dyslipidaemia, diabetes, degenerative diseases, hypertension, cancer and the aging process (Gottieb, *et al.*, 2011; Simões, 2003; Valko, *et al.*, 2007). Prashant Akila *et al.* (2007) have shown that elderly patients with diseases such as diabetes and/or hypertension present higher MDA values compared to older people without the disease. These diseases were accompanied by intense production of ROS and lipid peroxidation. Their results are consistent with those found in this study, namely that older people with NCTDs showed higher levels of MDA.

Polyunsaturated fatty acids, both isolated and incorporated into fats, are easily attacked by FRs and oxidized lipid peroxides, causing changes in the cell membrane functionality and the generation of toxic products such as MDA (Gottieb *et al.*, 2011; Santos, 1998). Pirinccioglu *et al.* (2010) found significantly elevated MDA levels in patients with familial hypercholesterolaemia. Importantly, the oxidation of LDL by FRs plays a crucial role in the emergence of diseases such as atherosclerosis, affecting most of the elderly and this confirms the presence of hypercholesterolaemia. These results may explain the positive correlation found in the elderly without disease between the levels of MDA and TC, LDL, TG

and VLDL, demonstrating the relationship between oxidative stress and the lipid profile in this group.

Further evidence of oxidative stress generation found in this study was the positive correlation between hyperglycaemia and MDA presented by elderly patients with NTCDs. Hyperglycaemia and marked production of ROS are associated with an increased flow towards the polyols, the activation of protein kinase C (PKC) and an increase in the formation of non-enzymatic AGEs from the auto-oxidation of glucose. Oxidized sugars react with lipoprotein components and membrane receptors, stimulating the formation of superoxide anions and hydrogen peroxide, resulting in the formation of MDA (Ayaz *et al.*, (2011); Valko *et al.*, 2007).

In our study, we also carried out an indirect measurement of NO by nitrite dosage using the Griess method. NO plays an important role as a mediator in various physiological, biological, immunological, biochemical and neurological activities. NO is synthesized when L-arginine is converted to L-citrulline, mainly by the action of the enzyme nitric oxide synthase (NOS) (Khazan & Hdayati, 2014; Tatsch, *et al.*, 2011; Valko *et al.*, 2007). The elderly patients with NTCDs had higher levels of NO compared to the elderly without NTCDs. At low concentrations, NO is beneficial; however, NO can be toxic at high concentrations or in the presence of ROS (Harman, 2001; Simões, 2003; Suresh *et al.*, 2010). Although NO is an important molecule in the control of blood flow and vasoprotective actions, it is an FR and its exacerbated synthesis is related to various pathological processes, such as dyslipidaemia, obesity, diabetes and hypertension. Although we found a negative correlation between levels of MDA and NO in elderly people with NTCDs, the Griess technique does not detect all the products generated by nitrosative oxidative stress, such as the toxic peroxynitrite FR. It is known that the superoxide anion ($O^{\cdot-}_2$) reacts with NO to form peroxynitrite (ONOO-), leading to cell damage by the nitration of proteins and causing lipid peroxidation (Yamaguchi *et al.*, 2006; Khazan & Hdayati, 2014).

The deleterious effects caused by FRs can be counteracted by antioxidant defences provided by endogenous and exogenous antioxidant compounds (Valko *et al.*, 2007; Nasser *et al.*, 2011; Barreiros *et al.*, 2006; Hardman, 1956). We conducted this study to determine the total TEAC; the mean concentrations of total antioxidants of elderly patients with or without NTCDs were not significantly different. However, there was a negative correlation between MDA and the TEAC in elderly patients without NTCDs. The increase in MDA and decrease in antioxidants among elderly people indicate that there is an increase in the generation of peroxidative damage in the aging process. This occurs mainly by the accumulation of ROS,

especially with a decline in mitochondrial metabolism (Bonnes & Guérin, 1992; Hardman, 1956; Simões, 2003). These results suggest that the elderly patients without NTCDs only had minor deficiencies in the endogenous and exogenous antioxidants compared with the elderly patients with NTCDs in the survey period.

One of the strategies used to mitigate the generation of FRs and therefore their biological damage is the consumption of nutrients with antioxidant properties, among them vitamin C, selenium and flavonoids (Zimmermann & Kirsten, 2008). Therefore, the identification of the contribution of specific antioxidant doses arising from food and enzyme activity is needed to assess these antioxidants in this population.

5. Conclusion

In this study, we noted the presence of oxidative stress in the elderly, not only in the human aging process, but also in the pathogenesis of age-related diseases, including diabetes and hypertension. The antioxidant defence mechanisms were not sufficient to prevent the increased generation of ROS and RNS in the elderly patients evaluated. Once oxidative stress and abnormal lipid profile have occurred in both groups, it is suggested that the hyperglycemia present in the group with chronic diseases has been determinant for the increase of the oxidative stress found in this group.. A study to analyse the impact of nutrient supplementation with antioxidant properties may be beneficial to prevent redox imbalance and biological damage in the elderly and sick.

However, other mechanisms need to be investigated to better elucidate the relationship between the aging, the hyperglycemia process and the imbalance redox.

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