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(RESEARCH ARTICLE)

Oxidative stress indices in apparently healthy blood donors in Ibadan

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Abstract

Background/Objective: Blood donors are life savers. They are also exposed to both exogenous and endogenous sources of free radical production. Therefore, this study aimed at investigating the oxidative stress status in apparently healthy blood donors in Ibadan.

Method: This study was carried out in 100 urban and 67 rural male and female blood donors between the ages of 18 and 65 years after obtaining their consent. Ten (10) ml of venous blood was collected from each participant into heparinised bottles. The total plasma peroxides (TPP) and total antioxidant capacity (TAC) were determined using spectrophotometer and oxidative stress index (OSI) was calculated. All data were expressed as Mean ± SD. Results were analysed using one sample T-test to test the statistical significance between the variables. The level of significance was fixed at $p \leq 0.05$.

Result: In this study, the mean values of TPP and OSI were observed to be significantly higher in the urban blood donors (200±62.9µmol H_2O_2/L and 3.4±1.3%) compared with the rural blood donors (57.46±10.28µmol H_2O_2/L and 2.9±0.98%) ($p < 0.001$). Similarly, TAC (6388.7±1788.7 Vs 2133.99±708.1 p=0.000) was observed to be significantly higher in the urban blood donors compared with their rural counterparts.

Conclusion: Significantly higher total plasma peroxides observed in urban blood donors is detrimental to the person receiving the blood. Therefore, intending blood donors should be educated on how to keep healthy feeding habits and life styles in order to improve their own health and the health of those they intend to save.

Keywords: Blood donors; Free radical; Total Plasma Peroxide; Total Plasma Capacity; Oxidative stress index

1. Introduction

Free radicals are molecules or molecular fragments containing one or more unpaired electrons in their outer atomic or molecular orbitals (Halliwell and Gutteridge, 1999; Gilbert, 2000). They are generally unstable and very reactive molecules which are mostly produced as by-products of oxidation processes and other chemical reactions that occur in animal and human bodies under normal physiological condition as well as pathological condition (Gilbert, 2000). Free radicals may be centred on carbon, oxygen, nitrogen or sulphur ('thiyl' radicals) atoms (Preedy et al., 1998). Examples of oxygen free radicals include superoxide ($O_2^{\cdot -}$), hydroxyl ($HO^{\cdot}$), peroxyl ($RO_2^{\cdot}$), alkoxyl ($RO^{\cdot}$) and hydroperoxyl ($HO_2^{\cdot}$), while nitrogen radicals are nitric oxide ($^{\cdot}NO$) and nitrogen dioxide ($^{\cdot}NO_2$). These radicals can be converted into other non-radical reactive species collectively referred to as reactive oxygen species (ROS) such as hydrogen peroxide (H_2O_2), hypochlorous acid (HOCl), hypobromous acid (HOBr) and reactive nitrogen species (RNS) including peroxynitrite ($ONOO^-$) (Valko *et al*., 2007; Esra *et al*., 2012).

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Free radicals can be obtained from both the endogenous and exogenous sources (Santa-Maria *et al*., 2013). The important sources of endogenous free radicals production are by-products of aerobic oxidation, respiratory burst, enzyme reactions and auto-oxidation reactions, while ultraviolet radiation, gamma radiation, cigarette smoke, xenobiotics and environmental pollutant are among the exogenous initiators of free radical reactions (Omar and Wasan, 2013). Under normal physiological condition, the deleterious effects of free radicals can be reduced by a wide range of antioxidant defence system. This defence system helps to scavenge free radicals through enzymatic and non-enzymatic reaction and thus rendering them harmless (Carl *et al*., 2011). When the rate of ROS productions exceeds the scavenging capacity of available antioxidant defence system, it results in oxidative stress (OS) which is an imbalance between the pro-oxidant and antioxidant in favour of pro-oxidant (Valko *et al*., 2007). This OS damages cells by a variety of complex interacting mechanisms resulting in the disruption of biomolecules such as lipids, proteins, amino acids and DNA (Yun-Zhong *et al*., 2002). Indeed, OS has been implicated in the aetiology and progression of many human diseases such as cardiovascular disease, cancer, neurological disorders, diabetes mellitus, ischemia/reperfusion and other diseases as well as ageing (Sies, 2000; Chang et al., 2003; Dalle–Donne et al., 2006).

Blood donors are usually apparently healthy people who weighed at least 50kg and they have not donated blood or taken antibiotics within the past 8 weeks (Nwogoh *et al.,* 2012). They donate blood for transfusions or pharmaceutical purposes in order to save lives (Brecher, 2005). They are people from within the society or communities that are equally exposed to the exogenous and endogenous sources of free radical or oxidative stress generation and thus are not exempted from the deleterious effects of these free radicals or reactive species. Generally, people requiring blood transfusions are already in a pathological condition. Therefore, transfusing blood rich in oxidative species or free radicals can exacerbate their condition. In order to enhance quick recovery in these people, they should not be given blood containing excess free radicals or reactive species but should be transfused with blood high in antioxidant. There are no reports on the assessment of the antioxidant status of blood donors before donating blood in Nigeria. Therefore, this study is designed to assess the antioxidant status of apparently healthy blood donors in Ibadan.

2. Materials and method

2.1. Study population

A study population comprising 67 rural and 100 urban apparently healthy blood donors between the ages of 18 and 65 years were randomly recruited into the study. The rural blood donors were recruited from Idi-Ayunre Farm Settlement of Oluyole Local Government Area, while the urban blood donors were recruited from the Blood Bank of University College Hospital (UCH), Ibadan. The participants who were apparently healthy and, who weighed 50 kg and above and tested negative for transfusion transmissible infections (TTIs) such as HIV – 1/2, HBV, HCV and positive for copper sulphate screening as well as those who signed the written informed consent forms were recruited into the study. While those who have low body weight with low packed cell volume and tested positive for TTIs as well as those who did not sign the written informed consent forms were excluded from the study.

2.2. Analytical Methods and Procedures

Total plasma peroxide (TPP) and TAC were determined spectrophotometerically by the method of Harma and Coll. (2003) at the wavelengths of 560 nm and 593 nm respectively.

Oxidative stress index (OSI), an indicator of the degree of OS, is the percentage ratio of total plasma peroxide (TPP) to total antioxidant capacity (TAC) values (Harma *et* al., 2003) and calculated as follows:

$$\text{OSI (\%)} = \frac{\text{TPP}}{\text{TAC}} \times 100$$

2.3. Statistical Analysis

The data was analyzed using a software package for social sciences (SPSS) version 17. All data were expressed as Mean ± SD. Results were analyzed using one sample T-test to test the statistical significance between the variables. The level of significance was fixed at $p \leq 0.05$.

3. Results

The table shows that the mean TAC and TPP levels in this study were significantly higher in urban blood donors compared with the rural blood donors. The mean OSI was slightly higher and significantly different in urban blood donors compared with the rural blood donors.

Table 1 Oxidative Stress Index mean values of Subjects as Measured by TPP, TAC and OSI

	Urban blood donors (n=100)	**Rural blood donors (n=67)**	**T- test**	**P-value**
TPP (μmolH_2O_2/L)	200.8±67.9	57.46±10.28	22.79	0.000
TAC (μmolTroloxequiv/L)	6388.7±1788.7	2133.99±708.1	23.79	0.000
OSI (%)	3.4±1.3	2.9±0.98	3.46	0.001

4. Discussion

The findings of this study revealed significant increases in the levels of TPP and OSI in the urban blood donors compared with the rural blood donors. This result suggests that the urban donors are more exposed to exogenous initiators of free radical reactions such as ultraviolet radiation, gamma radiation, cigarette smoke, xenobiotics and environmental pollutants (Omar and Wasan, 2013) than the rural donors. This finding is in agreement with the research work of Burke and Fitzgerald, (2003) where they reported that urban dwellers are greatly exposed to environmental contaminants. These contaminants increase free radical load tremendously. Studies have shown that the rate of air pollution in the urban area is getting higher and higher day by day (Ekpenyong *et al*., 2012). The increase in air pollution arises from automobile exhaust, industrial manufacturing facilities, cigarettes and even moving traffic as well as over exposure to sunlight and prolonged exposure to X-rays (Arogunjo *et al*., 2004, Ademola *et al*., 2005).

Other sources include toxic chemicals and pesticides, petroleum based products, unhealthy food such as processed/refined foods, fried foods, barbecued and charbroiled foods, toxic products found in furniture polish and paints like toluene, benzene and formaldehyde (Sema *et al*., 2013). A wide range of chemicals are released during these processes, which when inhaled, ingested, or come in contact with through the skin, increase the oxidant loads that can cause potential threat to human health. This further strengthens the observed increase in levels of TPP and OSI of the urban donors indicating their continuous exposure to environmental pollutions as mentioned above. Total antioxidant capacity is the term used to describe the ability of antioxidants in different food to mop-up harmful free radicals in the blood and cells (Nicoletta *et al*., 2003). Total antioxidant capacity takes into account the amount of water-based and fat-based antioxidants present in food. In this study, there was a substantial increase in the TAC of urban blood donors when compared with rural blood donors. This increase in TAC may be a compensatory mechanism by which the body responded to the very high TPP levels in the urban blood donors in order to prevent tissue damage that may be caused by OS induced by TPP.

Recommendation

Most people requiring blood transfusion are in a pathological condition. In this condition, more free radicals are being produced which tends to overwhelm the antioxidant status of the patient. If blood rich in free radical is administered to a patient in such pathological condition, this can further worsen their condition. Therefore, it will be recommended that all 'intending blood donors' should be educated on the adverse effect of environmental pollution which is detrimental to their health and the patient they want to save. Similarly, they should be adviced to keep healthy feeding habits and life styles. All these, will go a long way to minimise and protect the blood they are giving from excess free radicals and/or oxidants that can be harmful to the 'would be receivers' of the blood and thus, help to ameliorate and hasten recovery rather than worsen the 'would be receivers' pathological conditions.

5. Conclusion

Multidrug – resistant tuberculosis is associated with increased oxidative stress due to increased free radical generation.

Increasing intake of nutritional antioxidants as found in fruits and vegetables apart from supplemental antioxidants may help to improve prognosis of this disease condition.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Ethical approval for this study was obtained from the University of Ibadan/ University College Hospital Ethical Committee; IRB approval – UI/EC/14/0168

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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