Original Article

The Total Antioxidant Status and Antioxidant Vitamins in Gombe, Nigeria

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Abstract

Background: Measuring individual oxidants and antioxidants as markers of oxidative stress may be expensive, time-consuming, and open to a great deal of errors. In addition to freedom from the above, total antioxidant status (TAS) combines the synergistic effects of all the antioxidants in the system including those yet to be discovered. **Aims and Objectives:** The aim of this study was to evaluate the correlation between plasma levels of antioxidant vitamins (Vitamins A, C, and E) and TAS in Gombe, Nigeria. **Materials and Methods:** Pearson's correlation was used to correlate between plasma levels of antioxidant vitamins (Vitamins A, C, and E) and TAS among 180 people. Antioxidant vitamins (Vitamins A, C, and E) were analyzed using high-performance liquid chromatography and TAS was analyzed using standard colorimetric methods. **Results:** The mean age of the participants is 29.14 ± 3.6 years, and the mean body mass index is 23.26 ± 3.1. There was a significant strong ($P < 0.001$) positive correlation between TAS and Vitamin A ($r = 0.59$), Vitamin E ($r = 0.52$), and Vitamin C ($r = 0.62$). **Conclusion:** This study has demonstrated a high level of correlation between plasma levels of antioxidant vitamins (Vitamins A, C, and E) and TAS. This is an indication that TAS may assume a clinical status as a marker of oxidative stress. It may reduce the number of analytes, cost, time, and errors involved in assessing individual oxidants and antioxidants as markers of oxidative stress.

Keywords: Antioxidants, gasoline, Gombe, trace metals, vitamins

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Introduction

Oxidative stress, which occurs when free radicals usually reactive oxygen species (ROS) rate of generation exceeds the available antioxidant defenses, is implicated in many chronic diseases including cancers, hearing loss, the central nervous system, lung, liver, kidney, and heart diseases.[1-3] Oxidative stress occurs due to the increased production of ROS and/or because of a deficiency of antioxidant defenses. Antioxidant deficiencies can develop as a result of decreased antioxidants (such as Vitamins A, C, and E), either due to decreased intake or due to increased utilization by the body.

Different researchers evaluate oxidative stress using different markers. These include measuring the ROS, antioxidants (vitamins, trace metals, etc.), or the products of the oxidative process. These are done either alone or in combination.[4-6] This involves consumption of a lot of resources including time and materials. This problem will be minimized by measuring total antioxidant status (TAS) which combines the synergistic effects of all the antioxidants including those yet to be known in the body.[7,8] It also saves time and other resources while reducing the errors that could arise from assaying individual antioxidants and/or oxidants.

However, few studies are available that correlate the TAS with antioxidants. Understanding the relationship will help in generating data to be used in the timely and cost-effective clinical assessment of oxidative stress. This study, therefore, correlates TAS with antioxidant vitamins (Vitamins A, C, and E).

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Materials and Methods

Setting

This study was conducted in the Department of Chemical Pathology, University College Hospital, Ibadan. The hospital serves as a major referral center in Nigeria. The participants in the study were recruited from Gombe State, North East Nigeria.

Design

This was a cross-sectional study approved by both the Gombe State Ethical Committee and the Joint Ethical Review Committee of the University of Ibadan/University College Hospital, Ibadan, recruiting 180 participants after obtaining their informed consent.

Anthropometric measurements

- Height (HT) – This was measured to the nearest centimeter against a flat, vertical surface with the participants standing upright. A sliding headpiece was brought to the vertex of the participant's head, and the reading at this level was taken
- Weight (WT) – This was taken with a salter bathroom scale placed on a flat surface. The reading was recorded to the nearest 0.5 kg. Body mass index (BMI) was then calculated using the formula:

$$\text{BMI}\left(\text{kg}/\text{m}^2\right)=\frac{\text{WT}\left(\text{kg}\right)}{\text{HT}\left(\text{m}^2\right)}$$

Their blood pressure was measured using standard procedures. Random plasma glucose was done using a glucometer. The questionnaires were administered to participants who were asked to fast for sample collection the next morning.

Sample collection and laboratory procedures

Five milliliters of fasting venous blood was collected from each of the 180 participants into a heparinized plastic tube. Plasma was separated by centrifugation and frozen within an hour of collection till the time of analysis.

Total antioxidant status estimation

TAS was estimated in this study by the method described by Koracevic *et al*., 2001.[9]

Vitamin A, C, and E assays were performed using an ultrasensitive and specific high-performance liquid chromatography.[10]

Statistical analysis

The data were analyzed using IBM SPSS statistics, version 20, New York, USA for Windows. The mean (X) and standard deviation (SD) for HT, WT, BMI, systolic blood pressure (SBP), diastolic blood pressure (DBP), and TAS of the study participants were computed. The mean (X) and SDs for antioxidant vitamins (Vitamins A, C, and E) were also computed.

Pearson correlation coefficient was used to establish the relationship between TAS and antioxidant vitamins (Vitamins A, C, and E).

Results

The mean ± SD of age, BMI, SBP, and DBP is 29.14 ± 3.60, 23.26 ± 3.14 kg/M2, 130 ± 13.6 mmHg, 77 ± 5.6 mmHg, respectively. Fifty percent (90) of the respondents are petrol dispensers. Ten (11.1%) are teachers, 9 (10%) are farmers, 17 (18.9%) are students, and 20 (22.2%) are other occupations. The mean ± SD of TAS, Vitamin A, Vitamin C, and Vitamin E is 0.94 ± 0.46 mmol/L, 62.09 ± 9.71 µg/dl, 0.86 ± 0.23 µg/dl, and 0.86 ± 019 µg/dl, respectively [Table 1].

There is a statistically significant positive correlation between TAS and antioxidant vitamins (Vitamins A, E, and C) [Table 2].

Discussion

The measurement of TAS has been shown to be a better marker of oxidative stress than the individual antioxidants and oxidants[7,11] because it combines the synergistic effects of all the antioxidants in the system including those yet to be discovered.[7,8] In addition, it may also reduce cost, time, and errors involved in measuring the individual oxidants and antioxidants. The TAS, in this study, shows a strong positive correlation with antioxidant vitamins (Vitamins A, C, and E).

Some biomarkers of oxidative stress been exploited include antioxidant vitamins such as β-carotene and other carotenoids, Vitamin E, and Vitamin C.[4] Others are antioxidant trace metals such as selenium, zinc, cobalt, and copper.[5] Some researchers measure antioxidant enzymes including catalase,[12-14] superoxide dismutase,[13-16] glutathione peroxidase,[12,13] and thioredoxin reductase,[17] whereas others exploit the products of lipids, protein, or nucleic acid oxidation.[18] These can be said to be too many if all are done to prove the presence of oxidative stress. Can TAS be used as a marker in place of various combinations of oxidants and antioxidants? This study has demonstrated a high correlation between TAS and

Table 1: Mean and standard deviation of some variables

	n	Mean±SD
Age (years)	180	29.14±3.60
BMI (kg/m²)	180	23.26±3.14
SBP (mmHg)	180	130.18±13.60
DBP (mmHg)	180	77.37±5.62
TAS (mmol/L)	179	0.94±0.46
Vitamin A (µg/dl)	179	62.09±9.71
Vitamin C (µg/dl)	180	0.86±0.23
Vitamin E (µg/dl)	180	0.86±0.19

SD: Standard deviation, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure, TAS: Total antioxidant status

Table 2: Correlation between total antioxidant status and other markers of oxidative stress

	r	*P*
Vitamin A	0.587	0.000
Vitamin C	0.617	0.000
Vitamin E	0.518	0.000
TAS	1	

TAS: Total antioxidant status

antioxidant vitamins (Vitamins A, C, and E). These findings are similar to what was found in other studies.[7,19-21] Other studies found a simultaneous decrease in TAS and some antioxidant vitamins in people exposed to oxidative stress.[22]

There are other studies which show a positive correlation between TAS and other antioxidants such as polyphenols, superoxide dismutase and glutathione reductase enzymes, bilirubin, uric acid, and minerals.[19,23] Some of these studies have suggested the joint action and synergy of these antioxidants in combating oxidative injuries and the fact that TAS may represent this synergy between all the antioxidants in the body including those yet to be discovered.[7,8,24]

Since it is now evident from the pool of data provided by various researches that oxidative stress contributes to the etiology and pathogenesis of various chronic diseases and their complications, the finding, therefore, of the high correlation between TAS and antioxidant vitamins in this study as well as others that show a correlation of TAS and other antioxidants may predict the possibility of TAS overtaking all others as a maker of oxidative status of an individual. This may help in preventing chronic diseases and their complications. This is further supported by the suggestion of TAS combining the joint action and synergy of all antioxidants including those not yet discovered.

The reduction of cost and time spent in assessing the various individual antioxidants and the reduction of possibility of errors associated with such measurements are other benefits of accepting TAS as a leading clinical maker of oxidative status. Assessing nutritional supplementation may be more easily monitored using TAS than individual antioxidants since assessing all the antioxidants and their synergy including those not discovered may only be assessed using TAS.

Conclusion

This study has demonstrated a positive correlation between TAS and antioxidant vitamins (Vitamins A, C, and E). We suggest that in combination with evidence from other studies, TAS assumes a clinical status for determining the oxidative status of individuals with chronic diseases associated with oxidative stress. Risk assessment for developing complications in such patients may also be considered using TAS. It should also be considered as a maker for monitoring nutritional supplementation in patients requiring such supplement.

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Conflicts of interest

There are no conflicts of interest.

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