



Association of Vitamin E Use with Oxidative Stress and Antioxidant Biomarkers in Adults: A Comparative Observational Study

Rajappayya T Desai¹, Dr. Vidyashree K Patil², Dr. Shubham Jayantkumar Shete³

¹Assistant Professor, Department of Pharmacology, K H Patil Institute of Medical Sciences (GIMS) Gadag, Karnataka India

²Post graduate, Department of Pharmacology, K H Patil Institute of Medical Sciences (GIMS) Gadag, Karnataka India

³Post Graduate Student, Department of Pharmacology, K H Patil Institute of Medical Sciences (GIMS) Gadag, Karnataka India,



Correspondence:

Rajappayya T Desai

Assistant Professor,
Department of Pharmacology,
K H Patil Institute of Medical
Sciences (GIMS)
Gadag, Karnataka India

Received: 12-08-2026

Revised: 30-08-2026

Accepted: 25-09-2026

Published: 30-09-2026

Abstract

Background: Vitamin E participates in lipid-phase antioxidant defence. Comparisons of oxidative damage and antioxidant biomarkers can describe biochemical differences associated with supplement use, without establishing clinical benefit. **Objectives:** To compare plasma malondialdehyde and total antioxidant capacity and erythrocyte superoxide dismutase and glutathione peroxidase activities between adult Vitamin E users and non-users. **Methods:** This study was carried out at K H Patil Institute of Medical Sciences, Gadag, Karnataka, India, during June 2025 to March 2026. 50 adults: 25 users and 25 non-users were included in the study. Unadjusted mean differences and approximate 95% confidence intervals were calculated using Welch methods. **Results:** Mean age was 40.2 ± 10.4 years among users and 41.0 ± 9.8 years among non-users. Malondialdehyde was 2.80 ± 0.65 versus 4.10 ± 0.90 $\mu\text{mol/L}$, respectively. Total antioxidant capacity was 1.42 ± 0.24 versus 1.08 ± 0.22 mmol/L. Superoxide dismutase activity was $1,280 \pm 210$ versus $1,050 \pm 190$ U/g haemoglobin; glutathione peroxidase activity was 48.6 ± 8.4 versus 39.2 ± 7.6 U/g haemoglobin. Users had 31.7% lower mean malondialdehyde and higher means for all three antioxidant measures. **Conclusion:** Vitamin E users demonstrated significantly lower plasma malondialdehyde levels and higher total antioxidant capacity, superoxide dismutase activity, and glutathione peroxidase activity than non-users. These findings indicate a favourable association between Vitamin E use and the oxidative stress-antioxidant biomarker profile in adults. The lower lipid peroxidation observed among users, together with higher endogenous antioxidant enzyme activity, supports the biological role of Vitamin E in antioxidant defence.

Keywords: Vitamin E; oxidative stress; malondialdehyde; total antioxidant capacity; superoxide dismutase; glutathione peroxidase; observational study.



This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (<http://creativecommons.org/licenses/by/4.0/>).

INTRODUCTION

Oxidative stress describes disruption of redox signalling and control, together with molecular damage arising from an excessive oxidant burden. Reactive oxygen species also participate in normal cellular regulation, so their biological effects depend on concentration, location, and the capacity of protective systems. This distinction is relevant when interpreting antioxidant studies: a lower oxidative damage marker does not automatically demonstrate improved health. Measurements should therefore address both oxidative injury and antioxidant defence rather than rely on a single biochemical endpoint.[1] Vitamin E is a lipid-soluble nutrient with an established role in protecting polyunsaturated lipids against oxidation. Alpha-tocopherol interrupts lipid peroxidation by donating hydrogen to lipid peroxy radicals, thereby limiting propagation of oxidative reactions. Its antioxidant action depends on its distribution within membranes and lipoproteins and on interactions with other components of the redox network.[2,3] Vitamin E comprises several tocopherols and tocotrienols, which differ in metabolism, tissue retention, and biological activity. Consequently, supplement formulation and exposure cannot be treated as interchangeable characteristics.[4]

Malondialdehyde (MDA), a product associated with lipid peroxidation, is frequently measured in studies of oxidative damage. However, its interpretation depends on specimen handling and analytical specificity; different assays do not necessarily quantify identical biochemical signals.[5] Plasma total antioxidant capacity (TAC) provides a complementary estimate of collective antioxidant activity under defined assay conditions. The ferric reducing ability of plasma method illustrates one approach to assessing reducing capacity, although a global assay cannot identify the contribution of an individual nutrient.[6]

Enzymatic defences provide another dimension of redox assessment. Superoxide dismutase (SOD) catalyses conversion of superoxide to hydrogen peroxide and oxygen, while glutathione peroxidase (GPx) participates in peroxide removal using reduced glutathione.[7,8] Erythrocyte activities, expressed relative to haemoglobin, offer a practical means of examining these systems. Nevertheless, higher activity can reflect differences in regulation or exposure rather than a direct pharmacological effect of Vitamin E. Considering MDA, TAC, SOD, and GPx together supports a broader biochemical comparison, while preserving the distinct meaning of each measurement.

Observational comparisons are useful for exploring biomarker patterns among adults who already use supplements. Such comparisons also require attention to smoking, metabolic disorders, body composition, dietary intake, and other supplement use, because these characteristics influence exposure selection and oxidative status. Regional evidence is valuable when it is grounded in documented recruitment and validated measurements. The objective of this comparative observational study was to compare plasma MDA and TAC and erythrocyte SOD and GPx activities between adult Vitamin E users and non-users at K H Patil Institute of Medical Sciences, Gadag, Karnataka, India. A secondary objective was to describe demographic and clinical characteristics relevant to interpretation of the between-group differences.

MATERIALS AND METHODS

Study design, setting, and period

This comparative observational study was conducted at K H Patil Institute of Medical Sciences, Gadag, Karnataka, India, from June 2025 to March 2026. A total of 50 adults were included and divided into two groups: 25 Vitamin E users and 25 non-users. Biomarker assessment was performed at a single time point; therefore, longitudinal follow-up and evaluation of changes from pretreatment or baseline values were not undertaken. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[9]

Participants and study size

The study population comprised adults classified according to their existing Vitamin E use. A total of 50 participants were included, with 25 Vitamin E users and 25 non-users.

Exposure and clinical variables

The primary exposure variable was Vitamin E use at the time of enrolment. Participants were classified into Vitamin E users and non-users based on their existing supplement-use status. Information on the dose, formulation, frequency, duration, and indication for Vitamin E supplementation was obtained from the participant history and available study records. Demographic and clinical variables included age, sex, body mass index, smoking status, alcohol use, relevant comorbidities, concomitant medications, dietary factors, and use of other antioxidant supplements. These variables were assessed because of their potential influence on oxidative stress and antioxidant biomarker levels and were considered as possible confounding factors in the comparison between the two groups.

Biomarker assessment and bias

Oxidative stress and antioxidant status were assessed using plasma malondialdehyde, total antioxidant capacity, erythrocyte superoxide dismutase activity, and glutathione peroxidase activity. Blood samples were collected using standardized procedures and processed according to the laboratory protocol. Malondialdehyde was expressed in $\mu\text{mol/L}$, total antioxidant capacity in mmol/L , and superoxide dismutase and glutathione peroxidase activities in U/g haemoglobin. To minimize measurement bias, identical sample collection, handling, processing, and assay procedures were applied to both Vitamin E users and non-users. Laboratory analyses were performed under uniform conditions using the same analytical methods. Potential selection and confounding biases were addressed by applying consistent participant assessment procedures and documenting relevant demographic, lifestyle, clinical, dietary, and medication-related variables that could influence oxidative stress biomarkers. As Vitamin E exposure was pre-existing and not randomly assigned, residual confounding could not be completely excluded.

Statistical analysis

Statistical analysis was performed using descriptive and inferential methods. Continuous variables were summarized as mean $\pm$ standard deviation (SD), while categorical variables were expressed as frequencies and percentages. Biomarker values were compared between Vitamin E users and non-users using Welch's independent-samples t test, which does not assume equal variances between groups. Between-group differences were reported as unadjusted mean differences with corresponding 95% confidence intervals (CIs). Percentage differences in mean biomarker concentrations or activities were additionally calculated to facilitate interpretation. All statistical tests were two-sided, and a p value <0.05 was considered statistically significant.

Ethical considerations

Necessary Permissions were obtained before starting the study.

RESULTS

Demographic characteristics

The study comprised 50 adults, with 25 in each exposure group. Mean age was 40.2 ± 10.4 years among Vitamin E users and 41.0 ± 9.8 years among non-users. Men constituted 52.0% and 56.0% of the respective groups. Mean body mass index was 25.2 ± 3.1 versus 25.6 ± 3.4 kg/m². Demographic characteristics are presented in Table 1.

Table 1. Demographic characteristics of study participants (N = 50)

Characteristic	Vitamin E users (n = 25)	Non-users (n = 25)
Age, years	40.2 ± 10.4	41.0 ± 9.8
Male, n (%)	13 (52.0)	14 (56.0)
Female, n (%)	12 (48.0)	11 (44.0)
Body mass index, kg/m ²	25.2 ± 3.1	25.6 ± 3.4

Note. Values are mean $\pm$ standard deviation or number (percentage).

Clinical characteristics

Current smoking was recorded for four users (16.0%) and five non-users (20.0%). Diabetes mellitus occurred in three (12.0%) and four (16.0%), while hypertension occurred in five (20.0%) and six (24.0%), respectively. These conditions are summarised in Table 2.

Table 2. Clinical characteristics of the study sample

Characteristic	Vitamin E users (n = 25)	Non-users (n = 25)
Current smoking, n (%)	4 (16.0)	5 (20.0)
Diabetes mellitus, n (%)	3 (12.0)	4 (16.0)
Hypertension, n (%)	5 (20.0)	6 (24.0)

Note. Clinical categories are not mutually exclusive.

Oxidative stress and antioxidant biomarkers

Mean plasma MDA was lower among users than non-users (2.80 ± 0.65 versus 4.10 ± 0.90 μ mol/L). Mean TAC was higher among users (1.42 ± 0.24 versus 1.08 ± 0.22 mmol/L). Erythrocyte SOD activity was $1,280 \pm 210$ versus $1,050 \pm 190$ U/g haemoglobin, and GPx activity was 48.6 ± 8.4 versus 39.2 ± 7.6 U/g haemoglobin. Biomarker summaries appear in Table 3.

Table 3. Oxidative stress and antioxidant biomarkers

Biomarker	Vitamin E users (n = 25)	Non-users (n = 25)
Plasma MDA, μ mol/L	2.80 ± 0.65	4.10 ± 0.90
Plasma TAC, mmol/L	1.42 ± 0.24	1.08 ± 0.22
Erythrocyte SOD, U/g Hb	$1,280 \pm 210$	$1,050 \pm 190$
Erythrocyte GPx, U/g Hb	48.6 ± 8.4	39.2 ± 7.6

Note. Values are mean $\pm$ standard deviation. MDA = malondialdehyde; TAC = total antioxidant capacity; SOD = superoxide dismutase; GPx = glutathione peroxidase; Hb = haemoglobin.

Unadjusted between-group comparisons

The unadjusted mean differences were -1.30 μ mol/L for MDA, 0.34 mmol/L for TAC, 230 U/g haemoglobin for SOD, and 9.4 U/g haemoglobin for GPx.

Table 4. Unadjusted differences calculated from summary values

Biomarker	Mean difference	95% confidence interval	p value
Plasma MDA, μ mol/L	-1.30	-1.75 to -0.85	<0.001
Plasma TAC, mmol/L	0.34	0.21 to 0.47	<0.001
Erythrocyte SOD, U/g Hb	230	116 to 344	<0.001
Erythrocyte GPx, U/g Hb	9.4	4.8 to 14.0	<0.001

Note. Differences represent Vitamin E users minus non-users, in the units shown. Confidence intervals and two-sided p values use Welch t methods with n = 25 per group. Calculations are approximate because summaries are rounded. Comparisons are exploratory and unadjusted for confounding or multiplicity.

Relative to the non-user group mean, MDA was 31.7% lower among users. TAC, SOD, and GPx means were 31.5%, 21.9%, and 24.0% higher, respectively.

DISCUSSION

The study shows lower MDA alongside higher TAC, SOD, and GPx values among Vitamin E users. The mean MDA difference was $-1.30 \mu\text{mol/L}$, equivalent to a 31.7% lower group mean relative to non-users. The corresponding differences for TAC, SOD, and GPx were 0.34 mmol/L , $230 \text{ U/g haemoglobin}$, and $9.4 \text{ U/g haemoglobin}$. These coherent directions provide an example of how oxidative injury and antioxidant defence can be discussed together.

The MDA pattern is biologically compatible with Vitamin E acting as a lipid-phase chain-breaking antioxidant.[2,3] However, mechanistic plausibility does not resolve confounding or prove that supplementation produced the difference. In a human supplementation study, Roberts and colleagues reported dose-dependent suppression of plasma F2-isoprostanes, illustrating that exposure intensity is relevant to an oxidative damage endpoint.[10] F2-isoprostanes and MDA measure different aspects of lipid oxidation, and their numerical results cannot be directly compared. Differences in baseline oxidative burden, treatment duration, and assay performance further restrict comparisons between studies.

Higher TAC in the user group suggests greater measured antioxidant capacity under the conditions of the unspecified assay. This result cannot be attributed exclusively to Vitamin E because plasma reducing activity reflects several constituents.[6] Similarly, higher erythrocyte SOD and GPx activities do not demonstrate direct enzyme induction. These enzymes occupy different positions in antioxidant defence, and their activities depend on biological and analytical conditions.[7,8] The absence of measured circulating alpha-tocopherol also prevents confirmation that the exposure categories corresponded to different biochemical Vitamin E status.

Biomarker differences should be distinguished from patient-important outcomes. In the Heart Outcomes Prevention Evaluation trial, Vitamin E did not reduce cardiovascular events among high-risk participants.[11] The Selenium and Vitamin E Cancer Prevention Trial reported increased prostate cancer risk in men allocated to Vitamin E supplementation.[12] A meta-analysis by Miller and colleagues raised concerns about all-cause mortality with high-dose supplementation.[13] A broader Cochrane review likewise found no basis for routine antioxidant supplementation to prevent mortality and identified potential harm with some agents.[14] These findings concern different populations and outcomes, but they demonstrate why favourable surrogate measurements cannot establish clinical benefit or justify supplementation recommendations.

CONCLUSION

Vitamin E users demonstrated lower plasma malondialdehyde levels and higher total antioxidant capacity, superoxide dismutase activity, and glutathione peroxidase activity compared with non-users. These findings suggest that Vitamin E use is associated with a more favourable oxidative stress and antioxidant biomarker profile in adults. The observed reduction in lipid peroxidation, together with higher antioxidant enzyme activity, is consistent with the established antioxidant role of Vitamin E.

REFERENCES

1. Sies H. Oxidative stress: a concept in redox biology and medicine. *Redox Biol.* 2015;4:180-3. doi: 10.1016/j.redox.2015.01.002. PMID: 25588755.
2. Traber MG, Atkinson J. Vitamin E, antioxidant and nothing more. *Free Radic Biol Med.* 2007;43(1):4-15. doi: 10.1016/j.freeradbiomed.2007.03.024. PMID: 17561088.
3. Niki E. Role of vitamin E as a lipid-soluble peroxy radical scavenger: in vitro and in vivo evidence. *Free Radic Biol Med.* 2014;66:3-12. doi: 10.1016/j.freeradbiomed.2013.03.022. PMID: 23557727.
4. Jiang Q. Natural forms of vitamin E: metabolism, antioxidant, and anti-inflammatory activities and their role in disease prevention and therapy. *Free Radic Biol Med.* 2014;72:76-90. doi: 10.1016/j.freeradbiomed.2014.03.035. PMID: 24704972.
5. Tsikas D. Assessment of lipid peroxidation by measuring malondialdehyde (MDA) and relatives in biological samples: Analytical and biological challenges. *Anal Biochem.* 2017;524:13-30. doi: 10.1016/j.ab.2016.10.021. PMID: 27789233.
6. Benzie IF, Strain JJ. The ferric reducing ability of plasma (FRAP) as a measure of "antioxidant power": the FRAP assay. *Anal Biochem.* 1996;239(1):70-6. doi: 10.1006/abio.1996.0292. PMID: 8660627.
7. McCord JM, Fridovich I. Superoxide dismutase. An enzymic function for erythrocyte hemoglobin (hemocuprein). *J Biol Chem.* 1969;244(22):6049-55. PMID: 5389100.
8. Paglia DE, Valentine WN. Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. *J Lab Clin Med.* 1967;70(1):158-69. PMID: 6066618.
9. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP, et al. The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med.* 2007;4(10):e296. doi: 10.1371/journal.pmed.0040296. PMID: 17941714.
10. Roberts LJ 2nd, Oates JA, Linton MF, Fazio S, Meador BP, Gross MD, et al. The relationship between dose of vitamin E and suppression of oxidative stress in humans. *Free Radic Biol Med.* 2007;43(10):1388-93. doi: 10.1016/j.freeradbiomed.2007.06.019. PMID: 17936185.

11. Heart Outcomes Prevention Evaluation Study Investigators, Yusuf S, Dagenais G, Pogue J, Bosch J, Sleight P. Vitamin E supplementation and cardiovascular events in high-risk patients. *N Engl J Med.* 2000;342(3):154-60. doi: 10.1056/NEJM200001203420302. PMID: 10639540.
12. Klein EA, Thompson IM, Tangen CM, Crowley JJ, Lucia MS, Goodman PJ, et al. Vitamin E and the risk of prostate cancer: the Selenium and Vitamin E Cancer Prevention Trial (SELECT). *JAMA.* 2011;306(14):1549-56. doi: 10.1001/jama.2011.1437. PMID: 21990298.
13. Miller ER 3rd, Pastor-Barriuso R, Dalal D, Riemersma RA, Appel LJ, Guallar E. Meta-analysis: high-dosage vitamin E supplementation may increase all-cause mortality. *Ann Intern Med.* 2005;142(1):37-46. doi: 10.7326/0003-4819-142-1-200501040-00110. PMID: 15537682.
14. Bjelakovic G, Nikolova D, Gluud LL, Simonetti RG, Gluud C. Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database Syst Rev.* 2012;2012(3):CD007176. doi: 10.1002/14651858.CD007176.pub2. PMID: 22419320.