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Relationship between Dementia and Oxidative Stress Among Elderly Men

Sherief A. Abdelghany*, Hala S. Sweed, Mohamed M. Mohamed, and Mohamed A. Alsadany
Department of Geriatrics and Gerontology, Faculty of Medicine, Ain Shams University, Cairo, Egypt
***Corresponding author:** Sherief A. Abdelghany,
Mobile: (+20) 01286172144, **Email:**sheshosport2020@gmail.com

ABSTRACT

Background: Dementia is a complex condition that affects the elderly and expands global health burdens. Numerous endogenous and external activities can result in the production of reactive oxygen and nitrogen species (RONS).
Goal: To evaluate the association between oxidative stress markers and dementia in elderly men.
Patients and Methods: A case-control study. Eighty males who were admitted to the Geriatrics and Gerontology Departments at Ain Shams University Hospitals as well as those who were recruited from the geriatric medicine outpatients' clinic were included in the study. The participants were split into two groups: a case group, which consisted of 40 adults with dementia, and a control group, which consisted of 40 participants without dementia. Participants underwent geriatric evaluations, and blood samples were obtained for measurement of oxidative stress blood levels as malondialdehyde (MDA), glutathione peroxidase enzyme (GPX), and total antioxidant capacity (TAC)
Results: MDA blood levels were significantly higher in the case group, while GPX and TAC bloodlevels were significantly lower in the case group. According to statistical analysis, GPX with a cutoff point of 83.2 or lower, TAC with a cutoff point of 20.9 or lower, and MDA with a cutoff point of >82.5; all had high specificity and sensitivity for detecting dementia cases.
Conclusion: Higher blood levels of MDA and lower blood levels of GPX and TAC in dementia cases compared to the control group indicate that oxidative stress plays a substantial role in the development of dementia.
Keywords: Antioxidants, Markers of oxidative stress, Dementia.

INTRODUCTION

A common geriatric condition, dementia affects individuals and families as well as the government in a significant social and economic way. Deterioration of memory and other cognitive skills that leads to the loss of independent function is how it is described [(1)]. Dementia is the main factor causing dependency and inability. The number of people with dementia is predicted to double in the next 30 years, and the socioeconomic burden of dementia will increase at the same time [(2)].

The phrase "oxidative stress" describes a situation where there is an imbalance between antioxidants and oxidants that favors the oxidants and results in molecular damage or a disruption of redox signaling and control [(3)]. Reactive oxygen species (ROS) formation in cells may be accelerated by environmental triggers like such as exposure to cigarette smoke, UV radiation, heavy metal ions, ozone, allergies, medications or poisons, pollution, pesticides, or insecticides [(4)]. Both endogenous and external sources can produce reactive oxygen and nitrogen species (RONS). Myeloperoxidase (MPO), nicotinamide adenine dinucleotide oxidase (NADPH) oxidase lipoxygenase and angiotensin II are examples of endogenous RONS. NADPH oxidase primarily produces superoxide anion [(5)].

Antioxidants are necessary for maintaining better health in order to reduce oxidative processes and the harmful effects of ROS [(6)]. Numerous antioxidants, including glutathione, vitamin A, alpha-lipoic acid, coenzyme Q, polyphenols, ascorbic acid, alpha-tocopherol, and beta carotenoids, as well as antioxidant enzymes, such as catalase, superoxide dismutase, glutathione peroxidases, glutathione reductases, and glutathione transferases, have been thoroughly investigated for the prevention and treatment of diseases processes [(7)]. Glutathione peroxidase (GPX), the main enzyme in the GSH antioxidant system, catalyzes the removal of oxidative stress byproducts such as lipid peroxidation indicators [(8)].

The serum's overall antioxidant capacity is increased by a balanced diet that includes plenty of fruits and vegetables (TAC). Research demonstrating that following the Mediterranean diet was favorably connected to TAC levels and negatively related to the oxidation of the atherogenic LDL- cholesterol highlighted similar issues [(9)].

Arachidonic acid's major metabolite, MDA, serves as a reliable biomarker for oxidative stress. MDA is a three-carbon dialdehyde that is produced by the metabolism of arachidonic acid and polyunsaturated fatty acids. It is extremely reactive, mutagenic, and tumorigenic. The central nervous system is vulnerable to lipid peroxidation because of its high oxygen demand and high content of polyunsaturated fatty acids [(10)].

The study's goal was to evaluate the association between blood levels of oxidative stress indicators and dementia in elderly men.

PATIENTS AND METHODS

Study design and Sample size:

This was a case-control study. Eighty men participated in the study; they were split into two groups: the case group and the control group**.**

Study Setting and period:

Participants in the study were chosen from the inpatient ward and outpatient clinic of the geriatric medicine facility at Ain Shams University Hospital in

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Cairo, Egypt. The study began in June 2021, and it was completed in December 2021.

Study population:

Older male volunteers were split into two groups:

(A) The case group consisted of 40 older participants who had dementia (with its different stages). The Arabic version [(11)] of the Mini-Mental State Examination was initially used for dementia screening. [(12)], then making a dementia diagnosis that is in line with Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-V criteria) [(13)]. (b) Control group: forty older participants who, following cognitive testing, did not have dementia were included.

Inclusion criteria: were elderly men, 60 years and older, who accepted to participate in the study and gave an informed consent by the participants themselves or their caregivers.

Exclusion Criteria: included (1) patients with acute severe medical illness (e.g., uncontrolled hypothyroidism or hyperthyroidism, autoimmune disorders, sepsis, drug overdose, severely disrupted liver/kidney/lung /cardiac function, and acute stroke), (2) patients with delirium, (3) patients with history of major psychiatric condition including schizophrenia, bipolar disorder, and depression, or on regular use of antidepressants or antipsychotics, (4) patients with history of brain tumor or other cancers, and (5) Those who were taking antioxidants supplements.

Study Tools:

All the study participants were subjected to:

(1) Complete geriatric evaluation, comprising demographic information, relevant past medical history, drug history, and thorough physical examination, including a neurological examination. multiple co-morbidities present if there were two or more chronic illnesses multiple co-morbidities. More than five prescriptions in one month were considered polypharmacy.

(2) Cognitive evaluation: The Arabic version [(11)] of the Mini Mental State Examination (MMSE) [(12)] was used first to screen for dementia before DSM-V criteria were used to confirm the diagnosis [(13)]. The MMSE score was then adjusted for both education level and age [(14)].

(3) Depression screening utilizing the Patient Health Questionnaire 2 (PHQ-2) for the control group [(15)] and the Cornell scale [(16)] for individuals with dementia.

(4) Functional evaluation utilizing the Activities of Daily Living Scale (ADL)[(17)] and the Instrumental Activities of Daily Living Scale (IADL) [(18)]

(5) Nutritional evaluation: using the Mini nutritional assessment (MNA) [(19)].

(6) Blood oxidative stress marker measurements: Glutathione peroxidase enzyme (GPX), malondialdehyde (MDA) as well as total antioxidant capacity (TAC).

All participants' venous blood was drawn at the Geriatric Medicine Hospital at Ain Shams University. After centrifugation, the samples were maintained in a refrigerator at -20°C.

Ethical considerations:

The patient or the patient's legal guardian was the study's intended audience. Data confidentiality was guaranteed, and only the primary researcher gets access to examine a patient's medical records. The Academic and Ethical Committee of Ain Shams University approved the project. Each patient or his caregiver signed a written informed consent form to agree to participate in the study. The Declaration of Helsinki, the code of ethics of the World Medical Association was followed when conducting this research on humans.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS) version 22 for Windows (IBM SPSS Inc, Chicago, IL, USA) was used to code, process, and analyze the obtained data. All quantitative variables' data were described using the mean, standard deviation (SD), and range. For each qualitative variable, frequency and percentage calculations were made. To compare two groups, the t-test was used to compare quantitative data. When necessary, the Chi-square test or Fisher's exact test was used to compare qualitative variables. P value < 0.05 was considered significant and <0.01 was considered highly significant.

RESULTS

Results revealed no statistically significant variations in age, body mass index, education level, marital status, occupation, income, or specific medical habits between cases and controls. Most of the participants (cases and control) were uneducated, married, retired/not employed, had just a little income, smokers, and were not depressed.

Cases showed a significantly lower functional level in the IADL evaluation and a statistically significant positive family history of dementia (p-value = 0.001). ADL, MNA, prior medical history, medication history, and other medical/clinical factors did not significantly differ between cases and controls. The majority of cases were in a moderate stage of dementia (37.5%), and the majority of them were of mixed-type dementia (40%), followed by cases of Alzheimer's type (37.5%). The majority of dementia cases evaluated by Cornell did not have depression (57.5%).

Total antioxidant capacity (TAC) and glutathione peroxides enzyme (GPX) blood levels were both considerably higher in the control group compared to cases, while malondialdehyde (MDA) blood levels were significantly higher in cases compared to control group (Table 1)

Table (1): Oxidative stress markers among studied groups

		Control group	Cases group	Test value•	P-value	Sig.
		No. = 40	No. = 40			
Glutathione peroxidase enzyme (GPX) (mU/ml)	Mean±SD	141.39 ± 18.23	50.82 ± 12.31	25.174	<0.001	**HS**
Total antioxidant capacity (TAC) (mM/L)	Mean±SD	32.44 ± 7.13	15.76 ± 3.40	10.130	<0.001	**HS**
Malondialdehyde (MDA) (nmol/ml)	Mean±SD	48.83 ± 11.61	162.27 ± 38.51	-13.845	<0.001	**HS**

HS: highly significant; •: Independent t-test.

According to the ROC curve of oxidative stress markers, GPX at cutoff point of 83.2, TAC at cutoff point of 20.9, and MDA at cutoff point >82.5 had good specificity and sensitivity to identify dementia cases (Table 2 and figure 1)

Table (2): Diagnostic performance of the studied markers in diagnosing dementia

Parameter	AUC	Cut of Point	Sensitivity	Specificity	PPV	NPV
Glutathione peroxidase enzyme (GPX) (mU/ml)	1.000	≤83.2	100.0	100.0	100.0	100.0
Total antioxidant capacity (TAC) (mM/L)	0.976	≤20.9	85.0	100.0	100.0	87.0
Malondialdehyde (MDA) (nmol/ml)	0.998	>82.5	100.0	95.0	95.2	100.0

AUC=Area under the curve, **PPV=** Positive predictive value, **NPV=** Negative predictive value, **mU/ml:** milliunits/milliliter, **mM/L:** millimolar /liter, **nmol/ml:** Nanomole/milliliter.

As the greatest levels were seen in participants who were obese (mean ± SD= 59.30 ± 8.47), GPX blood levels demonstrated a significant correlation with increases in body mass index. Additionally, extremely significant correlations between GPX blood level and each of the following were found: the severity of dementia, polypharmacy, and the presence of comorbidities (Table 3).

Table (3): GPX blood level in relation to some demographic and clinical data

		Glutathione peroxidase enzyme blood level (mU/ml)		Test value••	P-value	Sig.
		Mean ± SD	Range			
Age (years)	Age (60 - 69)	53.92 ± 12.83	30.8 – 68.2	1.046	0.384	NS
	Age (70 - 79)	48.18 ± 11.08	31.6 – 83.2			
	Age (80 - 89)	54.60 ± 13.33	37.5 – 68.9			
	Age (90 - 99)	35.60 ± 0.00	35.6 – 35.6			
Body mass index (Kg/m^2)	Underweight	47.36 ± 11.12	31.6 – 68.9	3.461	**0.026**	**S**
	Normal	56.03 ± 13.61	32.6 – 83.2			
	Overweight	41.43 ± 6.89	30.8 – 48.6			
	Obese	59.30 ± 8.47	49.6 – 65.2			
Occupation	Business work	38.45 ± 9.24	30.8 – 46.1	1.072	0.373	NS
	Profession work	52.60 ± 11.30	42.1 – 66.8			
	Employee	40.20 ± 7.92	34.6 – 45.8			
	Not working or retired	52.02 ± 13.07	31.6 – 83.2			
Special habits	Non-smoker	56.89 ± 13.57	32.6 – 83.2	2.631	0.065	NS
	Smoker	50.79 ± 12.21	32.6 – 68.9			
	Ex-smoker	42.64 ± 10.03	30.8 – 64.5			
	Alcoholic	42.10 ± 0.00	42.1 – 42.1			
Past medical history	No	45.04 ± 9.84	42.1 – 68.2	3.507••	**0.005**	**HS**
	DM	43.25 ± 5.48	34.6 – 49.6			
	HTN	56.72 ± 13.31	30.8 – 83.2			
	CVD	37.50 ± 6.93	32.6 – 42.4			
	CLD	36.80 ± 2.97	34.7 – 38.9			
	COPD or BA	32.60 ± 0.00	32.6 – 32.6			
	Malignancy	38.70 ± 9.04	31.6 – 45.8			
	Psychiatric illness	64.50 ± 0.00	64.5 – 64.5			
	Neurological ds	39.20 ± 0.00	39.2 – 39.2			
	Multiple ds (2 or more)	59.57 ± 11.20	37.5 – 68.9			
Polypharmacy (≥ 5 medications)		57.64 ± 12.17	37.5 – 68.9	6.888•	**0.003**	**HS**
Dementia Severity	Mild MMSE (21-24)	61.25 ± 12.76	32.60 – 83.20	7.571••	**0.002**	**HS**
	Moderate MMSE (10-20)	46.01 ± 11.28	30.80 – 65.70			
	Severe MMSE below 10	45.54 ± 11.25	31.60 – 65.10			
Types of dementia	Mixed dementia	45.27 ± 9.49	30.8 – 65.7	2.661••	0.063	NS
	Alzheimer	56.99 ± 13.21	32.6 – 83.2			
	Vascular	52.26 ± 12.80	31.6 – 68.9			
	Frontotemporal	35.60 ± 0.00	35.6 – 35.6			
Depression severity	No depression	53.78 ± 13.12	31.6 – 83.2	2.046••	0.125	NS
	Mild to moderate	40.81 ± 7.16	30.8 – 48.6			
	Severe	50.03 ± 11.55	37.5 – 63.1			
MNA	Well-nourished	54.84 ± 13.11	32.6 – 83.2	1.632••	0.209	NS
	Risk of malnutrition	47.03 ± 10.92	30.8 – 65.2			
	Malnourished	47.36 ± 10.66	31.6 – 68.9			

NS: Non-significant; **S:** Significant; **HS:** Highly significant; **•:**Independent t-test; **••**: One Way ANOVA test. **MMSE=** mini-mental state of examination. **HTN=** Hypertension, **DM=**Diabetes mellitus, **HF=** Heart failure, **CVD=** Cardiovascular disease; **CLD=** Chronic liver diseases, **COPD=** Chronic obstructive pulmonary disease, **BA=** Bronchial asthma, **ds:** Diseases**; MNA=** Mini nutritional assessment.

Additionally, there was a significant correlation between MDA blood levels and depression severity,with MDA levels being greater in cases with mild to moderate depression (Table 4).

Table (4): Assessment of MDA blood level in relation to some demographic and clinical data

		Malondialdehyde blood level (nmol/ml)		Test value••	P-value	Sig.
		Mean ± SD	Range			
Age (years)	Age (60 - 69)	153.75 ± 37.24	87.6 – 219.5	0.450	0.719	NS
	Age (70 - 79)	167.67 ± 40.13	84.1 – 235.2			
	Age (80 - 89)	159.34 ± 38.87	90.4 – 224.5			
	Age (90 - 99)	201.80 ± 0.00	201.8 – 201.8			
Body mass index (Kg/m^2)	Underweight	174.96 ± 42.19	95.3 – 224.5	1.574	0.213	NS
	Normal	148.22 ± 35.03	84.1 – 229.1			
	Overweight	183.22 ± 44.06	94.2 – 235.2			
	Obese	141.33 ± 19.70	124.3 – 162.9			
Occupation	Business work	185.45 ± 2.90	183.4 – 187.5	0.976	0.415	NS
	Profession work	149.40 ± 33.67	87.6 – 214.6			
	Employee	210.55 ± 12.66	201.6 – 219.5			
	Not working or retired	159.73 ± 38.52	84.1 – 235.2			
Special habits	Non-smoker	152.57 ± 35.14	84.1 – 235.2	0.883	0.459	NS
	Smoker	162.26 ± 38.39	87.6 – 224.5			
	Ex-smoker	180.57 ± 35.80	115.6 – 221.4			
	Alcoholic	124.80 ± 0.00	124.8 – 124.8			
Past medical history	No	140.26 ± 33.64	87.6 – 229.1	1.238••	0.310	NS
	DM	167.92 ± 38.66	84.1 – 219.5			
	HTN	164.08 ± 28.78	125.3 – 189.6			
	CVD	120.90 ± 3.11	118.7 – 123.1			
	CLD	203.10 ± 14.99	192.5 – 213.7			
	COPD or BA	235.20 ± 0.00	235.2 – 235.2			
	Malignancy	218.55 ± 4.03	215.7 – 221.4			
	Psychiatric illness	127.80 ± 0.00	127.8 – 127.8			
	Neurological ds	115.60 ± 0.00	115.6 – 115.6			
	Multiple ds (2 or more)	156.32 ± 35.24	95.3 – 224.5			
Polypharmacy (≥5 medications)		147.66 ± 33.88	95.3 – 224.5	1.439••	0.250	NS
Dementia severity	MMSE (21-24)	160.06 ± 33.50	87.60 – 229.10	0.161••	0.852	NS
	MMSE (10-20)	167.83 ± 32.79	84.10 – 235.20			
	MMSE below 10	157.70 ± 38.89	95.30 – 221.40			
Types of dementia	Mixed dementia	162.59 ± 39.12	84.1 – 214.6	0.477••	0.700	NS
	Alzheimer	153.89 ± 54.24	87.6 – 235.2			
	Vascular	172.39 ± 41.71	113.5 – 224.5			
	Frontotemporal	201.80 ± 0.00	201.8 – 201.8			
Depression severity	No depression	154.42 ± 33.05	84.1 – 229.1	3.281••	**0.032**	**S**
	Mild to moderate	186.04 ± 45.74	113.5 – 235.2			
	Severe	118.10 ± 17.60	95.3 – 137.2			
MNA	Well-nourished	163.35 ± 35.04	84.1 – 235.2	0.774••	0.469	NS
	Risk of malnutrition	148.85 ± 36.11	113.5 – 215.7			
	Malnourished	174.96 ± 41.19	95.3 – 224.5			

NS: Non-significant; **S:** Significant; **HS:** Highly significant; ••: One Way ANOVA test. **MMSE=** mini-mental state of examination. **HTN=** Hypertension, **DM=**Diabetes mellitus, **HF=** Heart failure, **CVD=** Cardiovascular disease; **CLD=** Chronic liver diseases, **COPD=** Chronic obstructive pulmonary disease, **BA=** Bronchial asthma, **ds:** Diseases**; MNA=** Mini nutritional assessment. **P-value >0.05:** Non-significant (NS); **P-value <0.05:** Significant (S); **P-value< 0.01:** Highly significant (HS), **••:** One Way ANOVA test; **HTN=** Hypertension, **DM=** Diabetes mellitus, **HF=** Heart failure, **CVD=** Cardiovascular disease; **CLD=** Chronic liver diseases, **COPD=** Chronic obstructive pulmonary disease, **BA=** Bronchial asthma, **MNA=** Mini nutritional assessment.

However, neither demographic nor clinical parameters including age, body mass index, occupation,peculiar habits, prior medical history, polypharmacy, dementia severity, types of dementia, depressionseverity, or findings of a mini-nutritional evaluation significantly impacted TAC blood levels.

DISCUSSION

The brain has a relatively high metabolic rate and weak antioxidant defenses, making it more susceptible to increasing ROS. The high concentration of polyunsaturated fatty acids (PUFAs) that is present in the brain's membrane-rich architecture causes oxidative damage to the brain to manifest primarily as lipid peroxidation. [20].

The aim of this study was to investigate the association between oxidative stress and dementia in elderly males. Three well-known oxidative stress markers were chosen to evaluate in the study participants' blood: glutathione peroxidase enzyme (GPX), total antioxidant capacity (TAC), and malondialdehyde (MDA).

In the GSH antioxidant system, glutathione peroxidase (GPX), the main enzyme, catalyzes the removal of oxidative stress byproducts such as lipid peroxidation indicators [8]. Malondialdehyde (MDA), is the primary metabolite of arachidonic acid and a good biomarker for oxidative stress [10], and total antioxidant capacity (TAC), is a measure of DNA oxidation brought on by the oxidation of DNA bases [21].

In terms of GPX blood levels, we found that these levels were much lower in males with dementia as compared to controls, indicating that the antioxidant system had not been able to eliminate the oxidative damage brought on by ROS. Although their subjects and methodologies were different from ours as they included participants with Alzheimer's disease, MCI, and healthy controls, but they also reported a significant decline in serum GPX activity among cases in comparison to controls, these previous studies as **Rinaldi *et al.*** [22], **Puertas *et al.*** [23], **Padurariu *et al.*** [24], and **Casado *et al.*** [25]. However, a different study by **Baldeiras *et al.*** [26] found that individuals with cognitive impairment had higher GPX enzyme activity. The discrepancy between our study and theirs can be attributed to the fact that their study only included MCI and AD patients with mild to moderate dementia and excluded individuals with later stages of the disease.

The highest levels of GPX were identified in participants who were obese, indicating that body mass index had a major impact on GPX blood levels. This result was contrary to **Rinaldi *etal.*** [22], who found no significant differences in body mass index between the selected groups, the discrepancy may be the result of selection criteria, as their study only included patients with MCI and Alzheimer's disease.

Furthermore, we discovered that GPX blood levels were highly impacted by dementia severity, which was at lower levels in those people with severe stages of dementia. This result came matched with **Torres *et al.*** [27] who demonstrated a positive association between MMSE scores and GPX blood levels, indicating that poorer antioxidant defenses are significantly connected with significantly worse cognitive function.

In our study, we discovered that MDA blood levels were considerably higher in dementia cases compared to controls. Findings from earlier research by **Casado *et al.*** [25] and **Torres *et al.*** [27] provided support for this. However, in other research, there was no significant difference in the blood levels of MDA between patients and controls. As an illustration, **Sekler *et al.*** [28] comprised 88 people with solely Alzheimer's disease; 32 of them were females, while the remaining participants were males, as opposed to 29 healthy control participants.

Our study found that major depressive disorder patients had blood levels of MDA that were significantly higher than those of healthy control subjects, in line with **Alvarez-Mon *et al.*** [29] and **Camkurt *et al.*** [30]. This suggests that depression is a significant risk factor for having high levels of oxidative stress in the blood and that lipid peroxidation markers like MDA may act as a biomarker for depression.

In our study, MDA blood level was not significantly affected by the severity of dementia using MMSE, which came matched with **Zafrilla *et al.*** [31], who divided their study into two groups of Alzheimer's disease according to its severity: mild to moderate and severe in comparison to control group. On the other hand, our findings were mismatched with **Torres *et al.*** [27], who found MMSE was negatively correlated with MDA blood levels, including twenty-nine participants aged 66–90 years with AD and thirty-three individuals aged 61–89 years with MCI, thus demonstrating that lower cognitive performance was associated with lower antioxidant defenses mechanisms.

According to our study, the blood level of MDA did not significantly differ between dementia cases of any type and the control group. This finding was in contrast to those of **Gustaw-Rothenberg *et al.*** [32], who discovered that MDA blood levels were significantly higher in vascular dementia patients than in AD patients, when compared to the control group. The selection criteria used in their study may have been different from those used in our study, which included patients of relatively younger ages and included both genders. This difference may also be the result of their study's relatively smaller sample size, as the control group in their study consisted of only 29 participants.

In our study, we discovered that elderly men with dementia had significantly lower TAC blood levels than the control group. This was in line with previous study **El-Edel *et al.*** [21], which included 90 participants divided into three groups: the patients' group, which consisted of 30 elderly patients aged 60 to 80; the control group, which consisted of 30 age-matched apparently healthy participants; and the pre-geriatric group, which consisted of 30 younger, apparently healthy participants aged 30 to 60.

Regarding TAC blood levels, our findings were consistent with those of some earlier studies,including **Sekler *et al.*** [28], **and Zafrilla *et al.*** [31], who both found

that patients with dementia of various stages (mild, moderate, and advanced disease) had lower TAC blood levels than control groups. This result supports the idea that dementia patients have a weak antioxidant system and are unable to handle oxidative stresses.

However, some earlier research, such **Pulido *et al.*** [33], and **Sinclair *et al.*** [34], did not find a significant difference between dementia cases and the control group regarding their blood TAC levels. The first study only included 20 AD patients and 22 controls of both genders, but the second study included a nearly equivalent number of participants. However, both researches included both genders, and the dementia cases in both studies were either AD or vascular dementia. Furthermore, unlike our study, which is a case-control study, **Sinclair *et al.*,** [34], study design was cross-sectional.

Finally, there were several strong points in our study. To our knowledge, it was the first study conducted in Egypt that focused on the crucial area of research examining the relationship between blood levels of oxidative stress markers and dementia in elderly men. Additionally, we eliminated significant medical diseases including delirium and psychiatric illnesses that would have affected our findings.
But our work had some limitations as participants were recruited from hospital setting either the outpatient clinic or the inpatient ward, in addition to the relatively small sample size that did not include other certain types of dementia such as dementia with Lewi bodies, and we did not include those subjects with mild cognitive impairment. So, we hope that future research is performed on subjects with MCI to assess the role of oxidative stress in early detection and prevention of progression of dementia.

CONCLUSION

Both blood levels of both glutathione peroxides enzyme (GPX) and total antioxidant capacity (TAC) were found significantly lower among patients with dementia compared to healthy subjects, while malondialdehyde (MDA) blood level was significantly higher. This means that oxidative stress plays a significant role in pathogenesis of dementia.

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