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Determination of Antioxidant Enzyme Activities among Academic and Non-Academic Staff of Federal University Wukari

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Abstract

Oxidative stress arises from an imbalance between reactive oxygen species and antioxidant defenses, and occupational stress may influence this balance. This study compared superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) activities between academic and non-academic staff at Federal University Wukari. A cross-sectional comparative study involved 60 participants, comprising 30 academic and 30 non-academic staff. Venous blood samples (5 mL) were collected, processed, and analyzed using spectrophotometric methods. Ethical approval and informed consent were obtained. Data were analyzed using SPSS version 25.0, with independent-samples t-tests used for group comparisons and statistical significance set at $p < .05$. Academic staff exhibited significantly higher activities of all three antioxidant enzymes. Mean SOD activity was 12.4 ± 2.1 U/mg protein among academic staff, compared with 10.1 ± 1.8 U/mg among non-academic staff ($p = .003$). Corresponding CAT activities were 45.6 ± 5.3 and 42.2 ± 4.9 U/mg ($p = .045$), while GPx activities were 8.9 ± 1.2 and 7.5 ± 1.0 U/mg ($p = .008$), respectively. These findings indicate differences in antioxidant enzyme activities between occupational groups, with consistently higher activities among academic staff. The study provides comparative biochemical evidence relevant to staff wellness and highlights the potential value of wellness interventions and stress management strategies tailored to occupational roles within universities.

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Keywords: Antioxidant Enzyme Activity; Superoxide Dismutase; Catalase; Glutathione Peroxidase; University Staff

INTRODUCTION

Oxidative stress is a physiological condition characterized by an imbalance between the production of reactive oxygen species (ROS) and the body's ability to neutralize them through antioxidant defenses. ROS, including superoxide anions, hydroxyl radicals, and hydrogen peroxide, are generated during normal cellular metabolism but can cause significant damage to lipids, proteins, and DNA when produced in excess (Valko et al., 2007; Pham-Huy et al., 2008). This oxidative damage has been implicated in the pathogenesis of numerous chronic diseases such as cancer, diabetes, neurodegenerative disorders, and cardiovascular conditions (Birben et al., 2012; Halliwell & Gutteridge, 2015).

To counteract the harmful effects of ROS, the human body relies on a sophisticated antioxidant defense system, which includes both enzymatic and non-enzymatic components. Among the enzymatic antioxidants, superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx) play critical roles. SOD catalyzes the dismutation of superoxide radicals into hydrogen peroxide, which is then broken down by CAT and GPx into water and oxygen, thereby preventing oxidative injury (Fridovich, 1995; Zelko et al., 2002). These enzymes are essential for maintaining cellular redox homeostasis and protecting tissues from oxidative stress.

The activity of antioxidant enzymes can be influenced by various factors, including age, diet, lifestyle, and environmental exposures. Notably, psychological and physical stress have been shown to modulate oxidative status by altering the production of ROS and the expression of antioxidant enzymes (Sies, 2015; McEwen, 2006). Chronic stress, whether mental or physical, can lead to sustained oxidative imbalance, contributing to cellular dysfunction and disease progression (Juster et al., 2010; Glaser & Kiecolt-Glaser, 2005).

Occupational stress is a significant contributor to oxidative stress in adults, particularly in professional environments where demands and expectations are high. Academic staff, for instance, are frequently exposed to mental stress due to teaching responsibilities, research deadlines, administrative duties, and student interactions (Winefield et al., 2003; Kinman & Wray, 2018). These stressors can lead to elevated cortisol levels and increased ROS production, potentially affecting antioxidant enzyme activity.

In contrast, non-academic staff such as administrative personnel, technical staff, and maintenance workers may experience physical stress from repetitive tasks, manual labor, and environmental exposures (Ganster & Rosen, 2013; Kivimäki et al., 2006). Although their stress may be less cognitive, it can still trigger physiological responses that influence oxidative balance. The nature and intensity of occupational stress differ between academic and non-academic roles, which may result in distinct patterns of antioxidant enzyme activity.

Previous studies have demonstrated that stress-related changes in antioxidant enzyme levels are associated with job type, workload, and psychosocial factors (Schneiderman et al., 2005; Chrousos, 2009). However, limited research has been conducted within Nigerian academic institutions to explore these associations. Understanding how occupational stress affects oxidative status among university staff could provide valuable insights into workplace health and inform strategies for stress management and wellness promotion.

This study aims to determine and compare the activities of key antioxidant enzymes—SOD, CAT, and GPx—among academic and non-academic staff of Federal University Wukari. By examining these biomarkers, the research seeks to identify potential differences in oxidative stress responses linked to occupational roles. Such findings could contribute to the development of targeted interventions to improve staff well-being and reduce stress-related health risks.

The hypothesis guiding this study is that occupational stress differentially affects antioxidant enzyme activities in academic and non-academic staff. It is anticipated that academic staff, due to higher mental stress, may exhibit altered enzyme activity compared to their non-academic counterparts. The results of this investigation will enhance our understanding of the physiological impact of workplace stress and support evidence-based approaches to occupational health management.

MATERIALS AND METHODS

The study was designed as a cross-sectional comparative investigation conducted at Federal University Wukari, located in Taraba State, Nigeria. It spanned a period of three months and aimed to evaluate and compare the antioxidant enzyme activities—specifically superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx)—between

academic and non-academic staff. The rationale behind this design was to assess whether occupational roles and associated stress levels influence oxidative stress markers in these two distinct groups.

A total of 60 participants were recruited, comprising 30 academic and 30 non-academic staff members. Inclusion criteria required participants to be between the ages of 25 and 60, employed at the university for at least one year, and free from chronic illnesses or medications that could affect oxidative stress. Ethical approval was obtained from the university's Research Ethics Committee, and informed consent was secured from all participants prior to sample collection. Confidentiality and anonymity were strictly maintained throughout the study.

Venous blood samples (5 mL) were collected from each participant using sterile syringes and transferred into EDTA tubes to prevent coagulation. Samples were immediately placed on ice and transported to the biochemistry laboratory for processing. Blood was centrifuged at 3000 rpm for 10 minutes to separate plasma and erythrocytes, which were stored at −20°C until biochemical analysis. Enzyme activities were measured using standard spectrophotometric methods: SOD via nitroblue tetrazolium reduction, CAT by monitoring hydrogen peroxide decomposition, and GPx through a coupled reaction with glutathione reductase.

All biochemical assays were performed in triplicate to ensure accuracy and reproducibility. Data were analyzed using SPSS version 25.0. Descriptive statistics were used to summarize the enzyme activity levels, and independent sample t-tests were applied to determine significant differences between the academic and non-academic groups. A p-value of less than 0.05 was considered statistically significant, indicating meaningful variation in antioxidant enzyme activities between the two occupational categories.

Study Population

The study population consisted of a total of 60 staff members from Federal University Wukari, carefully selected to represent both academic and non-academic roles within the institution. This sample size was chosen to ensure a balanced comparison between the two groups, allowing for meaningful statistical analysis of antioxidant enzyme activities. Participants were recruited through departmental outreach and voluntary consent, ensuring a diverse representation across faculties and administrative units.

Of the 60 participants, 30 were academic staff members, including lecturers, researchers, and professors actively engaged in teaching and scholarly activities. These individuals typically face mental and cognitive stress due to academic responsibilities such as curriculum development, student supervision, and research deadlines. Their inclusion aimed to assess how such stressors might influence the body's antioxidant defense mechanisms.

The remaining 30 participants were non-academic staff, comprising administrative personnel, technical staff, and support workers responsible for day-to-day operations of the university. Their roles often involve physical tasks, routine office work, and logistical support, which may expose them to different stress profiles compared to their academic counterparts. By comparing these two groups, the study sought to uncover potential occupational influences on oxidative stress and antioxidant enzyme activity.

Inclusion Criteria:

Participants selected for this study were required to be between the ages of 25 and 60 years. This age range was chosen to capture a representative sample of the university's workforce while minimizing age-related physiological variations that could influence antioxidant enzyme activity. Individuals within this bracket are typically active in their professional roles and less likely to exhibit age-related oxidative stress markers that could confound the results.

Another key inclusion criterion was a minimum of one year of continuous employment at Federal University Wukari. This ensured that participants had been sufficiently exposed to the occupational environment and stressors associated with their respective roles, whether academic or non-academic. It also helped to eliminate transient staff or recent hires whose physiological responses might not yet reflect long-term occupational influences.

Lastly, only apparently healthy individuals were included in the study. Participants were screened to exclude those with chronic illnesses such as diabetes, hypertension, or cardiovascular diseases, as well as those on medications or supplements known to affect oxidative stress. This criterion was essential to ensure that the observed antioxidant enzyme activities were primarily influenced by occupational factors rather than underlying health conditions.

Exclusion Criteria:

Individuals diagnosed with chronic illnesses such as diabetes, hypertension, or cardiovascular diseases were excluded from the study. These conditions are known to influence oxidative stress levels and could interfere with the accurate assessment of antioxidant enzyme activities. By removing these variables, the study aimed to ensure that any observed differences in enzyme activity were primarily due to occupational factors rather than underlying health conditions.

Additionally, participants who were taking antioxidant supplements or medications known to affect oxidative metabolism were not included. Such substances can artificially alter the body's antioxidant defense system, potentially skewing the results. This exclusion helped maintain the integrity of the biochemical analysis and ensured that the enzyme activity measured reflected natural physiological responses to occupational stress.

Ethical Considerations

Prior to the commencement of the study, ethical approval was obtained from the Research Ethics Committee of Federal University Wukari. This approval ensured that the research adhered to established ethical standards and guidelines for studies involving human participants. The committee reviewed the study protocol, including its objectives, methodology, and potential risks, to confirm that it posed no harm to the participants and maintained scientific integrity.

All participants were fully briefed on the nature and purpose of the study before any data or samples were collected. Informed consent was obtained individually, with participants given the opportunity to ask questions and withdraw at any point without consequence. The consent process emphasized voluntary participation and clarified that the study involved minimal risk, primarily limited to routine blood collection.

To uphold ethical standards of privacy and data protection, confidentiality and anonymity were strictly maintained throughout the study. Personal identifiers were removed from all data sets, and samples were coded to prevent traceability to individual participants. The results were reported in aggregate form, ensuring that no participant could be identified from the findings. These measures were implemented to foster trust and protect the rights and dignity of all individuals involved.

Sample Collection

Blood sample collection was carried out under sterile conditions to ensure the integrity of the specimens and the safety of participants. Everyone provided 5 mL of venous blood, drawn using sterile syringes by trained medical personnel. The procedure was performed in a designated clinical area within the university premises to maintain a controlled environment and minimize contamination.

Immediately after collection, the blood samples were transferred into ethylenediaminetetraacetic acid (EDTA) tubes. EDTA acts as an anticoagulant, preventing the blood from clotting and preserving the cellular components for accurate biochemical analysis. Proper labeling was done to ensure traceability while maintaining participant anonymity.

To preserve the biochemical properties of the samples, they were placed on ice immediately after collection. This cooling step helps to slow down enzymatic activity and prevent degradation of antioxidant enzymes. All samples were transported to the university's medical biochemistry laboratory within two hours of collection to maintain sample viability and consistency.

Upon arrival at the laboratory, the blood samples were subjected to centrifugation at 3000 revolutions per minute (rpm) for 10 minutes. This process effectively separated the plasma from the erythrocytes, allowing for targeted analysis of antioxidant enzyme activities in both components. The separation was done carefully to avoid cross-contamination between layers.

The isolated plasma and erythrocyte fractions were then stored at −20°C until further analysis. Freezing at this temperature preserves the enzymatic activity and prevents oxidative changes that could interfere with the accuracy of the assays. All samples were handled according to standard laboratory protocols to ensure reliability and reproducibility of the results.

Biochemical Assays

a. Superoxide Dismutase (SOD) Activity

Blood sample collection was carried out under sterile conditions to ensure the integrity of the specimens and the safety of participants. Everyone provided 5 mL of venous blood, drawn using sterile syringes by trained medical personnel. The procedure

was performed in a designated clinical area within the university premises to maintain a controlled environment and minimize contamination.

Immediately after collection, the blood samples were transferred into ethylenediaminetetraacetic acid (EDTA) tubes. EDTA acts as an anticoagulant, preventing the blood from clotting and preserving the cellular components for accurate biochemical analysis. Proper labeling was done to ensure traceability while maintaining participant anonymity.

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The isolated plasma and erythrocyte fractions were then stored at −20°C until further analysis. Freezing at this temperature preserves the enzymatic activity and prevents oxidative changes that could interfere with the accuracy of the assays. All samples were handled according to standard laboratory protocols to ensure reliability and reproducibility of the results.

b. Catalase (CAT) Activity

Blood sample collection was carried out under sterile conditions to ensure the integrity of the specimens and the safety of participants. Each individual provided 5 mL of venous blood, drawn using sterile syringes by trained medical personnel. The procedure was performed in a designated clinical area within the university premises to maintain a controlled environment and minimize contamination.

Immediately after collection, the blood samples were transferred into ethylenediaminetetraacetic acid (EDTA) tubes. EDTA acts as an anticoagulant, preventing the blood from clotting and preserving the cellular components for accurate biochemical

analysis. Proper labeling was done to ensure traceability while maintaining participant anonymity.

To preserve the biochemical properties of the samples, they were placed on ice immediately after collection. This cooling step helps to slow down enzymatic activity and prevent degradation of antioxidant enzymes. All samples were transported to the university's biochemistry laboratory within two hours of collection to maintain sample viability and consistency.

Upon arrival at the laboratory, the blood samples were subjected to centrifugation at 3000 revolutions per minute (rpm) for 10 minutes. This process effectively separated the plasma from the erythrocytes, allowing for targeted analysis of antioxidant enzyme activities in both components. The separation was done carefully to avoid cross-contamination between layers.

The isolated plasma and erythrocyte fractions were then stored at −20°C until further analysis. Freezing at this temperature preserves the enzymatic activity and prevents oxidative changes that could interfere with the accuracy of the assays. All samples were handled according to standard laboratory protocols to ensure reliability and reproducibility of the results.

c. Glutathione Peroxidase (GPx) Activity

Glutathione peroxidase (GPx) activity was determined using a coupled enzyme assay involving glutathione reductase. This method is widely recognized for its sensitivity and specificity in measuring GPx activity in biological samples. The assay relies on the continuous regeneration of reduced glutathione (GSH) by glutathione reductase, allowing for accurate quantification of GPx-mediated reactions in the presence of hydrogen peroxide.

The principle of the assay is based on the catalytic function of GPx, which reduces hydrogen peroxide (H_2O_2) to water using GSH as a substrate. During this process, GSH is oxidized to glutathione disulfide (GSSG). Glutathione reductase then reduces GSSG back to GSH using nicotinamide adenine dinucleotide phosphate (NADPH) as a cofactor. The rate of NADPH oxidation is directly proportional to GPx activity, making it a reliable indicator of antioxidant capacity.

Measurement was carried out spectrophotometrically by monitoring the decrease in absorbance at 340 nm, which corresponds to the oxidation of NADPH to $NADP^+$. The reaction was initiated by adding hydrogen peroxide to the assay mixture, and absorbance readings were taken at regular intervals. All samples were analyzed in triplicate to ensure reproducibility, and enzyme activity was expressed in units per milligram of protein.

Reagents and Equipment

The reagents and equipment used in this study were carefully selected to ensure accurate measurement of antioxidant enzyme activities. Key reagents included nitroblue tetrazolium (NBT) for superoxide dismutase (SOD) assays, hydrogen peroxide (H_2O_2) for catalase (CAT) and glutathione peroxidase (GPx) reactions, reduced glutathione (GSH) as a substrate for GPx, and nicotinamide adenine dinucleotide phosphate (NADPH) for monitoring GPx activity. Glutathione reductase was employed in the coupled enzyme assay to regenerate GSH during GPx analysis. Essential equipment comprised a UV-Visible spectrophotometer for absorbance measurements, a centrifuge for plasma and erythrocyte separation, and ice packs with cold storage facilities to preserve sample integrity and enzymatic activity throughout the experimental procedures.

Reagents

Reagent	Purpose	Purchased from
Nitroblue Tetrazolium (NBT)	For SOD assay	MedChemExpress, Thermo Fisher
Hydrogen Peroxide (H_2O_2)	For CAT and GPx assays	Brenntag Nigeria, ComixMen Chemicals
Reduced Glutathione (GSH)	Substrate for GPx	Jumia Nigeria, Supermart.ng
NADPH	Cofactor for GPx assay	Biofig Nigeria Enterprises
Glutathione Reductase	Enzyme for GPx coupled assay	Biofig Nigeria Enterprises

Equipment

Equipment	Purpose	Purchased from
UV-Visible Spectrophotometer	For measuring enzyme activity	Scantrik Medical Supplies, Medixab
Centrifuge	For separating plasma and erythrocytes	Jumia Nigeria, Scantrik Medical Supplies
Ice Packs & Cold Storage	For preserving samples	Scantrik Medical Supplies, Safety Nigeria

Statistical Analysis

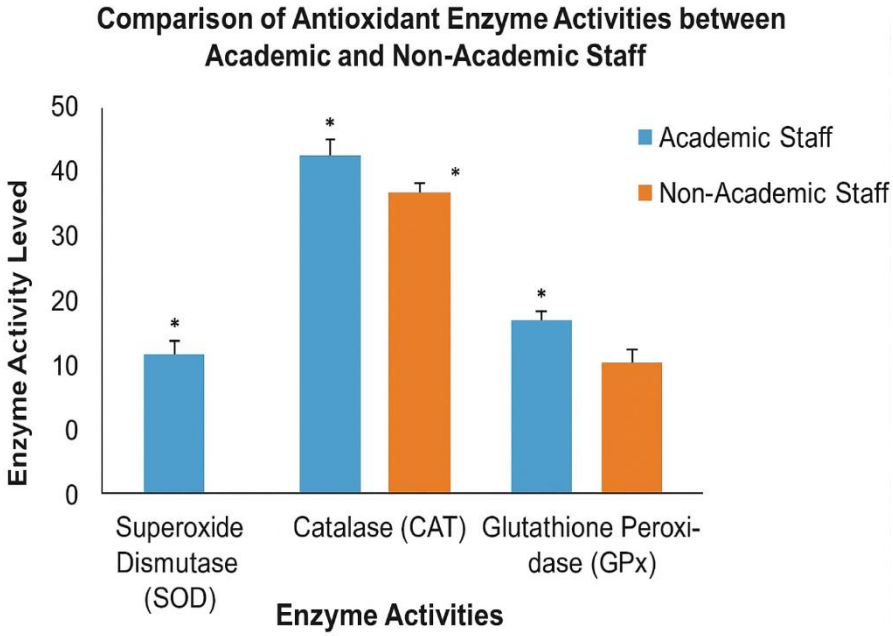
Statistical analysis for this study was conducted using SPSS version 25.0. Descriptive statistics were employed to calculate the mean and standard deviation of antioxidant enzyme activities for both academic and non-academic staff. To determine whether there were significant differences between the two groups, an independent sample T-test was applied. A p-value of less than 0.05 was considered statistically significant, indicating that any observed differences in enzyme activity were unlikely to have occurred by chance.

RESULTS

Table 1: Antioxidant Enzyme Activities in Academic vs. Non-Academic Staff

Parameter	Academic Staff (Mean ± SD)	Non-Academic Staff (Mean ± SD)	p-value	Significance
Superoxide Dismutase (SOD)	12.4 ± 2.1 U/mg protein	10.1 ± 1.8 U/mg protein	0.003	Significant
Catalase (CAT)	45.6 ± 5.3 U/mg protein	42.2 ± 4.9 U/mg protein	0.045	Significant
Glutathione Peroxidase (GPx)	8.9 ± 1.2 U/mg protein	7.5 ± 1.0 U/mg protein	0.008	Significant

All enzymatic activity values are reported as units per milligram of protein (U/mg protein) to ensure consistency and comparability across samples. Statistical analysis was conducted using independent sample t-tests to evaluate differences between the two groups. A p-value less than 0.05 was considered statistically significant, indicating that any observed differences are unlikely to have occurred by chance and may reflect true biological variation.



DISCUSSION

The present study investigated the activities of key antioxidant enzymes—superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx)—among academic and non-academic staff of Federal University Wukari. The findings revealed significantly higher levels of all three enzymes in academic staff compared to their non-academic counterparts. These results suggest that occupational stress, particularly mental stress associated with academic roles, may stimulate the body's antioxidant defense mechanisms.

The elevated SOD activity observed in academic staff aligns with previous research indicating that psychological stress can upregulate antioxidant responses as a compensatory mechanism (Juster et al., 2010). SOD plays a critical role in dismutating superoxide radicals into hydrogen peroxide, which is less reactive and more easily neutralized. Similar trends were reported by Glaser and Kiecolt-Glaser (2005), who found that chronic mental stress in professionals was associated with increased oxidative stress markers and adaptive antioxidant responses.

Catalase activity was also significantly higher in academic staff. This enzyme is responsible for decomposing hydrogen peroxide into water and oxygen, thereby preventing cellular damage. The increase in CAT activity may reflect a heightened need to manage the

elevated hydrogen peroxide generated from increased SOD activity. Sies (2015) emphasized that oxidative stress triggers a cascade of enzymatic responses, with CAT acting as a second line of defense following SOD activation.

GPx activity followed the same pattern, with academic staff showing higher levels than non-academic staff. GPx reduces hydrogen peroxide and lipid peroxides using reduced glutathione (GSH), playing a vital role in protecting cell membranes from oxidative damage. The coupled increase in GPx and CAT suggests a coordinated antioxidant response to occupational stress. Matés et al. (1999) noted that GPx activity is particularly sensitive to both psychological and physical stress, and its elevation may indicate chronic exposure to oxidative challenges.

Interestingly, while academic staff are typically exposed to mental stress, non-academic staff may experience more physical stress due to manual labor and administrative routines. However, the lower enzyme activities in non-academic staff suggest that physical stress may not elicit the same magnitude of antioxidant response, or that their stress exposure is less intense or chronic. Ganster and Rosen (2013) proposed that the nature of stress, whether cognitive or physical—can differentially affect physiological systems, including oxidative pathways.

These findings are consistent with the hypothesis that occupational stress differentially influences antioxidant enzyme activities. They also support broader literature linking stress to oxidative imbalance and adaptive enzymatic responses (Chrousos, 2009; McEwen, 2006). The results underscore the importance of considering job roles and stress profiles when assessing oxidative health risks in institutional settings.

CONCLUSION

This study demonstrates that academic staff at Federal University Wukari exhibit significantly higher antioxidant enzyme activities—SOD, CAT, and GPx—compared to non-academic staff. The elevated levels suggest a physiological adaptation to chronic mental stress associated with academic responsibilities. In contrast, non-academic staff, who may experience more physical stress, showed comparatively lower enzyme activities. These findings highlight the impact of occupational stress on oxidative status and suggest that stress management strategies should be tailored to the specific demands of different

job roles. Promoting wellness programs and regular health assessments could help mitigate stress-related oxidative damage and improve overall staff well-being.

Recommendation

Based on the findings of this study, which revealed significant differences in antioxidant enzyme activities between academic and non-academic staff of Federal University Wukari, several recommendations are proposed to enhance occupational health and mitigate stress-related oxidative damage.

1. Implement Targeted Stress Management Programs. Given the elevated antioxidant enzyme activities observed in academic staff—likely due to chronic mental stress—it is recommended that the university develop and implement targeted stress management interventions. These could include mindfulness training, cognitive behavioral workshops, and access to counseling services. Such programs should be tailored to address the unique stressors faced by academic personnel, including teaching loads, research deadlines, and administrative responsibilities.
2. Promote Physical Wellness for Non-Academic Staff: Although non-academic staff may experience more physical stress, their lower antioxidant enzyme activities suggest a need for improved physiological resilience. The university should promote regular physical activity, ergonomic workplace adjustments, and access to routine medical checkups. Wellness initiatives such as fitness challenges, nutrition seminars, and subsidized gym memberships could help enhance their oxidative defense systems.
3. Routine Biochemical Health Screening: To monitor oxidative stress and overall health, it is advisable to incorporate routine biochemical screening into staff health programs. Periodic assessment of antioxidant enzyme levels, along with other biomarkers, can help identify individuals at risk of stress-related conditions and guide timely interventions. This proactive approach supports early detection and personalized health management.
4. Occupational Role-Based Health Policies: The university should consider developing health policies that reflect the distinct occupational demands of academic and non-academic staff. For example, academic staff may benefit from flexible scheduling and reduced administrative burdens during peak academic periods, while non-academic staff may require improved safety protocols and workload distribution to minimize physical strain.

5. Further Research and Longitudinal Monitoring: This study provides a snapshot of antioxidant enzyme activity, but longitudinal research is needed to understand the long-term effects of occupational stress on oxidative health. Future studies should explore seasonal variations, gender differences, and the impact of lifestyle factors such as diet, sleep, and smoking. Collaborations with public health institutions could enrich data quality and broaden the scope of analysis.
6. Institutional Support and Policy Advocacy: University leadership should prioritize staff well-being as a strategic objective. Establishing a dedicated Occupational Health and Wellness Committee could facilitate the integration of research findings into policy and practice. Advocacy for national guidelines on workplace oxidative health may also be warranted, especially in academic environments where stress is pervasive.

These recommendations aim to foster a healthier, more resilient workforce by addressing the biochemical consequences of occupational stress. By investing in staff wellness, Federal University Wukari can enhance productivity, reduce absenteeism, and promote a culture of care and sustainability.

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