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# Serum Glutathione Peroxidase and Superoxide Dismutase Levels in Young Adult Active Smokers and Non-Smokers in a Southwest Based Tertiary Institution

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**Abstract**

Cigarette smoking is still a major public health issue, as it is the primary cause of various preventable diseases and premature deaths around the world. Previous studies have shown that tobacco components aggravate respiratory burst thus increasing the generation of reactive oxygen species (ROS). This case-control study is to examine glutathione peroxidase and superoxide dismutase levels among young adult active and non-active cigarette smokers at a tertiary institution in South West, Nigeria. This descriptive comparative study was carried out to compare the levels of serum glutathione peroxidase by Paglia and Valentine method and Nebot method of superoxide dismutase estimation in young adult active smokers and non-smokers in Ogun state based tertiary institution, between February and June, 2021. There was a significantly higher level ($p = 0.000$) of glutathione peroxidase in the case ($55.39 \pm 2.87$) compared to the control ($42.59 \pm 2.41$). There was no significant difference in the level of the measured antioxidants at different categories of years of smoking among the group of smokers. There was no significant difference in the level of the measured antioxidants at different quantities of cigarettes smoked by the participants. This study revealed that there was no significant difference in the level of the measured antioxidants at different categories of years and quantity of cigarette smoked among the group of smokers. Prolonged exposure and quantity of cigarette smoke by smokers did not cause depletion of antioxidants among active smokers. However, smoking was associated with a higher level of oxidative stress marker

**Keywords:** Serum Glutathione Peroxidase, Superoxide Dismutase, Anti-oxidants, Smokers, Oxidative stress.

## Introduction

Cigarette smoking is considered a global public health problem. It is a risk factor for variety of diseases (cardiovascular disease, stroke, chronic pulmonary disease, Alzheimer's disease, Parkinson's disease) (Gboyega, 2013).

Cigarette smoking remains an enormous public health problem and is now the world's single leading cause of several preventable diseases and premature deaths. Smoking has been described as the only risk factor shared by four major non-communicable diseases; cardiovascular disease, diabetes, cancer and chronic respiratory diseases (Wipfli, 2012).

Cigarette smoking is said to be responsible for over 25 diseases in humans some of which include chronic bronchitis, ischaemic heart disease and cancers of the lung, oral cavity, urinary bladder, pancreas, and larynx (Desalu *et al*., 2008). Cigarette smoking has also been implicated either as a contributory factor or causal agent in the following health conditions: osteoporosis, blindness, impotence, loss of teeth, diabetes, reduced fertility, cataracts, asthma, reduced sperm count, fungal eye infection, early menopause, stomach ulcers, cardiovascular heart diseases, reduced lung function, reduced lung growth, and atherosclerosis (USDHHS, 2012).

The tobacco epidemic is one of the biggest public health threats the world has ever faced, killing

more than 7 million people every year (WHO,2017). The use of tobacco initiates behavioral process which elicits psychological and physiologic addictive mood among active smokers. The active ingredient in tobacco is nicotine, this substance is highly addictive, thereby resulting in sustained tobacco use among its users over a period of time. Tobacco product are classified into two and these includes; combustible and non-combustible tobacco products. Combustible tobacco products include: cigarettes, cigars, cigarillos, small cigars, water pipes (hookah), and pipes. Non-combustible tobacco products include electronic cigarettes and tobacco formulations developed for chewing, dipping, or snuffing (WHO, 2015).

In 2010, the global prevalence of tobacco smoking was estimated at 22.1% (36.9% male, 7.3% female) globally and 12.8% (23.2% male, 2.5% female) in Africa region (WHO, 2010). In 2010 WHO projected the global prevalence of tobacco smoking to decrease from 22.1% to 18.1% and an increasing trend in Africa regional from 12.8% to 18.9% respectively by 2025 (WHO, 2010).

The recent estimates by WHO indicates the global and Africa regional prevalence of tobacco use to be 19.9% (17.5% male, 2.2% female) and 9.8% (33.7% male, 6.2% female) in 2015. It is clearly observed that in all countries, the rate of tobacco smoking is much more common among men than women. However, WHO data, based on a fifteen-year - 2000 to 2015 - monitoring, indicates a general decline in smoking rates in most countries worldwide. Noteworthy, the rate of smoking increased in 27 countries; all of which are developing countries and 15 of which are in sub-Saharan Africa (SSA). This observation calls for improved strategies for tobacco control in these regions (WHO, 2010).

The prevalence of tobacco use in Nigeria is considered low. A multi-country study found the lowest prevalence of current use of any tobacco product in Nigeria (5.6%, 95% CI: 4.9–6.2) and the highest rates in Bangladesh (43.2%, 95% CI: 41.5– 44.8) (Agaku *et al*., 2014). A similar prevalence rate was also reported by the 2012 Nigeria Global Adult Tobacco Survey (GATS, 2012; Caleyachetty *et al*., 2014). Both forms of tobacco, smoking and smokeless, are available in the country, and consumption was more prevalent among men (12%, 95%CI: 11.1–12.8, $p<0.001$) compared to women (0.6%, 95%CI: 0.4–0.8, $p<0.001$) (Tafawa *et al*., 2012). Tobacco use varies: by ethnicity, with the highest prevalence among the Igbo ethnic group (6.7%, 95%CI: 5.9–7.5, $p<0.0001$); religion, with highest prevalence among Muslims (19.2%, 95%CI: 14.4–24.1, $p<0.001$); and place of residence, with a higher prevalence among rural dwellers (4.5%, 95% CI: 4.0–4.9, $p=0.05$) (Tafawa *et al*., 2012).

In a nutshell, smoking harms the lungs, heart, arteries, brain, kidneys, bladder, skin and eyes; even unborn children whose mothers are either active or passive smokers. Smoking speeds up the aging process and raises blood pressure, harming the unborn baby directly by lowering birth weight and increasing the unborn child's susceptibility to disease. The major components of cigarette that constitute the greatest health hazard are nicotine and tar. The increased risk of smoking is said to be positively correlated with the number of cigarettes smoked and with their tar and nicotine content (WHO, 2010).

Tobacco constituents are known to exacerbate aspects of the respiratory burst and enhance reactive oxygen species (ROS) production (Jenifer *et al*., 2015). Reactive oxygen species (ROS) are chemically reactive molecules containing oxygen. Oxygen is a highly reactive atom that is capable of becoming part of potentially damaging molecules commonly called “free radicals (Mayne, 2003). Superoxide Dismutase (SOD) catalyzes the conversion of superoxide radicals into hydrogen peroxide and molecular oxygen. SOD plays a critical role in the defense of cells against the toxic effects of oxygen radicals. It competes with nitric oxide (NO) for superoxide anions, which react with NO to form peroxynitrite (Mayne, 2003).

According to Metta *et al*. (2015), erythrocytic activity of GPx is the most significant indicator of oxidative stress in smokers in association with acute myocardial infraction (AMI) as smoking increases erythropoiesis by producing more

carboxyhaemoglobin and making haemoglobin inaccessible for oxygen transport, leading to altered erythrocyte indices. Glutathione peroxidase (GPx) is an enzyme responsible for the removal of hydroperoxides formed in cells, it reduces hydrogen and lipid peroxides to less toxic hydroxyl fatty acids using glutathione as a reducing agent, and these compounds play a major role in defending the body against reactive oxygen species (Rahman et al., 2009).

## Materials and Method

### Ethical Consideration

Prior to the commencement of the study, ethical approval was obtained from Babcock University Health Research Ethics Committee (BUHREC). Participation in this study was voluntary and consent form was duly signed by participants to seek their approval. All participants who gave consent were included in the study and all information gathered during the study was treated with utmost confidentiality. The result of this study will be beneficial in health management.

### Study Design

This descriptive comparative study compared the levels of serum glutathione peroxidase and superoxide dismutase in young adult active smokers and non-smokers in a southwest based tertiary institution. The duration for sample collection was between March and June, 2021.

### Study Location

This study was conducted on young adult active smokers and non-smokers in a tertiary institution based in Ogun state, South-west, Nigeria. Ogun state borders Lagos state to the south, Oyo and Osun state to the north, Ondo State to the east, and Republic of Benin to the west.

### Research Setting

The participants for this study consisted of undergraduate students of Ogun State College of Health Technology, Ilese, Ogun State. The study site was selected based on easy access of sample and available memorandum of understanding between the researcher and the authority of institution.

A total of ninety (90) apparently healthy students were recruited to participate in this study. Sixty young adult active smoker students made up the test participants and thirty young adult non-smoker students were the controls. Blood samples was collected from the participants, questionnaire was administered and anthropometric indices (such as body mass index (BMI), waist circumference, neck circumference and blood pressure were measured).

### Materials

Materials to be used in this study include; Cotton wool, needle and syringe, plain bottle, Lithium heparin, methylated spirit, Gloves, micropipette, Tourniquet, automatic micropipette, pipette tips, spectrophotometer, spectrophotometric cuvette, water bathe, vortex mixer, disposable test tubes, Eppendorf centrifuge, NADPH reagent, NADPH diluents, assay buffer, hydrogen peroxide reagent, and microplates.

### Inclusion Criteria

Participants included in this study were apparently young adult students between the ages of 18-35 years with tobacco smoking habits of not less than a year. Control participants were age- matched, young adult non -smokers

### Exclusion Criteria

The following prospective participant who did not meet the inclusion criteria were excluded from the study; participants with any underlying systemic disease which may also influence the antioxidant level and participants using any antioxidant and dietary supplements.

### Sampling Technique and Sample Size Determination

The participants in this study were selected by simple random sampling. The sample size for this study was obtained using the formula as described by Araoye (2004). Prevalence was taken from the study conducted in Nigeria (Agaku *et al*., 2014), which is equal to 5.6% (0.056).

$$N = \frac{Z^2PQ}{d^2}$$

Where:

N = sample size,

Z = Z statistic for a level of confidence, usually set at 1.96 ($\approx$2.0) at 95% confidence interval.

P = expected prevalence or proportion (5.6/100=0.056)
q=1.0 - p
q=1-0.056 = 0.944
d= is the degree of precision which is set at 0.05

Therefore,

$$N = \frac{(1.96)^2(0.056) \times 0.944}{(0.05)^2} = \frac{0.203}{0.003} = 67.7 \approx 68.$$

Though the sample size determined using the formula is 68, for the purpose of this study, a total sample size of 90 will be used.

**Data Collection and Sampling**

After obtaining ethical approval from BUHREC and informed consent form from various participants, about five milliliters of venous whole blood sample was collected from all participants of the study by a qualified Medical Laboratory Technician and was aseptically dispensed into plain anticoagulant free sample containers, allowed to clot and retract and then centrifuged at 500 *g* for 10 minutes at room temperature. Serum samples collected was stored at 20°C until time of analysis for laboratory estimation of Glutathione peroxidase and Superoxide dismutase.

**Methodology of Superoxide Dismutase Estimation (Nebot, 1993)**

**Principle**

The method is based on SOD-mediated increase of autoxidation of 5,6,6 a11btetrahydro-3,9,10-tryhydroxybenzo[c]fluorene in aqueous alkaline solution to yield a chromophore with maximum absorbance at 525 nm. The SOD activity was determined from the ratio of the autoxidation rates in the presence (Vs) and absence Vc) of SOD. One SOD-525 activity unit is defined as the activity that doubles the autoxidation rate of the blank control.

**Procedure**

**Buffer preparation**

- The required amount of buffer was placed in an open container at 37°C and allows equilibrating with air. Repeatedly drawing and expelling Buffer into the container with a pipette speed the oxygen saturation of the buffer
- A minimum of 4 blank controls with each set of sample data was used.
- The first sample assayed was used as a guide to determine the desired time range for the linear portion of the reaction.

**Assay procedure**

- The spectrophotometer was zeroed at 525 ± 2 nm with deionized water.
- 900 µL Buffer was added to all test tubes for each blank and sample.
- 40 µL of Blank or Sample was added to the test tube.
- 30 µL of R2 was added to the test tube and vortex.
- Test tubes was Incubated at 37°C for 1 minute.
- 30 µL of R1was added to the test tube and vortexed briefly.
- The samples were then transferred to a spectrophotometric cuvette to measure the absorbance.

**Methodology for Glutathione Peroxidase (Paglia and Valentine, 1967)**

**Principle**

Glutathione Peroxidase catalyzes the reduction of hydrogen peroxide ($H_2O_2$), oxidizing reduced glutathione (GSH) to form oxidized glutathione (GSSG). GSSG is then reduced by glutathione reductase (GR) and β-nicotinamide adenine dinucleotide phosphate (NADPH) forming NADP+ (resulting in decreased absorbance at 340 nm) and recycling the GSH. Because GPx is limiting, the decrease in absorbance at 340 nm is directly proportional to the GPx concentration.

**Assay procedure**

***Standard Procedure for Microplate Assay***

- All reagents were brought to room temperature.
- After removing microplate from plastic bag, 50 µL of diluted sample (or controls if present) was added to wells.
- 50 µL of *working NADPH* was added to each well.
- Then 50 µL of *working $H_2O_2$ was added* to each well.

- Samples were left for 1 minute and A340 was monitored for 5 minutes with a recording interval of every 30 seconds.
- Glutathione peroxidase activity was then calculated from the net rate.

**Statistical Analysis**

The data collected was analyzed statistically using the statistical package for the social sciences (SPSS) version 20. Descriptive statistics and correlation parameters using the Pearson's correlation coefficient was applied in analyzing the data from this study. Values will be deemed significant if p is less than 0.05.

**Result**

Table 1 shows the socio-demographic characteristics of the study population. Majority of the participants were between 21-25 years especially among the group of smokers (case) which represented 45.6% of the entire study population. None of the study participants were of the female gender. While 10 (11.1%) of the test group were already married as at the time of this study. The table further reveals that most of the study participants were of Yoruba ethnicity. Figure 1 revealed that more participants in the control group rated their health status as excellent (76.7%) compared to those in the case (56.7%). This was statistically significant ($p = 0.049$).

Table 2 shows the history of diseases and their treatment were compared between the case and control populations. The table revealed that only 1 person had a history of high blood pressure among the control population while the rest of the study population claimed to have had a history of normal blood pressure. One participant among the case group claimed to have once been treated for kidney disease. There was no significant relationship between any of the history of diseases assessed and the group the participants belonged to. Table shows information on the level of general activity and indicated that most of the study population in both groups were active (case = 12.2%, control = 12.2%) or very active (case = 28.9%, control = 15.6%). However, the control group had more participants who claimed never to have had exercise ($p = 0.000$).

Figure 1 revealed that there was a reduction in the number of cigarettes smoked per day among the case population although 7 of them smoked above 10 sticks per day. Table 4 shows a comparison in the anthropometric measurements between case and control. The table revealed that the case had a significantly higher ($p = 0.009$) mean hip circumference compared to the control (case = $36.88 \pm 3.4$, control = $34.93 \pm 2.7$) as well as a higher waist/hip ratio (case = $0.19 \pm 0.09$, control = $0.11 \pm 0.02$, $p = 0.000$). Table 5 shows the comparison of the measured antioxidants between case and control. It shows that there was a significantly higher level ($p = 0.000$) of glutathione peroxidase in the case ($55.39 \pm 2.87$) compared to the control ($42.59 \pm 2.41$). Table 6 revealed that there was significant positive correlation between glutathione peroxidase and the hip circumference ($r = 0.301$, $p = 0.004$), and waist/height ratio ($r = 0.378$, $p = 0.000$) among the total population of study participants. There was however a significant negative correlation between the enzyme and the systolic blood pressure of the case ($r = -0.303$, $p = 0.018$). Table 7 revealed that there was a significant positive correlation between SOD and the diastolic blood pressure of the entire study population ($r = 0.252$, $p = 0.016$). Table 8 revealed that there was no significant difference in the level of the measured antioxidants at different categories of years of smoking among the group of smokers. Table 9 also revealed that there was no significant difference in the level of the measured antioxidants at different quantities of cigarettes smoked by the participants.

**Table 1: Socio-Demographic Characteristics of Study Population**

| VARIABLES | CASE N (%) | CONTROL N (%) | CHI-SQUARE VALUE | P-VALUE |
|---|---|---|---|---|
| **AGE (YEARS)** | | | | |
| 16-20 | 6 (6.7) | 18 (20.0) | | |
| 21-25 | 41 (45.6) | 12 (13.3) | 27.98 | 0.000* |
| 26-35 | 13 (14.4) | 0 (0.0) | | |
| **GENDER** | | | | |
| MALE | 60 (66.7) | 30 (33.3) | - | - |
| FEMALE | 0 | 0 | | |
| **MARITAL STATUS** | 10 (11.1) | 0 (0.0) | 5.63 | 0.018* |
| MARRIED | 50 (55.6) | 30 (33.3) | | |
| SINGLE | | | | |
| **RELIGION** | | | | |
| CHRISTIANITY | 43 (47.8) | 21 (23.3) | | |
| ISLAM | 15 (16.7) | 9 (10.0) | 1.20 | 0.550 |
| TRADITIONAL | 2 (2.2) | 0 (0.0) | | |
| **TRIBE** | | | | |
| YORUBA | 60 (66.7) | 29 (32.2) | 2.02 | 0.155 |
| IGBO | 0 (0.0) | 1 (1.1) | | |
| **LEVEL** | | | | |
| 100 Level | 9 (10.0) | 15 (16.7) | | |
| 200 Level | 13 (14.4) | 8 (8.9) | | |
| 300 Level | 12 (13.3) | 5 (5.6) | 18.27 | 0.001* |
| 400 Level | 22 (24.4) | 2 (2.2) | | |
| 500 Level | 4 (4.4) | 0 (0.0) | | |

*significant at $p < 0.05$

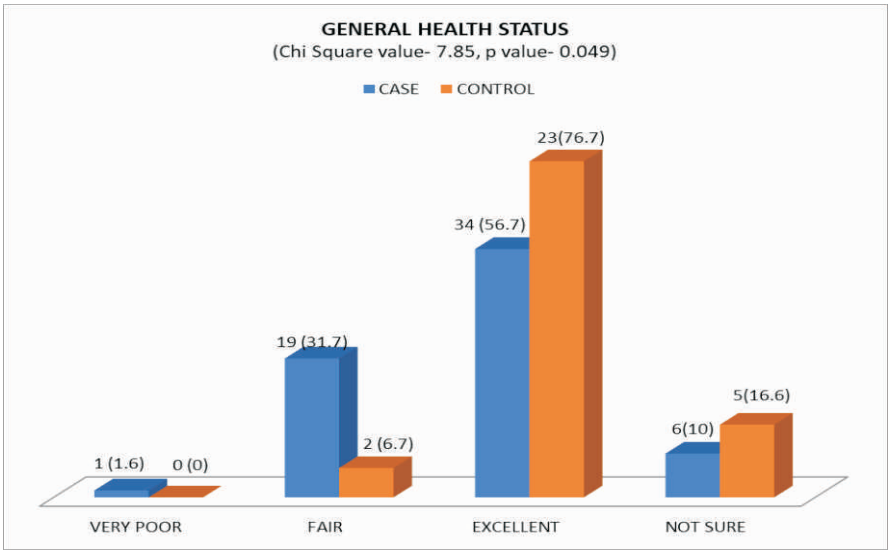


**Figure 1: General health status of case and control participants**

**Table 2: History of Disease and Treatments of Study Population**

| HEALTH STATUS | CASE N (%) | CONTROL N (%) | CHI-SQUARE VALUE | P-VALUE |
|---|---|---|---|---|
| **BLOOD PRESSURE (BP)** | | | | |
| HIGH | 0 (0.0) | 1 (1.1) | | |
| NORMAL | 60 (66.7) | 29 (32.2) | 2.02 | 0.155 |
| **TREATMENT OF BP** | | | | |
| YES | 0 (0.0) | 0 (0.0) | -- | -- |
| NO | 60 (66.7) | 30 (33.3) | | |
| **HEART DISEASE (HD)** | | | | |
| YES | 0 (0.0) | 0 (0.0) | -- | -- |
| NO | 60 (66.7) | 30 (33.3) | | |
| **TREATMENT OF HD** | | | | |
| YES | 0 (0.0) | 0 (0.0) | | |
| NO | 59 (65.6) | 30 (33.3) | 0.506 | 0.477 |
| **DON'T REMEMBER** | 1 (1.1) | 0 (0.0) | | |
| **KIDNEY DISEASE (KD)** | | | | |
| YES | 0 (0.0) | 0 (0.0) | -- | -- |
| NO | 60 (66.7) | 30 (33.3) | | |
| **TREATMENT OF KD** | | | | |
| YES | 1 (1.1) | 0 (0.0) | 0.506 | 0.477 |
| NO | 59 (65.6) | 30 (33.3) | | |
| **FAMILY HISTORY** | | | | |
| YES | 0 (0.0) | 0 (0.0) | -- | -- |
| NO | 60 (66.7) | 30 (33.3) | | |
| **MEDICATIONS** | | | | |
| YES | 0 (0.0) | 0 (0.0) | -- | -- |
| NO | 60 (66.7) | 30 (33.3) | | |

**Table 3: Pattern of Physical Activities of Study Population**

| PHYSICAL ACTIVITIES | CASE N (%) | CONTROL N (%) | CHI-SQUARE VALUE | P-VALUE |
|---|---|---|---|---|
| **GENERAL ACTIVITY** | | | | |
| Physically inactive | 12 (13.3) | 1 (1.1) | | |
| Mildly active | 7 (7.8) | 3 (3.3) | | |
| Moderately active | 3 (3.3) | 1 (1.1) | 7.32 | 0.198 |
| Active | 11 (12.2) | 11 (12.2) | | |
| Very active | 26 (28.9) | 14 (15.6) | | |
| **EXERCISE/SPORT ACTIVITIES** | | | | |
| YES | 36 (40.0) | 19 (21.1) | 1.04 | 0.792 |
| NO | 22 (24.4) | 11 (12.2) | | |
| **LEVEL OF EXERCISE** | | | | |
| REGULAR | 53 (58.9) | 13 (14.4) | | |
| NOT REGULAR | 5 (5.6) | 11 (12.2) | 23.70 | 0.000* |
| NOT AT ALL | 1 (1.1) | 6 (6.7) | | |

*significant at $p < 0.05$

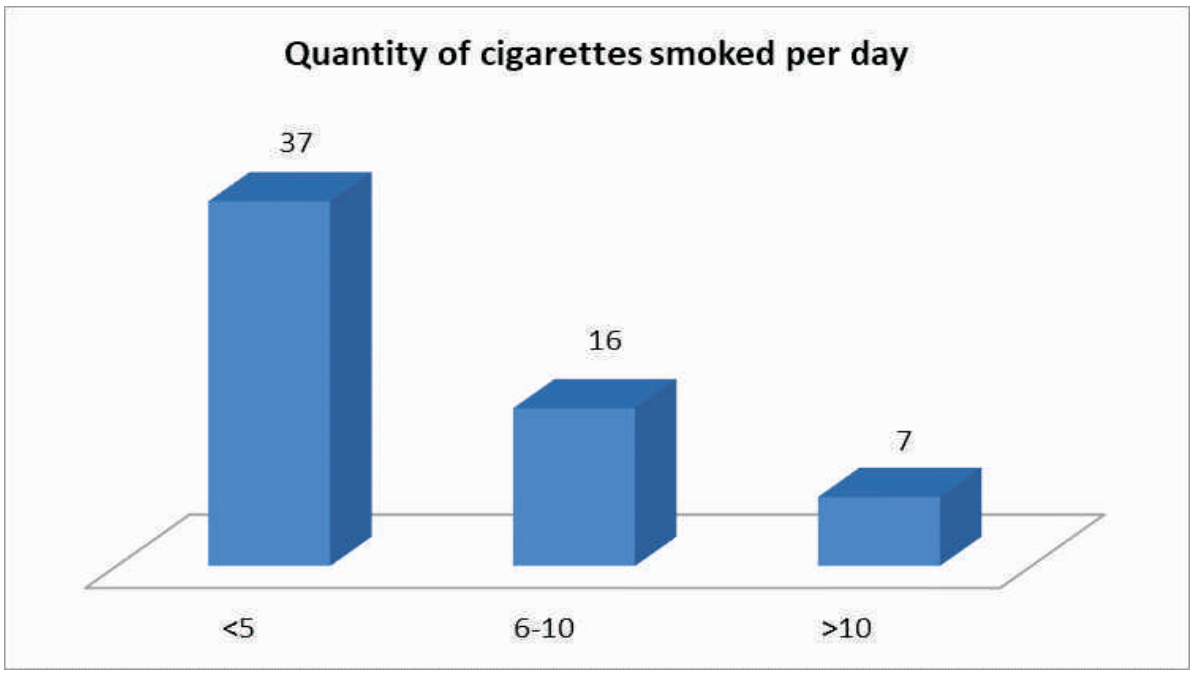


**FIGURE 2- Quantity of cigarettes smoked per day by the case group**

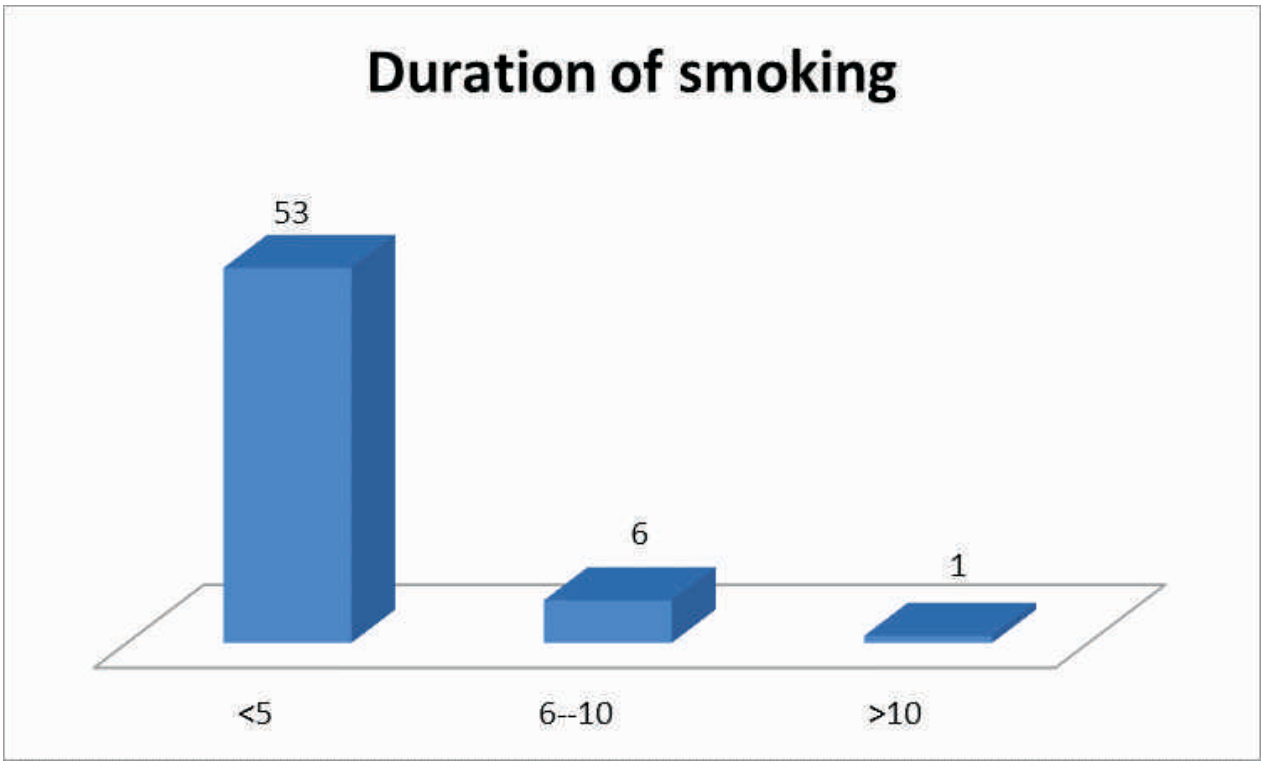


**Figure 3- Duration of smoking by case population (in YEARS)**

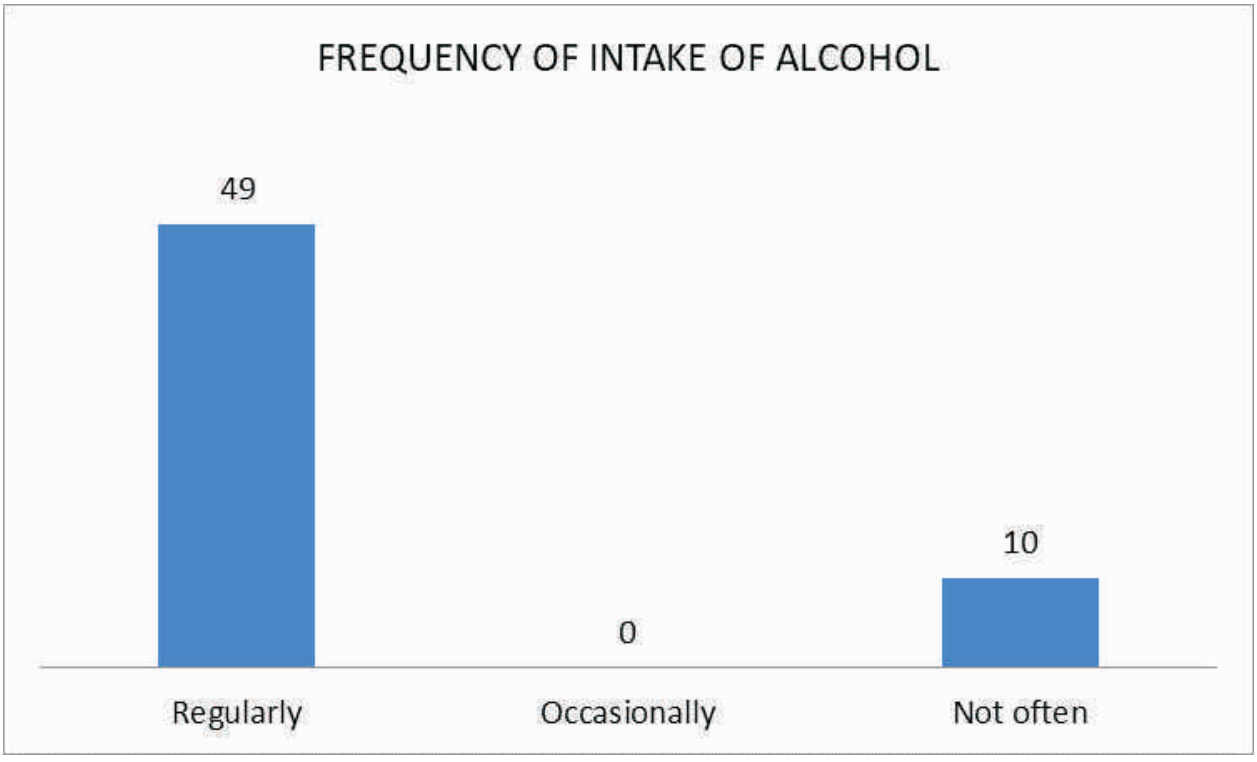


**Figure 4- Frequency of intake of alcohol**

**Table 4: Comparison of Anthropometry Measurements Between Case and Control**

| VARIABLES (UNIT) | CASE $\bar{x}$ ± SE | CONTROL $\bar{x}$ ± SE | t-value | p-value |
|---|---|---|---|---|
| WEIGHT (KG) | 64.7 ± 8.7 | 63.2 ± 8.4 | -0.788 | 0.433 |
| HEIGHT (m) | 1.73 ± 0.1 | 1.73 ± 0.0 | -0.008 | 0.993 |
| BMI (kg/ $m^2$) | 21.71 ± 3.2 | 21.04 ± 2.9 | -0.942 | 0.349 |
| Waist circumference (cm) | 35.83 ± 36.4 | 29.73 ± 1.9 | -0.913 | 0.364 |
| Hip circumference (cm) | 36.88 ± 3.4 | 34.93 ± 2.7 | -2.660 | 0.009* |
| Waist/hip ratio | 1.44 ± 4.6 | 0.80 ± 0.03 | -0.747 | 0.457 |
| Waist/height ratio | 0.19 ± 0.09 | 0.11 ± 0.02 | -4.982 | 0.000* |
| Neck circumference (cm) | 14.41 ± 1.2 | 14.02 ± 2.6 | -0.972 | 0.334 |
| SYSTOLIC BP | 116.17 ± 15.4 | 118.33 ± 11.7 | 0.677 | 0.500 |
| DIASTOLIC BP | 79.33 ± 13.0 | 81.67 ± 13.9 | 0.784 | 0.435 |

*significant at $p < 0.05$

**Table 5: Comparison of Antioxidant Level between Case and Control**

| ANTIOXIDANTS | CASE $\bar{x}$ ± SE | CONTROL $\bar{x}$ ± SE | t-value | p-value |
|---|---|---|---|---|
| **GLUTATHIONE PEROXIDASE** | 55.39 ± 2.87 | 42.59 ± 2.41 | -20.98 | 0.000* |
| **SUPEROXIDE DISMUTASE** | 41.20 ± 3.84 | 42.00 ± 2.98 | 1.00 | 0.319 |

*significant at $p < 0.05$

**Table 6- Relationship between glutathione peroxidase and anthropometric data using Pearson's correlation**

| MEASUREMENTS | TOTAL POPULATION r,p | CASE r,p | CONTROL r,p |
|---|---|---|---|
| HEIGHT (m) | -0.044, 0.68 | -0.083, 0.531 | -0.152, 0.424 |
| WEIGHT (kg) | 0.107, 0.315 | 0.057, 0.666 | 0.101, 0.594 |
| BMI (kg/ $m^2$) | 0.131, 0.217 | 0.061, 0.644 | 0.169, 0.372 |
| WAIST CIRCUMFERENCE (cm) | 0.113, 0.290 | 0.061, 0.641 | 0.243, 0.196 |
| HIP CIRCUMFERENCE (cm) | 0.301, 0.004* | 0.085, 0.521 | 0.288, 0.123 |
| WAIST TO HIP RATIO | 0.032, 0.768 | -0.083, 0.526 | -0.194, 0.305 |
| WAIST TO HEIGHT RATIO | 0.378, 0.000* | -0.087, 0.511 | 0.200, 0.289 |
| NECK CIRCUMFERENCE (cm) | 0.172, 0.105 | 0.113, 0.391 | 0.266, 0.156 |
| SYSTOLIC BLOOD PRESSURE | -0.194, 0.066 | -0.303, 0.018* | -0.126, 0.508 |
| DIASTOLIC BLOOD PRESSURE | -0.136, 0.200 | -0.147, 0.261 | -0.085, 0.656 |
| CIGARETTES PER DAY | --, -- | 0.095, 0.471 | --, -- |

*significant at $p < 0.05$

**Table 7- Relationship between superoxide dismutase and anthropometric data using Pearson's correlation**

| MEASUREMENTS | TOTAL POPULATION r,p | CASE r,p | CONTROL r,p |
|---|---|---|---|
| HEIGHT | 0.054, 0.611 | 0.072, 0.584 | -0.053, 0.781 |
| WEIGHT | 0.096, 0.370 | 0.047, 0.723 | 0.267, 0.154 |
| BMI | 0.051, 0.631 | -0.006, 0.964 | 0.261, 0.163 |
| WAIST CIRCUMFERENCE | 0.016, 0.883 | 0.027, 0.839 | 0.156, 0.410 |
| HIP CIRCUMFERENCE | 0.077, 0.468 | 0.179, 0.170 | -0.112, 0.556 |
| WAIST TO HIP RATIO | 0.112, 0.294 | 0.138, 0.294 | 0.115, 0.543 |
| WAIST TO HEIGHT RATIO | 0.074, 0.488 | 0.183, 0.161 | -0.237, 0.208 |
| NECK CIRCUMFERENCE | 0.011, 0.919 | 0.058, 0.659 | -0.019, 0.923 |
| SYSTOLIC BLOOD PRESSURE | 0.129, 0.226 | 0.090, 0.495 | 0.234, 0.213 |
| DIASTOLIC BLOOD PRESSURE | 0.252, 0.016* | 0.228, 0.080 | 0.298, 0.110 |
| CIGARETTES PER DAY | --, -- | 0.071, 0.587 | --, -- |

*significant at $p < 0.05$

**Table 8- Comparison of antioxidant level at different years of smoking (ANOVA)**

| | <5 $\bar{x} \pm$ SE | 6 - 10 $\bar{x} \pm$ SE | >10 $\bar{x} \pm$ SE | F-value | p-value |
|---|---|---|---|---|---|
| GLUTHATHIONE PEROXIDASE | 55.4± 2.94 | 54.9 ± 2.71 | 54.9 ± 0 | 0.083 | 0.921 |
| SUPEROXIDE DISMUTASE | 41.2 ± 3.47 | 40.2 ± 6.70 | 45.2 ± 0 | 0.742 | 0.481 |

**Table 9: Comparison of antioxidant levels at different quantities of cigarettes smoked per day (ANOVA)**

| | <5 $\bar{x}$ ± SE | 6 – 10 $\bar{x}$ ± SE | >10 $\bar{x}$ ± SE | F-value | p-value |
|---|---|---|---|---|---|
| **GLUTHATHIONE PEROXIDASE** | 55.5± 2.79 | 54.8 ± 3.08 | 56.4 ± 2.89 | 0.790 | 0.459 |
| **SUPEROXIDE DISMUTASE** | 41.3 ± 3.72 | 40.5 ± 4.38 | 42.2 ± 3.33 | 0.557 | 0.576 |

**Discussion**

Cigarette smoking has been implicated in a number of diseases and is a risk factor for six of the eight leading causes of death in the world (WHO, 2008). The prevalence of cigarette smoking among the respondents has been well documented in Nigeria (Adejuwon, 2009). However, with the report that tobacco kills one person every six seconds worldwide (Mathers and Loncar, 2006; Binu *et al*., 2010) and the fact smoking could be responsible for one billion deaths in the 21st century (Peto and Lopez, 2001; Binu *et al*., 2010) it becomes imperative that urgent steps are taken to reduce adverse effects of cigarette smoking among the population.

This study showed that majority of participants are between 21-25 years of age and they are all male gender. This outcome is consistent with Ayankogbe *et al.* (2003) and Desalu *et al*. (2008) who reported high prevalence of tobacco smoking among male adults in Nigeria. The higher prevalence among males and associated risks with passive smoking continues to endanger the health of innocent citizens, predominantly wives and children of smokers. In previous studies done across the globe, passive smoking has been found to also result in high morbidity and mortality (WHO, 2008). This finding showed that smoker men should be the target group for health warnings.

Our results also revealed that the level of education, marital status, religious and ethnic background may be relevant issues to take into account in smoking cessation interventions. These studies have also shown that adults who are educated, married and religious are less likely to smoke (Mann *et al*., 2007; Gillum and Sullins, 2008). Some elements of main stream of education and religions include a focus on avoiding unhealthy habits, and attendance of organized services and social events, the latter of which may be a good foundation of social support and care (Page *et al*., 2009).

In the present study, there was no significant relationship between any of the history of diseases assessed and the groups of the participants. However, the health status of control subjects is excellent compared to that case subjects in this study. According to Ni *et al*. (2015), cigarette smoking has been associated with different causes of death of which the great majority reflect causality, the causes of this death include ischemic heart disease, sudden heart attack (Patthi *et al*., 2018), and respiratory disease (Strzelak *et al*., 2018). History of individual health is noteworthy for smokers to stop cigarette smoking and it is necessary to put in place information, education, and communication strategies that will help the general population.

In this study, the case group was very active in general activity and engaged in more of exercise than the control group. In a similar report, by Kumar et al. (2005) the muscle flexibility of smoker athletes engaging in general activities and exercise is more than non-smoker ones. It seems that the smoking rate, duration of smoking and individuals' physical activities affects

muscle contractions and relaxation in smokers than non-smokers engaging in general activities and exercise.

The study reported reduction in the number of cigarettes smoked per day among the case population, However, seven (7) of them smoked more than 10 sticks per day. This outcome corroborates to a similar study by Adepoju *et al*. (2013) who reported heavy smoking of about 23 sticks per day among the smoking population. This high level of addiction among these smokers suggested that there must be measures to ensure tobacco use cessation, and it might be necessary to refer these smokers for tobacco cessation therapy.

In the present study, it was shown that the mean hip circumference of case subjects was higher when compared to the control as well as a higher waist/height ratio. This result is supported by Pisinger *et al*. (2009) who reported the relationship between smoking, lifestyle factors and body compositions; it was found that smokers had mean hip circumference, and higher waist-to-hip ratio than non-smokers. The mechanism via which smoking affects body composition and fat distribution is very complex, as it is influenced by many factors such as genetic structure and sex hormones, which affect body weight (Kwok *et al*., 2012).

Our study revealed a significantly higher level of glutathione peroxidase in the case compared to the control. This is consistent to a similar study of Yildiz *et al*. (2002) and Patel *et al*. (2005) who showed that erythrocyte SOD was lowered and GPx was elevated in tobacco users compared to non-tobacco users. Moreover, increase in the frequency of cigarette smoking could have caused increase in GPx levels among smokers when compared to non-smokers.

This study showed significant positive correlation between glutathione peroxidase and the hip circumference, and waist/height ratio among the total population of study participants. It has been demonstrated that excess body fat is an important risk factor for ischemic heart disease for active smokers. Investigators have shown that visceral fat resulting from smoking, represented by waist hip ratio, more accurately reflects abnormal metabolic status of smokers (Neela *et al*., 2007). Glutathione peroxidase acts as preventive antioxidants that play a very important role in protection against lipid peroxidation in metabolic disease state which could be triggered by smoking (Kurtu *et al*., 2004).

In this study, there was positive correlation between SOD and the diastolic blood pressure of the entire study population, and significant negative correlation between the enzyme and the systolic blood pressure of the case. In a similar study by Aquil *et al*., (2013), there was a strong association of oxidative stress with high blood pressure, and there was a correlation between the marker of oxidative markers and systolic and diastolic blood pressure. According to Ahmad *et al*. (2016) significant increase in the SOD and GPX levels was reported in oxidative stress triggered by smoking. This result may be partially explained by the increased oxidative stress caused by the overproduction of ROS in smokers and is paralleled by a significant increase in the levels of relevant enzymes, particularly GPX.

This study revealed that there was no significant difference in the level of the measured antioxidants at different categories of years and quantity of cigarette smoked among the group of smokers. According to Astagimath and Veena (2019), prolonged exposure and quantity of cigarette smoke by smokers causes depletion of antioxidants among smokers.

**Conclusion**

The present study enlightens the levels of glutathione peroxidase and superoxide dismutase in young active and non-active cigarette smokers and possible relationship between antioxidant enzymes levels, smoking habits and smoking duration in a south west-based tertiary institution. The mean GPx activity was significantly higher in smokers compared with the control group while the SOD enzyme activity was higher among control compared to the case group. Furthermore, a positive correlation existed between the serum GPx activity of cigarette smokers and waist circumference, and waist/ height ratio. In

addition, there was significant positive correlation between SOD and the diastolic blood pressure of the entire study population. However, there was a significant negative correlation between the enzyme and the systolic blood pressure of the case.

**Recommendation**

There should be more awareness on the health implication of smoking. Current efforts should be aimed at reducing smoking to the barest minimum especially among young population is very necessary. There is need for review of current health warnings on tobacco smoking which may not have been tailored for this category of subjects.

**Declarations**

**Availability of data and Materials**

The datasets during and/or analyzed during the current study is available from the corresponding author on reasonable request.

**Competing Interest**

No competing interests

**Funding**

Not applicable

**Authors Contributions**

All and every part of the work is a collection and contribution of the authors.

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