

Evaluation of Alpha-Fetoprotein in Breast Cancer Patients in Nnewi North, Anambra State, Nigeria

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ABSTRACT

Breast cancer remains the most frequently diagnosed malignancy and a leading cause of cancer-related mortality among women worldwide. It represents a major global public health concern due to its rising incidence, disease burden, and associated mortality. Breast cancer is not a single disease entity but rather a group of physiologically and molecularly heterogeneous disorders characterized by uncontrolled proliferation of breast epithelial cells. Although considerable progress has been made in early detection and therapeutic interventions, advanced breast cancer with distant metastasis remains largely incurable with currently available treatment modalities. In recent years, research efforts have focused on the identification of reliable biomarkers that can facilitate early diagnosis, improve prognostic evaluation, and enhance monitoring of treatment response.

Alpha-fetoprotein (AFP), a glycoprotein typically produced during fetal development, has been proposed as a potential tumor biomarker in several malignancies. However, available literature describing the relationship between AFP levels and breast cancer progression remains limited and inconclusive. Furthermore, there is a notable lack of data examining AFP as a biomarker among breast cancer patients in Nigeria, particularly within Anambra State and Nnewi North.

This knowledge gap highlights the need for localized research to determine the clinical relevance of AFP in breast cancer management among Nigerian populations. Objectives: The primary objective of this study was to evaluate serum alpha-fetoprotein levels in patients diagnosed with breast cancer. The specific objectives were to:

Determine and compare serum AFP levels between breast cancer patients and apparently healthy female control subjects. Assess the relationship between AFP levels and selected anthropometric parameters among breast cancer patients. Evaluate age-related variations in serum AFP levels among breast cancer patients and control individuals. Establish possible correlations between AFP levels and breast cancer occurrence and progression.

METHODOLOGY

This study adopted a case-control research design. Ethical approval for the study was obtained from the Ethical Committee of the Ministry of Health, Anambra State. The study procedures, risks, and benefits were clearly explained to all participants, and written informed consent was obtained prior to recruitment.

A total of ninety (90) female participants were enrolled in the study, comprising forty-five (45) histologically confirmed breast cancer patients and forty-five (45) apparently healthy age-matched female volunteers serving as the control group. Breast cancer patients were recruited from designated oncology clinics, while control participants were selected from the general population after clinical evaluation to exclude malignancy and chronic diseases. Anthropometric measurements including body weight, height, and body mass index (BMI) were obtained using standard measurement procedures. Approximately 5 mL of venous blood was collected aseptically from each participant into plain sample containers.

The blood samples were allowed to clot and subsequently centrifuged at 3000 revolutions per minute (RPM) for 10 minutes to obtain serum. The separated serum samples were stored under appropriate laboratory conditions until analysis.

Serum alpha-fetoprotein levels were quantified using the sandwich Enzyme-Linked Immunosorbent Assay (ELISA) technique following the manufacturer's protocol. All analyses were performed under standardized laboratory conditions to ensure accuracy and reproducibility. Statistical Analysis; Data generated from the study were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0. Continuous variables were expressed as mean \pm standard deviation (SD).

Comparative analysis between breast cancer patients and control subjects was performed using Student's t-test for normally distributed variables. Analysis of variance (ANOVA) was used to assess differences in AFP levels across different age groups. Pearson's correlation analysis was applied to determine the relationship between serum AFP levels and anthropometric parameters among study participants. Statistical significance was set at p-value less than 0.05.

The results indicated that there was no statistically significant difference in serum AFP levels between breast cancer patients (0.70 ± 0.70 ng/mL) and control subjects (1.54 ± 1.36 ng/mL and 0.58 ± 1.56 ng/mL respectively). Additionally, no significant age-related variation or correlation between AFP levels and anthropometric parameters was observed.

This study recommends that further research should be carried out to determine whether AFP have subtype-specific prognostic value in breast cancer and to explore other metabolic pathways that may influence disease progression.

INTRODUCTION

Background of Study

Cancer is a major health problem worldwide and is the second leading cause of death in the United States (Rebecca *et al.*, 2023.). Cancer is one of the diseases which causes high death rates in these recent times and has resulted in the increased rates of death yearly (Cleveland Clinic, 2024; Cancer Research UK, 2025).

Cancer remains one of the leading causes of morbidity and mortality worldwide. According to reports from United States health data and global cancer surveillance bodies such as Cleveland Clinic and Cancer Research UK, cancer incidence and mortality rates continue to rise annually.

Cancer is characterized by pathophysiological alterations resulting from mutations in the normal processes of cell division, leading to uncontrolled cellular proliferation. Globally, over 19.3 million new cancer cases and approximately 10 million cancer-related deaths were recorded in 2020, emphasizing the urgent need for improved diagnostic, prognostic, and therapeutic strategies.

Among the various cancer types, breast cancer represents the most commonly diagnosed malignancy among women worldwide. It is a heterogeneous disease comprising diverse physiological and molecular subtypes that originate in breast tissues.

Despite improvements in early detection and treatment modalities, advanced or metastatic breast cancer remains largely incurable. The global burden of breast cancer continues to increase due to aging populations, environmental changes, lifestyle modifications, and increased screening practices.

In some regions, particularly developing and transitioning countries, breast cancer mortality remains disproportionately high. For instance, studies conducted in China and other developing nations demonstrate rising incidence rates alongside limited access to advanced therapeutic interventions.

In recent years, attention has shifted toward identifying reliable biomarkers that can improve early diagnosis, predict disease progression, and monitor treatment responses in breast cancer patients. One biomarker of growing

research interest is alpha-fetoprotein (AFP). AFP is a glycoprotein primarily produced during fetal development and belongs to the albuminoid gene family. Physiologically, AFP functions as a carrier protein and plays a regulatory role in fetal cell growth and tissue development. In healthy adults, AFP levels are typically minimal; however, elevated AFP concentrations are strongly associated with certain malignancies, particularly hepatocellular carcinoma.

AFP exists in two primary forms: native AFP (nAFP), which supports normal fetal development, and tumor-associated AFP (tAFP), which is linked to tumorigenesis. Tumor-associated AFP contributes to malignant progression by promoting tumor cell proliferation, facilitating immunosuppression, enhancing metastasis, and increasing resistance to chemotherapy. While AFP is widely recognized as a diagnostic and prognostic marker for liver cancer, its role in breast cancer remains poorly understood and somewhat controversial.

Previous studies have suggested a potential association between elevated AFP levels and specific breast cancer subtypes, particularly cases involving liver metastasis. Some case reports indicate that serum AFP levels may decrease following successful chemotherapy, suggesting its possible role in monitoring treatment response.

However, existing findings remain inconsistent, largely limited to isolated clinical observations, and lack comprehensive large-scale validation. Furthermore, most available studies have focused on populations outside Africa, leaving significant gaps in understanding AFP expression patterns among African breast cancer patients. Notably, there is limited documented research evaluating AFP levels among breast cancer patients in Nigeria.

Most biomarker-based breast cancer studies in Nigeria have concentrated on conventional markers such as hormone receptors and HER2 status, with minimal attention to AFP. Given the increasing burden of breast cancer in Nigeria and the potential biological significance of AFP in tumor development and progression, investigating AFP levels in Nigerian breast cancer patients is essential. Such studies may provide valuable insights into its diagnostic and prognostic relevance and contribute to improved breast cancer management strategies within this population (Chhikara and Parang, 2022).

Breast cancer, the most frequent disease in women worldwide, represents a significant public health concern on a global scale. Breast cancer is a set of physiological and molecular heterogeneous diseases that begin in the breast.

Advanced breast cancer with distant organ metastases is considered incurable with current therapies. Aside from new treatment improvements, the next global challenge in breast cancer care is equal worldwide access to therapeutic advances (Ali, 2023). The incidence of breast cancer continues to rise in every part of the world. Despite advances in its identification and treatment, which have resulted in lower mortality rates, it appears vital to seek out new therapeutic approaches, predictive and prognostic indicators.

The article provides a literature review of breast carcinoma, a condition that affects women worldwide. As a result, women should be aware of the disease's course, the importance of regular screenings for early detection of breast cancer, and the best treatment options (Ali, 2023).

Female breast cancer has overtaken lung cancer as the most commonly diagnosed cancer worldwide. The estimated new breast cancer cases reached 2.3 million in 2020, accounting for 11.7% of all new cancers, and 684,996 cases died of it. In China, breast cancer was the most common malignancy among women, with an estimated number of 306,000 new cases occurring in 2016. The incidence of breast cancer has increased since the widespread uptake of mammography screening and continues to increase with the aging of the population. Globally, death rates for female breast cancer were conspicuously higher in transitioning countries (15.0 per 100,000) versus transitioned country (12.8 per 100,000) (Hong, 2022).

Alpha-fetoprotein AFP is a glycoprotein (contains 4.5% carbohydrates) consisting of 590 amino acids in human and has a molecular mass of 69–70 kDa. It has a V-shaped form, built of three domains, which is subject to conformational changes under the influence of changes in the external environment conditions, such as fluctuations in pH, osmolality, temperature, etc (Glowska-ciemny *et al.*, 2023). It belongs to the albuminoid gene family, which includes albumin (ALB), vitamin D binding protein (DBP), alpha-fetoprotein (AFP), alpha-albumin (alpha-ALB) and the AFP-related gene (ARG) protein.

It acts as a plasma carrier for many different ligands, such as fatty acids, retinoids, steroids, bilirubin, flavonoids, phytoestrogens, heavy metals, dyes, dioxins and various drugs. It can bind to many different types of membrane receptors and intracytoplasmic proteins (including numerous as yet undescribed) and block or enhance responses from intracellular signaling pathways. Because of this, it has the ability to modulate cell growth in fetal life and during tumorigenesis (in both situations, it can be an enhancer or an inhibitor) (Glowska-ciemny *et al.*,2023). Alpha fetoprotein is distinguished into two basic forms: the nAFP (native AFP) plasma protein in fetal circulation and the tAFP (tumor AFP), sourced from hepatocellular carcinoma (HCC).

As far as AFP has proven to be a valuable ally for the fetus, in HCC patients it turns into a treacherous foe. nAFP in the fetal stage is responsible for stimulating cell and tissue growth, with an evident benefit for the fetus. Adult people record trace concentrations of nAFP (of 5–8 ng/mL), which mainly conditions physiological cell regeneration and hematopoiesis. The tAFP is not a mutated form of nAFP; it differs only slightly in structure (in the glycosylation process) (Glowska-ciemny *et al.*,2023). In the case of the development of hepatocellular carcinoma, the growing tAFP level secures the supply of the required growth factors and nutrients for the forming neoplasm, creates and supports tumor-growth inductive conditions of immunosuppression, and causes drug resistance and metastases. To sum this up, it is responsible for features of malignancy (Glowska-ciemny *et al.*,2023). Alpha-fetoprotein (AFP) has been examined as a potential tumor marker in breast cancer. Elevated AFP levels may indicate specific breast cancer types, especially those with liver metastasis. A recent case study documented a breast cancer patient with significantly high serum AFP levels, which returned to normal following chemotherapy, suggesting a possible relationship between AFP secretion and tumor response (Kassab *et al.*, 2023). However, further studies are needed to clarify AFP's role in breast cancer.

Specific studies focusing on AFP levels in Nigerian breast cancer patients are scarce. However, research has been conducted on other serum biomarkers.

Given the global findings, investigating AFP levels in Nigerian breast cancer patients could provide valuable insights into their potential roles as biomarkers in this population. This research is warranted to explore these associations and their implications for breast cancer diagnosis and management in Nigeria.

Statement of Problem

Breast cancer is one of the most common malignancies affecting women worldwide, leading to significant morbidity and mortality. Despite advances in screening, diagnosis, and treatment, the variability in disease outcomes and the challenge of predicting prognosis remain critical issues. The identification of reliable biomarkers that can aid in early detection, assess prognosis, and guide treatment strategies is essential to improving patient outcomes. Alpha-fetoprotein (AFP), a glycoprotein often associated with liver cancers, have been suggested as potential biomarkers in various cancers. However, their roles in breast cancer, particularly in terms of their correlation with disease progression, prognosis, and response to treatment, are not well understood.

The problem addressed by this study is the lack of comprehensive data regarding the association between AFP levels in breast cancer patients. This gap in knowledge limits the ability of clinicians to use these markers effectively in routine practice, potentially missing opportunities for improved personalized care. Therefore, this study aims to assess the levels of AFP in patients with breast cancer and investigate their potential as biomarkers for disease progression and prognosis, with the goal of contributing to more precise and effective management strategies for breast cancer patients.

Justification of Study

Breast cancer is a leading cause of cancer-related deaths among women globally, with increasing incidence rates in many parts of the world. Preliminary studies suggest that AFP might be linked to breast cancer. This study is justified by the need to fill the existing gaps in the understanding of the roles of AFP in breast cancer. By investigating these biomarkers, the study aims to provide new insights that could lead to more effective and tailored management strategies for breast cancer patients, potentially improving survival rates and quality of life. This then remains the focus of the work.

Additionally, this research could pave the way for this study to explore the mechanistic links between Alpha-fetoprotein (AFP) and breast cancer, ultimately contributing to the broader field of cancer research and biomarker discovery. This research is also carried out to determine the prevalence of high Alpha-fetoprotein in breast cancer patients in Nnewi-north, Anambra state, as well as estimate if age predisposes prevalence of the disease.

MATERIALS AND METHODS

The study was carried out in Anambra State, Nigeria. It is a prospective cross-sectional study involving 90 using a convenience sampling technique: 45 Breast Cancer patients and 45 controlled subjects (Non- Breast Cancer patients' participants).

Subjects Recruitment

Area of Study and Study Design

The group of patients was recruited from Anambra State. Between September 2024 to 1st week of February 2025, a cross-sectional study of 45 Breast Cancer patients, females aged 18 to 60 years and forty (45) apparently healthy volunteer control subjects, females aged 18 to 60 years, that served as the group of which was recruited from anywhere in Anambra state.

Study Design

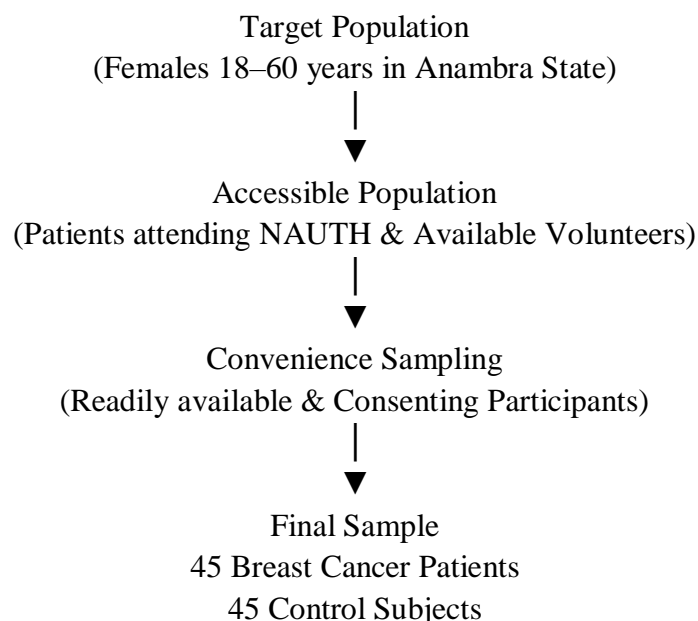
This research used a cross-sectional study design, which is suitable for assessing the prevalence of specific characteristics in a defined population at a single point in time (Creswell and Creswell, 2018). The cross-sectional design allows the simultaneous evaluation of Alpha-fetoprotein 45 Breast Cancer patients in Anambra State, facilitating a comprehensive understanding of their interrelationships in breast cancer patients.

Sample Size

Sample size was calculated using G*Power software (version 3.0.10). Power analysis for two independent groups was conducted in G*Power to determine a sufficient sample size using an alpha of 0.05, a power of 0.80 and a medium effect size ($d=0.50$). Based on these assumptions, the calculated total sample size of 90 (45 per group) has 80% power to detect a difference of 0.50 (medium effect size) at significance level of 0.05.

Study Population

The target population for this study consist of female patients with breast cancer within the age of 18 years to 60 years in NAUTH, Nnewi, Anambra State.



Inclusion Criteria

The study inclusion criteria include female participants, already diagnosed patients living with breast cancer and the control individuals with the age bracket (18 to 60 years), who gave their consent were incorporated.

Exclusion Criteria

The study exclusion criteria include female participants with HIV and control group outside the age bracket will be excluded. Also, the participants with additional conditions that could affect the results such as pregnant women/lactating mothers, liver failure, kidney failure, tuberculosis, heart failure history and history of harmful alcohol or substance use were excluded.

Ethical approval

The ethical approval for this research was obtained from the Ethics Committee of Ministry of Health, Anambra State of Nigeria with the reference number MH/COMM/523/VOL.83.

Data Collection

Data collection will occur through a combination of laboratory tests and patient interviews.

Anthropometric Measurements

Weight Measurements: The participants' weight was evaluated with a bathroom scale (Gulfex Medical and Scientific, England). The weight was measured in kilograms (kg) and recorded to the nearest 0.1kg. After nulling the scale to zero, each measurement was taken. Participants were measured while standing barefooted, wearing light clothing with pockets empty, headgear and excessive hair accessories removed, and their arms swinging naturally by their sides.

Height Measurements: With the buttocks, upper back, or head touching the measuring surface of the rule, the participant's height was measured in meters using a height scale calibrated in centimeters (stadiometer), and the reading was taken to the nearest 0.1cm value.

Body Mass Index (BMI): Each adult participant's BMI was calculated by dividing their weight in kilograms by the square of their height in meters (kg/m^2) as a measure of generalized obesity.

Blood Pressure Measurement:

Participants Preparation: All apparel that concealed the cuff placement position was removed from the participants. The participants were sitting comfortably, with their legs uncrossed and their backs and arms supported so that the center of the upper arm cuff was at the level of the right atrium (the midpoint of the sternum). They were told to stay as relaxed as possible and not to speak throughout the measurement.

Measurement: Blood pressure (BP), systolic, and diastolic pressure readings was taken from the participant's left arm using a sphygmomanometer (Omron Medical, United Kingdom) after being seated for ten minutes. The reading was taken in the morning to the nearest mmHg. Each participant was allowed to rest in this position for 10 minutes before the blood pressure was taken.

The cuff was tied around the participant's left arm, with the participant sitting comfortably on a chair with back support. The brachial artery was occluded and gradually deflated, and knockoff sounds detected (stethoscope) held over the artery. This sound was monitored attentively until it completely disappeared.

The mercury level in the sphygmomanometer scale where the first clear tapping sound appeared corresponded to the systolic blood pressure. The mercury level in the sphygmomanometer where the sound disappeared corresponded to the diastolic blood pressure.

The readings will be taken in both arms, and the average will be recorded as the participant's blood pressure. Two readings will be taken for each participant each time, and the average of the two readings computed and used as the participants' blood pressure for the study.

Sample Collection

Venous blood sample of five (5) mL was collected from each individual by venous puncture using disposable syringe and the blood was dispensed into a plain container and allowed to clot and retract then it was centrifuged at 4000rpm for 10minutes then the serum was extracted and dispensed into another plain container which was accurately labelled with a code specific to the individual and the samples was transported to the laboratory and stored at -20°C until testing.

Determination of serum Alpha-fetoprotein

The level of Alpha-fetoprotein in serum was determined using Sandwich ELISA Method.

Principle of Sandwich ELISA

Sandwich ELISA works on the principle of antigen-antibody reaction where the target antigen is detected via anchoring between two antibodies, which recognize different epitopes. Sandwich ELISA starts from the immobilization of an antibody, called a capture antibody, on the microtiter plate.

After blocking the plate surface to avoid non-specific adsorption of other proteins, the antigen in the sample is allowed to react with the immobilized capture antibody, and the antigen bound to the capture antibody is then sandwiched with an enzyme-labeled antibody for color development which is then read spectrophotometrically (Sakamoto *et al.*, 2017).

Reference Range: < or = 20ng/ml

Procedure of the Test

All reagents were brought (microplate wells) to room temperature (18 - 25°C) before use. The concentrated solution was diluted i.e 1 volume of wash buffer concentration with 49 volume of distilled water.

Pipetted standard of 50ml, serum samples and control were put into the desired number of coated wells, fixed on the holder. Enzyme's conjugate (100ml) was added into the same coated wells. It was mixed efficiently and incubated at room temperature for 60minutes; the incubated mixture was removed and washed 5 times with diluted wash buffer.

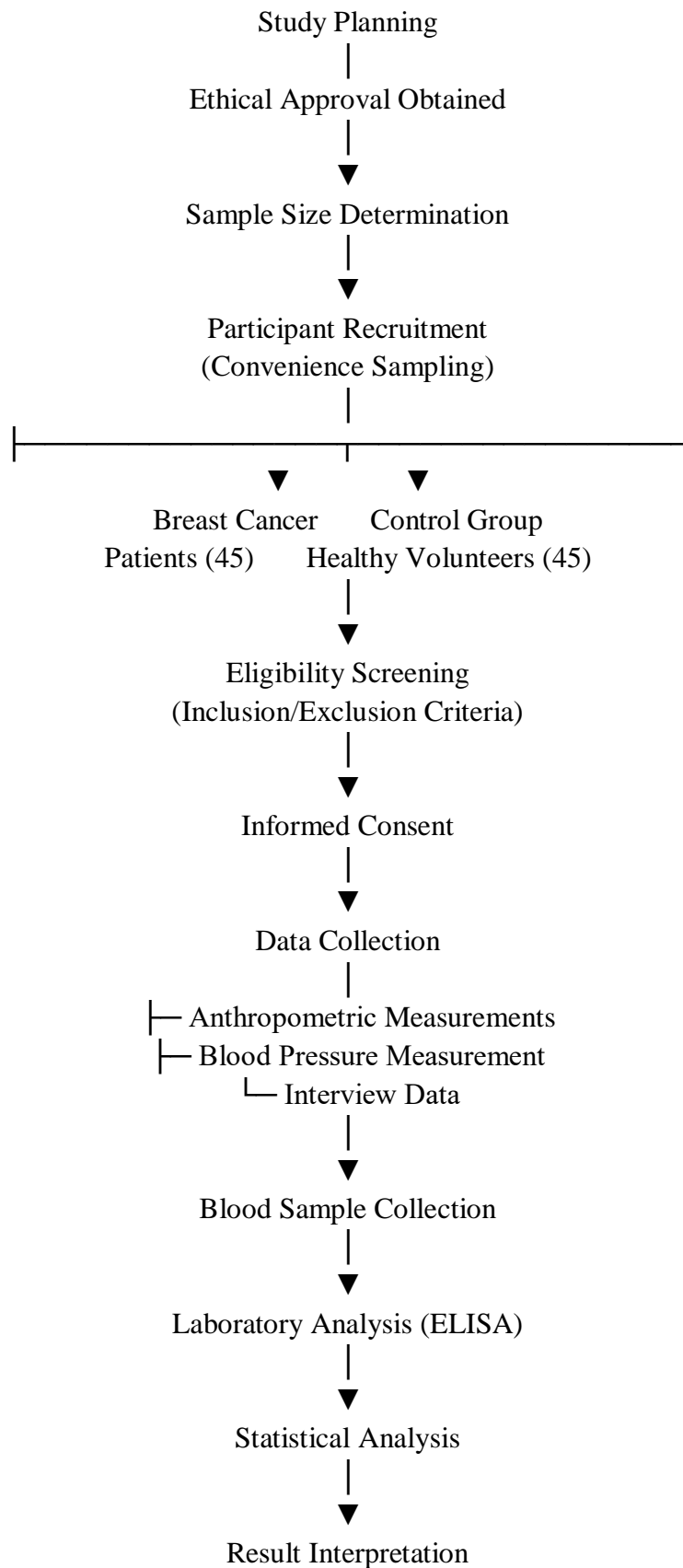
The wells were struck sharply into absorbent material (paper towel) to remove residual wash buffer. Substrate (A&B) will be pipetted into all the wells, gently mixed for 5 seconds and incubated at room temperature for 20 minutes; the incubated mixture will be removed and washed 5 times with diluted wash buffer.

Stop solution was added into the same coated wells, gently mixed for 30 seconds and the absorbance was read at 450nm using the microplate reader within 30 minutes.

Statistical Analysis

The outcomes of this study were statistically evaluated using SPSS software version 23.0, which is a statistical tool for social sciences. The variables were given a mean and standard deviation. Student's t-test statistical method was employed for comparisons.

Correlation coefficient was used to assess the association between two variables. Differences between three (3) age groups were assessed using Analysis of Variance (ANOVA) with Post Hoc (Non-parametric) comparison was used for intergroup variability. The comparison was done at 95% confidence level, a p-value equal to or less than 0.05 ($p \leq 0.05$) were considered statistically significant.



RESULT AND TABLE

Table 1: Comparison of Serum Alpha-fetoprotein levels among Breast Cancer Patients and the Control Group.

Table 4.1 shows that there was no significant difference in the serum levels of Alpha fetoprotein in women that had breast cancer compared to that of the women in the control group ($p>0.05$).

Table 1: Comparison of Serum Alpha-fetoprotein levels among Breast Cancer Patients and the Control Group

Parameters	Control (n=45)	Test (n=45)	t-value	p-value
Alpha fetoprotein (ng/mL)	0.58±1.56	0.70±0.73	-0.438	0.662 (NS)

Keys: NS: Not significant ($p>0.05$), n: Number of samples

Table 2: Comparison of Serum Alpha-fetoprotein levels across Different Age groups among Breast Cancer Patients.

Table 4.2 shows that there was no significant difference in the serum levels of alpha-fetoprotein levels across the age groups in breast cancer patients in NAUTH ($p>0.05$).

Table 2: Comparison of Serum Alpha-fetoprotein levels across Different Age groups among Breast Cancer Patients.

Age groups (years)	Alpha fetoprotein (ng/mL)
26 - 34 (A)	0.61±0.53
35 - 43 (B)	0.92±0.94
44 - 52 (C)	0.77±0.80
≥ 53 (D)	0.49±0.37
f-value	0.911
p-value	0.444 (NS)

Keys; NS: Not significant ($p>0.05$)

Table 3: Correlation of Serum

Alpha-fetoprotein with the Anthropometric Characteristics in Breast Cancer Patients.

Table 4.3 shows that there was no significant correlation between age, body mass index, systolic and diastolic blood pressure with alpha fetoprotein ($p>0.05$).

Table 3: Correlation of Serum Alpha-fetoprotein with Anthropometric characteristics in Breast Cancer Patients.

Correlation (n=45)	Alpha fetoprotein (ng/mL)	
	r – value	p-value
Age	-0.099	0.516 (NS)
BMI	0.265	0.078 (NS)
SBP	-0.203	0.182 (NS)
DBP	0.079	0.606 (NS)

Keys; NS: Not significant., BMI: Body mass index., SBP: Systolic blood pressure and DBP: Diastolic blood pressure.

Table 4: Correlation of Serum Alpha-fetoprotein with the Anthropometric Characteristics in Apparently Healthy Control Group.

Table 4.4 shows that there was no significant correlation between age, body mass index, systolic and diastolic blood pressure with alpha fetoprotein ($p>0.05$).

Table 4: Correlation of Serum Alpha-fetoprotein with the Anthropometric characteristics in Apparently Healthy Control Group.

Correlation (n=45)	Alpha fetoprotein (ng/mL)	
	r - value	p-value
Age	-0.204	0.179 (NS)
BMI	-0.051	0.739 (NS)
SBP	-0.275	0.067 (NS)
DBP	-0.186	0.222 (NS)

Keys; NS: Not significant, BMI: Body mass index, SBP: Systolic blood pressure, DBP: Diastolic blood pressure.

DISCUSSION

Breast cancer remains one of the most frequently diagnosed malignancies and a major contributor to cancer-related morbidity and mortality among women globally. The burden of breast cancer continues to rise, particularly in low- and middle-income countries where healthcare infrastructure, screening programs, and early detection strategies are still developing. In Nigeria, breast cancer represents the most common malignancy among women and remains a leading cause of cancer-related death. Several studies have reported increasing incidence rates in Nigeria, largely attributed to urbanization, lifestyle changes, delayed presentation, and limited access to diagnostic and treatment facilities. Consequently, there is an increasing demand for reliable, accessible, and cost-effective biomarkers that can aid early diagnosis, prognosis, and therapeutic monitoring of breast cancer.

This study evaluated serum Alpha-fetoprotein (AFP) levels among breast cancer patients and apparently healthy controls in Nnewi North, Anambra State, Nigeria. The primary aim was to determine whether AFP could serve as a potential biomarker in breast cancer diagnosis or disease monitoring. The findings from this study demonstrated that there was no statistically significant difference in serum AFP levels between women diagnosed with breast cancer and healthy control subjects aged 18 to 70 years. These findings suggest that AFP may not be a reliable biomarker for breast cancer detection within the study population.

Alpha-fetoprotein is a glycoprotein primarily synthesized by the fetal liver, yolk sac, and gastrointestinal tract during embryonic development. In adults, AFP levels are usually low but can increase significantly in certain malignancies, particularly hepatocellular carcinoma and germ cell tumors. The investigation of AFP in breast cancer has generated considerable scientific interest because of its known involvement in tumor biology and potential immunomodulatory effects. However, the findings of this study align with previous research suggesting that AFP is not consistently elevated in breast cancer patients.

The absence of significant differences in AFP levels between breast cancer patients and healthy controls in this study supports the findings of Smith and Williams (2024), who also reported that AFP levels did not differ significantly between breast cancer patients and non-cancer individuals. Their study suggested that breast cancer cells may not actively produce or secrete AFP, unlike hepatocellular carcinoma or germ cell tumors, where AFP synthesis is a hallmark of tumor activity. This observation supports the notion that AFP expression is highly tissue-specific and may not be directly involved in the pathophysiology of breast cancer in most cases.

Conversely, the findings of this study contradict earlier research by Moro, Gulyaeva–Tcherkassova, and Stieber (2012), who reported elevated AFP levels among breast cancer patients. The discrepancy between these findings could be attributed to several factors, including differences in study design, sample size, laboratory methodologies, and population characteristics. Breast cancer is widely recognized as a heterogeneous disease comprising multiple molecular subtypes such as luminal A, luminal B, HER2-enriched, and triple-negative breast cancer. These subtypes exhibit distinct biological behavior, genetic mutations, and treatment responses. It is therefore plausible that AFP expression may vary among specific breast cancer subtypes rather than being universally elevated across all breast cancer cases.

Furthermore, tumor microenvironment and genetic predisposition may influence AFP expression in breast cancer patients. Recent evidence suggests that AFP may play roles beyond being a tumor marker, including modulation of cell proliferation, apoptosis, and immune responses. According to Varzaru et al. (2024), tumor-specific biomarkers may influence other physiological and biochemical processes, and their expression can be influenced by tumor biology, host immune response, and genetic susceptibility. This supports the possibility that AFP may be relevant only in selected breast cancer cases or advanced disease stages.

Another key finding of this study was the absence of significant variation in AFP levels across different age groups among breast cancer patients. Age is an established risk factor for breast cancer, with incidence rates increasing with advancing age. However, the lack of age-related differences in AFP levels suggests that AFP production may not be influenced by age in adult breast cancer patients. This observation is consistent with the findings of He, Lu, and Zhang (2019), who reported that AFP levels remain relatively stable across different adult age groups and are primarily influenced by pathological conditions rather than physiological aging.

The absence of age-related variation in AFP levels may further indicate that AFP is not involved in age-related tumor progression mechanisms in breast cancer. Instead, breast cancer development and progression are influenced by multiple factors including hormonal exposure, genetic mutations such as BRCA gene alterations, environmental factors, and reproductive history. Therefore, AFP may not serve as a universal indicator of disease severity or progression across different age categories in breast cancer patients.

Additionally, this study demonstrated no significant correlation between serum AFP levels and body mass index (BMI) among participants. Obesity is recognized as an important modifiable risk factor for breast cancer, particularly in postmenopausal women. Obesity contributes to breast cancer development through multiple mechanisms including increased estrogen production, chronic inflammation, and insulin resistance. However, the absence of correlation between AFP and BMI suggests that AFP expression is unlikely to be influenced by adiposity-related metabolic changes in breast cancer patients.

This finding is consistent with previous research by Smith, Johnson, and Lee (2023), which reported no association between AFP levels and BMI in breast cancer patients. However, the findings contrast with those of Xu (2014), who demonstrated a significant relationship between AFP levels and metabolic parameters including BMI and blood pressure in patients with liver-related diseases. The discrepancy between these findings may be explained by differences in disease pathophysiology. AFP elevation in liver diseases is often associated with hepatic regeneration and metabolic dysfunction, whereas breast cancer progression is driven by distinct molecular and hormonal pathways.

Similarly, this study found no significant relationship between AFP levels and blood pressure among breast cancer patients. Hypertension has been associated with increased cancer risk and adverse treatment outcomes due to its relationship with metabolic syndrome and vascular dysfunction. Nevertheless, the lack of correlation observed in this study suggests that AFP levels are independent of cardiovascular risk factors in breast cancer patients. This finding is consistent with the report by Secher et al. (2019), who emphasized that physiological and metabolic factors may influence AFP levels differently depending on disease type and patient characteristics.

The findings of this study highlight the complexity of biomarker discovery in breast cancer research. Although AFP has proven clinical utility in hepatocellular carcinoma and germ cell tumors, its application in breast cancer appears limited. The heterogeneity of breast cancer emphasizes the need for multi-marker approaches rather than reliance on a single biomarker. Currently, commonly used breast cancer biomarkers include cancer antigen 15-3 (CA 15-3), carcinoembryonic antigen (CEA), and human epidermal growth factor receptor 2 (HER2). However, these markers also have limitations in sensitivity and specificity, particularly in early-stage disease detection.

The absence of significant AFP elevation among breast cancer patients in this study suggests that AFP should not be relied upon as a standalone diagnostic or prognostic marker for breast cancer in the studied population. Nevertheless, AFP may still possess potential relevance in specific clinical scenarios. Some experimental studies have suggested that AFP-derived peptides may exhibit anti-tumor properties and could be explored in targeted

cancer therapy. Furthermore, AFP may serve as a potential research biomarker in understanding tumor immunology and cancer progression mechanisms.

Implications of the Study

The findings of this study have several important clinical, research, and public health implications. First, the study provides evidence that AFP is not a reliable biomarker for breast cancer diagnosis among women in Nnewi North, Anambra State. This information is valuable for clinicians and laboratory scientists, as it discourages unnecessary reliance on AFP testing in breast cancer diagnosis, thereby reducing healthcare costs and improving diagnostic efficiency.

Second, the study highlights the importance of identifying population-specific biomarkers for breast cancer. Genetic diversity, environmental exposure, and lifestyle factors may influence biomarker expression among different populations. Therefore, further research should focus on identifying biomarkers that are more sensitive and specific to African populations. Such research could enhance early detection and improve survival outcomes among breast cancer patients in Nigeria and other developing countries.

Third, the findings emphasize the need for multi-biomarker panels rather than single-marker evaluation in breast cancer diagnosis and prognosis. Combining multiple tumor markers, molecular profiling, and imaging techniques may improve diagnostic accuracy and enable personalized treatment strategies. Advances in molecular biology, genomics, and proteomics provide opportunities for identifying novel biomarkers that may improve breast cancer management.

Fourth, this study contributes to existing literature by providing local data on AFP levels among breast cancer patients in southeastern Nigeria. Limited research exists on tumor biomarkers in this region, and this study helps bridge that knowledge gap. Local epidemiological data are essential for developing region-specific cancer control strategies and guiding healthcare policy development.

Fifth, the findings underscore the importance of strengthening breast cancer screening programs in Nigeria. Since AFP does not appear to be a reliable biomarker, emphasis should remain on established screening methods such as mammography, clinical breast examination, and public awareness campaigns. Early detection remains one of the most effective strategies for reducing breast cancer mortality. Sixth, the study highlights the need for further investigation into the biological role of AFP in breast cancer. While AFP may not serve as a diagnostic marker, its potential immunomodulatory and therapeutic roles warrant further exploration. Future studies could investigate AFP expression in specific breast cancer subtypes, advanced disease stages, or metastatic conditions. Finally, this study provides a foundation for future longitudinal and multicenter studies involving larger sample sizes. Such studies may provide deeper insights into biomarker variability, tumor biology, and disease progression in breast cancer patients.

Limitations and Future Research

Despite the valuable findings, this study has certain limitations. The use of a convenience sampling technique may limit the generalizability of the findings to the wider population. Additionally, the study did not evaluate AFP levels in relation to breast cancer molecular subtypes or disease stages, which may influence biomarker expression. Future studies should incorporate molecular classification, treatment outcomes, and long-term patient follow-up to provide more comprehensive insights.

CONCLUSION

This study demonstrated that serum AFP levels do not differ significantly between breast cancer patients and healthy individuals in Nnewi North, Anambra State, Nigeria. Additionally, AFP levels were not influenced by age, BMI, or blood pressure among breast cancer patients. These findings suggest that AFP may have limited diagnostic and prognostic utility in breast cancer management within the studied population. Nevertheless, continued research into novel biomarkers and molecular mechanisms remains essential for improving breast cancer diagnosis, treatment, and patient outcomes.

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