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EVALUATING THE AGE-SPECIFIC PREVALENCE OF PROGNOSTIC CANCER MARKERS AMONG CANCER PATIENTS IN LAGOS, NIGERIA

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Authors

Tunde Animashaun
Nzube Ekpunobi
Oluwatosin Idowu
Nwasolu Obidi

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Abstract

Cancer antigens serve as critical biomarkers for the diagnosis, prognosis and monitoring of various cancers. This study evaluates the age-specific prevalence of five key cancer antigens among cancer patients in Lagos, Nigeria—Carcinoembryonic Antigen (CEA), Cancer Antigen 125 (CA 125), Cancer Antigen 15-3 (CA 15-3), Cancer Antigen 19-9 (CA 19-9), and Prostate-Specific Antigen (PSA).

Utilizing a cross-sectional design, data from 572 cancer antigen-positive samples were collected from two diagnostic laboratories and analyzed to identify demographic patterns in antigen positivity. Results indicate distinct age and gender distribution for each antigen. PSA positivity was highest among males over 70 years, while CA 125 and CA 15-3 showed a significant prevalence in females aged 41-50 years. CA 19-9 and CEA levels were elevated in older age groups, particularly in individuals over 50, correlating with the age of gastrointestinal and colorectal cancer risks.

The findings highlight the potential of these biomarkers for targeted cancer screening based on age and gender, emphasizing the value of demographic-specific screening strategies in enhancing early detection and improving cancer management outcomes in Nigeria.

This study provides a basis for developing effective cancer screening programs to triage and optimize resource allocation, particularly in regions with limited access to diagnostic tools.

Keywords: Cancer antigens, Age-specific prevalence, Biomarkers, Cancer screening, Nigeria

1.0. Introduction

Cancer antigens are crucial biomarkers for the diagnosis, prognosis and monitoring of tumours. They can enable early cancer identification and support tailored therapy methods (1). Carcinoembryonic Antigen (CEA), Cancer Antigen 15-3 (CA 15-3), Cancer Antigen 19-9 (CA 19-9), Cancer Antigen 125 (CA 125) and Prostate-Specific Antigen (PSA) are all biomarkers that are typically linked to particular cancer types. As such, they allow for more precise detection or monitoring of specific cancers.

While cancers also have varying antigen expression patterns influenced by genetics, environment and lifestyle, age in particular is a significant factor in cancer development, as certain antigens appear more frequently at specific life stages (2, 3). For instance, PSA levels tend to rise in men over 50 years, with mortality risk correlating with older age at diagnosis (4).

Similarly, carcinoembryonic antigen (CEA) levels and CA 19-9 are elevated in older adults with colorectal cancer, with the highest levels seen in those over 75 years (5). Although, CEA assay may be non-specific for identifying a primary cancer site, critical levels above > 20 ng/mL do indicate the presence of Malignancy.

Also, elevated levels of CA 15-3 have been shown to indicate metastatic breast cancer in 76% of cancer patients (6, 7, 8).

The burden of cancer remains high in sub-Saharan Africa and Nigeria by extension, where limited access to healthcare services and early diagnostic tools contributes to higher cancer mortality. Aside from the emergence of antimicrobial resistance in the region, cancer has also become a public health concern with a potential threat to the healthcare system in Nigeria (9, 10).

There is also a notable scarcity of data on the age-specific prevalence of these cancer antigens among cancer patients in Nigeria. This gap in knowledge makes it difficult to determine optimal screening times and methods, potentially leading to delayed diagnosis.

This study aims to fill in that gap by evaluating cancer patients tested across Lagos, Nigeria. Understanding these age-related patterns is crucial for implementing effective screening programs across the country.

2.0. Methodology

2.1 Research Design

This is a retrospective study, utilizing a cross-sectional design to evaluate the prevalence of key cancer antigens across different age groups. This design will facilitate a snapshot assessment of risk across a demographically diverse population in Lagos.

The study focused on five cancer antigens that were confirmed positive by pathologists at the laboratories between July 2023 and September 2024. Data were collected retrospectively from laboratory records across two diagnostic centres in Lagos, matching the antigen test results with patient demographic information. The following details were extracted:

1. Demographic Information: Age and sex of the patient.

2. Antigen Test Results: Positivity status for any of the five cancer antigens (CEA, CA 125, CA 19-9, CA 15-3 and PSA).

The data was further screened for the positive cancer antigens with elevated values (I.e; CA 125: > 50 IU/mL; CA 19-9: > 50 IU/mL; CA 15-3: > 40 IU/mL; CEA: > 35 ng/mL; PSA: > 20 ng/mL)

Data accuracy was ensured by conducting thorough checks on the extracted records to identify and correct any inconsistencies, duplicate entries or incomplete records.

2.2 Inclusion Criteria

1. Cancer patients who underwent cancer antigen testing as part of their diagnostic/prognostic requirements in Lagos state within the study period.
2. Complete and verifiable records, including patient age, gender, and specific antigen test results.

2.3 Exclusion Criteria

1. Records lacking age information or results with normal/non-elevated values for any of the selected cancer antigens.
2. Incomplete records that would compromise the accuracy of the analysis, such as missing demographic details.

2.4 Data Analysis

Data was analysed using IBM SPSS 24.0 Statistical software to determine the prevalence of each cancer antigen across defined age groups. Basic descriptive statistics, such as frequency and percentage distribution, were computed for each antigen test result, stratified by age group.

Age groups were divided based on common demographic age ranges to facilitate comparative analysis. For each antigen, linear regression was considered to assess trends in prevalence rates across age groups. This allowed the study to determine if antigen positivity increases or decreases with age and to identify any antigen-specific trends associated with ageing.

2.5 Ethical Considerations

The study was carried out according to the ethical guidelines of the World Medical Association Declaration of Helsinki 2000 and did not cause harm to any human subject.

3.0. Results

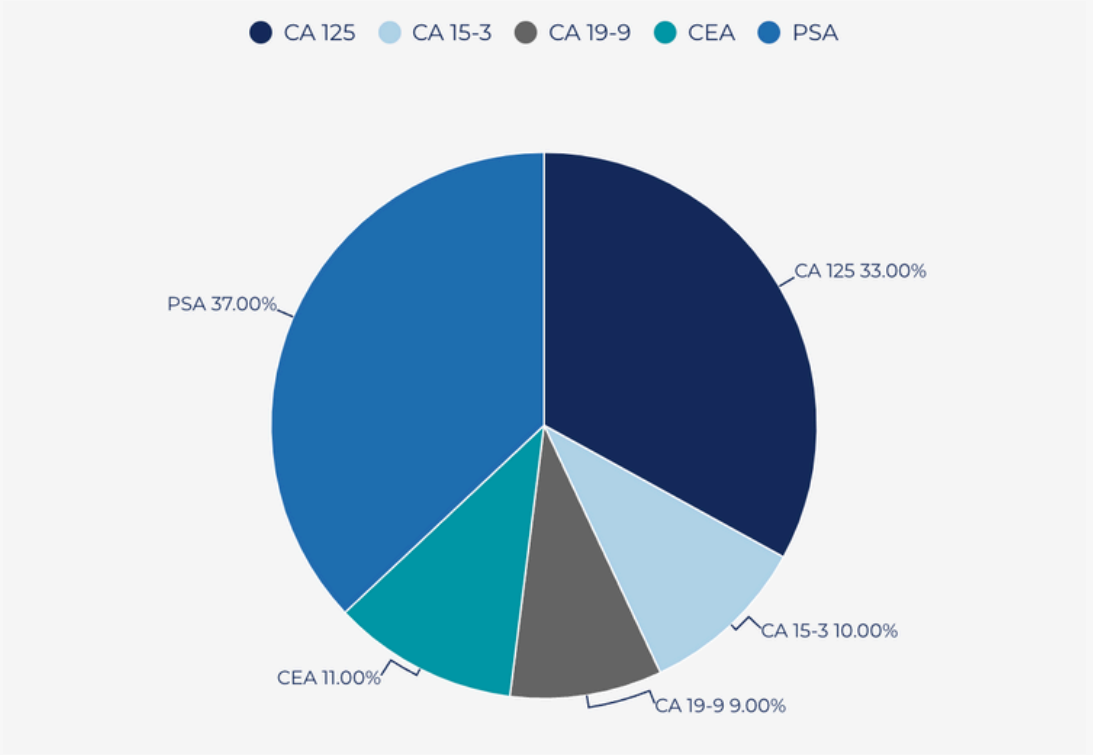

Figure 1: Distribution of Cancer Antigens in the study population

The dataset analysed a total of 572 cancer antigen-positive samples distributed across five key cancer antigens: Carcinoembryonic Antigen (CEA), Cancer Antigen 15-3 (CA 15-3), Cancer Antigen 19-9 (CA 19-9), Cancer Antigen 125 (CA 125) and Prostate-Specific Antigen (PSA).

3.0. Results Contd

Each antigen shows distinct positivity patterns across the sample population, indicating potential demographic trends by gender and age group. PSA positivity accounts for the highest number of samples, with 210 out of 572 cases (approximately 36.7% of the total).

CA 125 had 189 positive samples, representing 33% of the total cases. A total of 56 samples (9.8% of all cases) tested positive for CA 15-3. CA 19-9 was positive in 66 cases (11.5% of the total samples). And with 51 positive cases, CEA represented 8.9% of the dataset.

Table 1: Gender Prevalence of Cancer Antigen among the Study Population

CANCER ANTIGEN	MALE	FEMALE	TOTAL
Cancer Antigen 125	2	187	189
Cancer Antigen 15-3	5	51	56
Cancer Antigen 19-9	36	30	66
Carcinoembryonic Antigen	25	26	51
Prostate-Specific Antigen (PSA)	210	0	210
TOTAL	278	294	572

3.1 Gender Distribution

The majority of positive CA 125 samples (187 out of 189) were found in females, indicating a strong gender association. Similarly, CA 15-3 showed a pronounced gender bias, with 51 of the 56 positives occurring in females, suggesting its relevance in female populations.

CA 19-9 had a more balanced distribution across genders, with 36 positive samples in males and 30 in females. This indicates that CA 19-9 may not be significantly gender-biased. CEA displayed nearly equal positivity between males and females, with 25 male and 26 female cases, showing no marked gender difference.

3.2 Age-group Distribution

For CA 125, positive cases were primarily concentrated in the 41-50 age group, with 42 cases. Other significant counts were observed in the 31-40 group (39 positives) and the 51-60 group (34 positives). This indicates that Cancer Antigen 125 is most prevalent among middle-aged individuals, particularly in the 41-50 age bracket.

The highest positivity in Cancer Antigen 15-3 was also recorded in the 41-50 age group (24 cases), followed by the 51-60 group (12 cases). Very few positives were noted in younger age groups, indicating that CA 15-3 primarily affects middle-aged and older individuals. Cancer antigen 19-9 peaked in the 51-60 age group with 21 positive cases, while the 61-70 group followed with 15 positives.

3.0. Results Contd

The 41-50 group had 14 cases. These results suggest that Cancer Antigen 19-9 is more common in individuals aged 51 and above, with a gradual increase in positivity with age. Positivity for CEA was highest in the 61-70 age group, with 21 cases. The 51-60 and 41-50 groups each had 10 cases. This age-based pattern suggests that CEA positivity increases with age, reaching its peak in the 61-70 age range.

PSA had a significant concentration of positives in the 71-80 age group, where 82 cases were recorded. This was followed by the 61-70 age group (66 cases) and the 51-60 group (32 cases). The high prevalence in older age groups, especially those over 70, highlights the relevance of PSA screening for detecting prostate issues in ageing male populations.

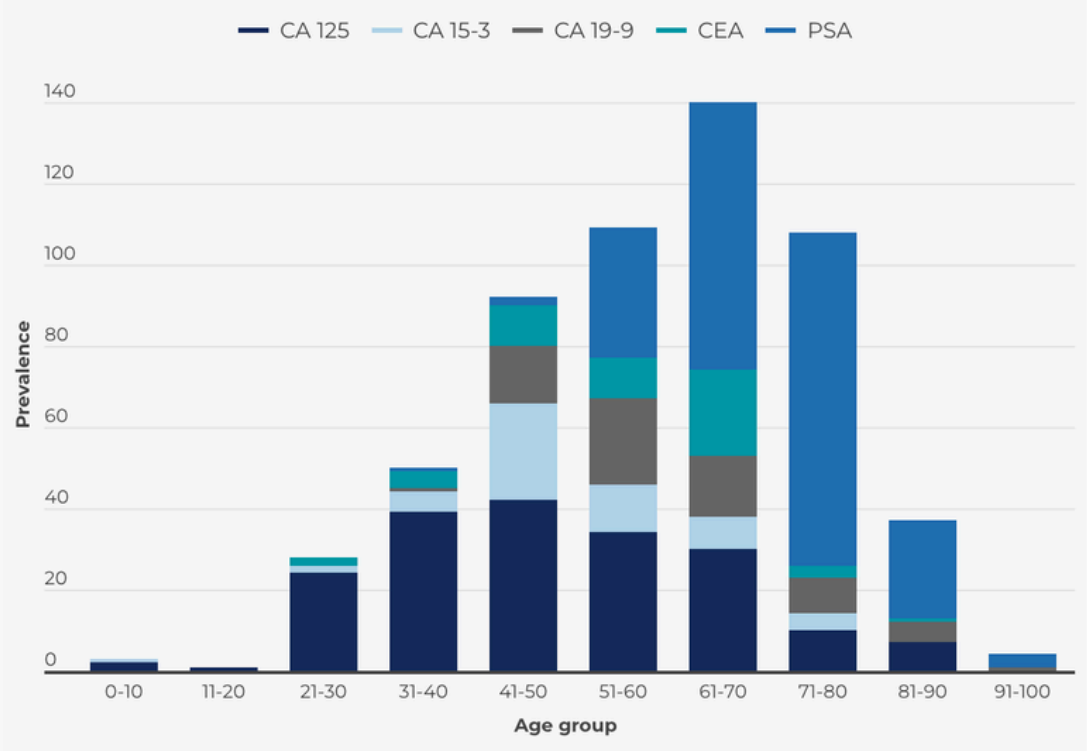

Figure 2: Age Prevalence of Cancer Antigens

4.0. Discussion

This study provides a comprehensive analysis of cancer antigen positivity across gender and age groups, focusing on PSA, CA 125, CA 15-3, CA 19-9, and CEA. The findings reveal distinctive demographic trends, particularly gender-specific differences in antigen positivity and a general increase in positivity with age. These results are consistent with known biological patterns associated with these markers, as well as with findings reported in related studies.

The observed gender disparity in cancer antigen positivity aligns with other studies examining PSA, CA 125, and CA 15-3. PSA, which exclusively affects males in our dataset, is a well-established marker for prostate cancer and related conditions, with positivity rates often peaking in older men due to age-associated prostate enlargement and cancer risk.

As studies show, PSA levels tend to increase with age, particularly in men over 50, due to both benign and malignant prostate conditions (11).

The predominance of CA 125 positivity among females supports its clinical relevance as a biomarker for ovarian cancer. A 2020 study by Charkhchi et al. found that elevated CA 125 is particularly valuable in monitoring high-risk populations of women aged 40 and above, emphasizing its significance for age-appropriate screenings (12).

But elevated serum CA 125 levels are not only linked to ovarian cancers. Two of the male subjects also had elevated values, which according to research, could be due to benign diseases like alcoholic hepatitis, cysts, pleuritis, pericarditis, and peritonitis. Elevated CA 125 levels in colorectal cancer are also known to be a sign of peritoneal dissemination (13, 14).

4.0. Discussion Contd

It is also worth noting that the use of this biomarker (in serum and bodily fluids) for diagnosing pulmonary and extrapulmonary tuberculosis (TB) has been the subject of approximately 35 publications in the PubMed database during the last five years. According to several case reports and the results of about five case-control studies, CA 125 may be a useful marker for identifying active pulmonary tuberculosis (13, 15, 16, 17).

The SLE (Systemic Lupus Erythematosus) bias observed in CA 15-3 positivity is consistent with its association with breast cancer. Research has demonstrated that CA 15-3 levels are often elevated in women with metastatic breast cancer, especially in those over 40 years (18). This correlates with the value of CA 15-3 as a diagnostic and monitoring tool for breast cancer, particularly in middle-aged women, as observed in similar studies.

The overall increase in cancer antigen positivity with age, particularly for PSA, CA 19-9, and CEA, aligns with trends noted in previous studies (19). CA 19-9 and CEA, both associated with gastrointestinal and pancreatic cancers, also demonstrated age-related increases in positivity, peaking in individuals over 50.

According to Locker et al., CA 19-9 elevations are particularly prevalent in populations over 50, which correlates with higher incidences of gastrointestinal cancers (20).

CEA's role as a general tumor marker especially in colorectal cancer, has also been widely noted in the literature. Reports suggest that CEA sensitivity in detecting colorectal cancers improves with age, particularly in individuals over 60 (21).

The peak in CA 125 and CA 15-3 positivity within the 41-50 age group for females highlights the importance of these markers in early to middle adulthood. Similar studies have found that CA 125 levels are particularly useful as a screening tool in women entering their 40s, especially for those with family histories of ovarian cancer or other risk factors (22).

Additionally, CA 15-3, often used to track breast cancer progression, has been noted to be particularly elevated in middle-aged women with advanced or metastatic disease. This aligns with findings in 2023 by Ryu et al., which report higher CA 15-3 levels in women aged 40 and above with advanced breast cancer (23).

4.1. Trend Analysis of Cancer Antigen Positivity

The analysis of cancer antigen positivity across different demographics reveals important trends that may guide future screening and monitoring strategies.

1. Gender-Specific Trends

PSA: Positivity for PSA was found exclusively in males, aligning with its application in prostate health assessments. PSA represented the largest subset of positive cases (36.7% of the total sample), indicating that prostate cancer or related conditions are a significant contributor to overall cancer antigen positivity in the male population.

CA 125 and CA 15-3: Both CA 125 and CA 15-3 showed strong female predominance. CA 125, comprising 33% of total positives, is most commonly associated with ovarian cancer detection, reflecting its higher positivity rate among females. CA 15-3, often used in breast cancer monitoring, similarly displayed a gender-specific pattern, with 91% of positive samples found in females. This trend underscores the role of these antigens in female-targeted cancer screenings.

2. Age-Specific Trends

Increasing Positivity with Age: A common trend observed across most antigens is an increase in positivity with age, suggesting a greater need for cancer screening among older populations. PSA positivity, for example, was most prominent in males over 70, aligning with the increased prevalence of prostate-related conditions in advanced age.

Older Age Peaks: CA 19-9 and CEA positivity peaked in the 51-70 age range, with the highest CEA positivity in the 61-70 group. These antigens are often associated with gastrointestinal and colorectal cancers, which tend to be more prevalent with age. The observed trends imply that routine screening for these antigens might be most impactful in populations over 50, particularly as positivity rates tend to increase with age.

3. Antigen-Specific Trends and Implications

Cancer Antigen 19-9: The distribution of CA 19-9 positivity suggests that this marker is relatively evenly distributed across genders but increases in older populations. This trend aligns with CA 19-9's association with gastrointestinal cancers, which become more common as individuals age.

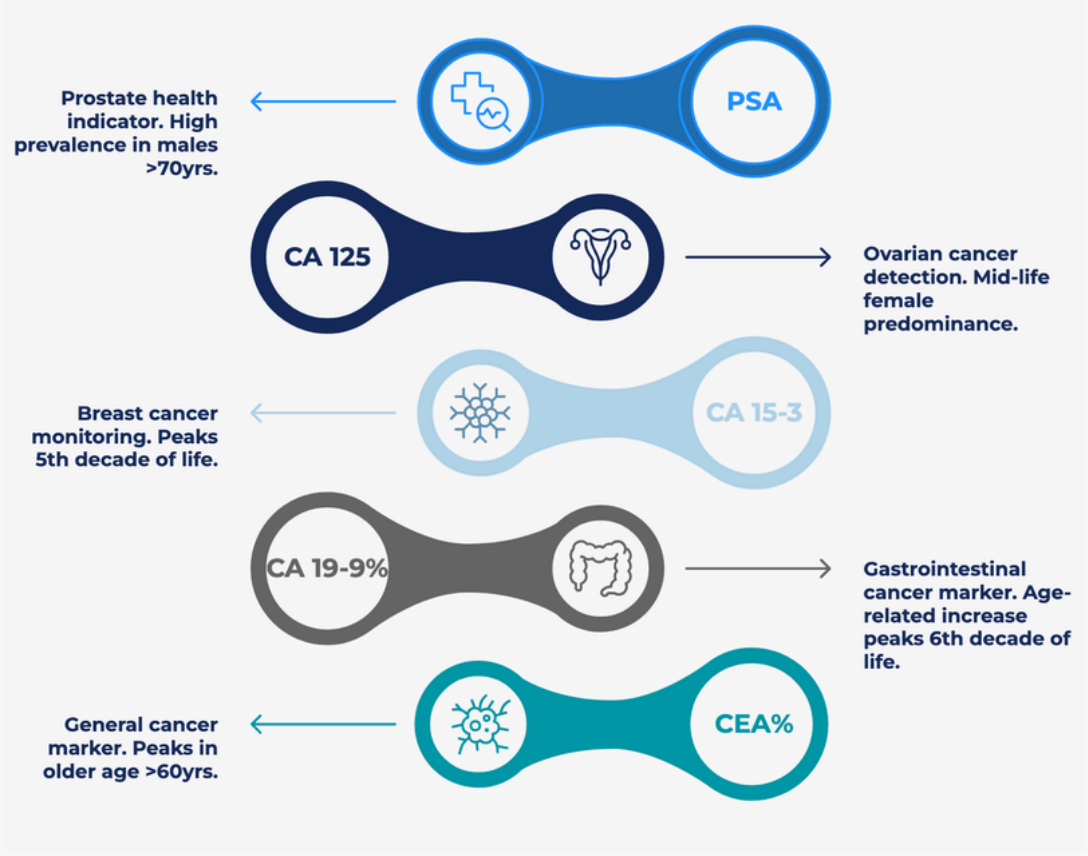

Figure 3: Cancer Antigen Trends by Demographics

Carcinoembryonic Antigen (CEA): CEA also showed balanced gender positivity but increased with age, peaking in the 61-70 age group. CEA's broader association with various cancers suggests that it may serve as a general marker in cancer screenings for older adults, where positivity rates are highest.

4. Summary of Trends

In summary, the trend analysis highlights distinct age- and gender-specific patterns in cancer antigen positivity:

Gender-Specific Trends: PSA positivity is male-exclusive, while CA 125 and CA 15-3 show strong female predominance.

Age-Related Trends: Cancer antigen positivity generally increases with age, particularly for PSA, CA 19-9, and CEA.

Middle vs. Older Age Peaks: CA 125 and CA 15-3 are most relevant for middle-aged females (41-50), while PSA, CA 19-9, and CEA positivity peaks in older populations (50 and above).

The trends identified in this study suggest that cancer antigen testing could be more effectively targeted by age and gender. PSA testing may be especially beneficial in men over 60, while CA 125 and CA 15-3 screenings could be prioritized for women starting in their early 40s, particularly those at high risk for ovarian or breast cancer. Similarly, routine screening for CA 19-9 and CEA may be most impactful for individuals over 50, where positivity rates indicate an increased likelihood of gastrointestinal or colorectal cancer.

This approach aligns with recommendations by established cancer screening guidelines, which advocate for demographic-specific screening protocols to enhance early detection and effective treatment (24).

Future research should consider longitudinal studies with diverse populations to confirm the observed trends and further elucidate the biological mechanisms underlying cancer antigen variation by age and gender. Expanding the scope to include other cancer antigens and risk factors could also provide a more holistic understanding of demographic patterns in cancer biomarker positivity.

5.0. Conclusion

This study highlights notable trends in cancer antigen positivity across gender and age groups, with clear patterns emerging for PSA, CA 125, CA 15-3, CA 19-9, and CEA. Our findings align with existing research that underscores the demographic-specific variations in these markers, providing insights into their potential roles in age- and gender-targeted cancer screening programs.

The predominance of PSA positivity in older males and the age-related increases in CA 19-9 and CEA positivity suggest a higher risk of prostate and gastrointestinal cancers in these groups. Similarly, elevated levels of CA 125 and CA 15-3 in females, particularly in middle-aged adults, support their diagnostic value in ovarian and breast cancers, respectively. These findings underscore the need for tailored screening strategies that could improve early detection, diagnosis and monitoring of cancer.

Although our study provides valuable insights, it also points to the need for further research across larger, more diverse populations to validate these trends. Additionally, longitudinal studies could help clarify the causative links between age, gender and cancer antigen levels, providing a clearer foundation for demographic-based cancer screening recommendations. This targeted approach to screening has the potential to optimize resource allocation and enhance outcomes in cancer care, particularly in high-risk populations.

6.0. Sponsorhip

This study was funded from the 2024 research and development budget of Metaphor Laboratory Partners LLC.

7.0 Conflict of Interest

There are no conflicts of interest.

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Web: www.metaphorlaboratory.com

Email: info@metaphorlaboratory.com