RESEARCH PAPER

Liquid Biopsy in Cancer Management: An Empirical Analysis of Awareness, Efficacy, and Adoption Barriers

Abdul Qadeer Memon[1], Dr. Sudhair Abbas Bangash[2*], Avrina Kartika Ririe[3], Axmedov Ahadullo Qosim o'g'li[4], Chukwuma J. Okafor[5]

[1]Assistant Professor, Department of Surgery, College of Medicine, King Faisal University, Saudi Arabia. Email: drqadeermemon@yahoo.com, amuhammad@kfu.edu.sa ORCID: https://orcid.org/0000-0002-7071-9489

[2*]Faculty of Life Sciences, Department of Pharmacy, Sarhad University of Science and Information Technology, Peshawar, Pakistan. Email: sudhair.fls@suit.edu.pk (Corresponding Author)

[3]Pathology & Laboratory Medicine, David Geffen School of Medicine at UCLA/UCLA Health, Los Angeles, California, USA. Email: ARirie@mednet.ucla.edu

[4]Assistant, Department of Propedeutics of Internal Diseases, Fergana Public Health Medical Institute, Fergana City, Uzbekistan. Email: axadulloaxmedov09@gmail.com

[5]Department of Pathology and Biochemistry, State University of Zanzibar, Tanzania. Email: chukwumakfr@gmail.com ORCID: https://orcid.org/0000-0002-2815-1439

ABSTRACT

Background: Liquid biopsy is one of the revolutionary and minimally invasive methods in the sphere of oncology that allows detecting and tracking cancer by employing circulating tumor DNA and circulating tumor cells as the biomarkers. It has immense benefits as compared to conventional tissue biopsy, such as real-time monitoring and reduced risk to the patient. Although this issue is increasingly becoming important, it still differs in awareness and acceptance across various groups of people and thus requires an empirical study.

Objective: The proposed study is designed to discuss the role of liquid biopsies in the diagnosis and monitoring of cancer by assessing consciousness, perceived efficacy, benefits, difficulties, and future opportunities, and how they can affect the perception in general.

Methodology: In the study, a structured questionnaire was used with 200 respondents (medical professionals, researchers, and students) as the quantitative, cross-sectional research design. The collection of data was done in a five-point Likert scale, with statistical analysis done in SPSS, including descriptive statistics, normality test, Cronbach's alpha test of reliability, KMO, Bartlett test of validity, Pearson correlation, regression analysis, t-test, one-way ANOVA, Kruskal-Wallis test, and Chi-square test.

Results: The results indicated that the data were normally distributed, dependable, and valid. The analysis of correlation showed that all the variables have strong positive relationships. Through regression analysis, it was established that awareness, effectiveness, monitoring, advantages, challenges, and future potential are important and have a positive impact on overall perception. Significant differences and associations among demographic variables (age and gender) were verified with the help of the inferential tests.

Conclusion: The paper has concluded that liquid biopsy is a very promising instrument in the diagnosis and monitoring of cancer, which is highly accepted due to its non-invasive, clinical, and potential. Nevertheless, in a bid to ensure its wide adoption, the issues of cost, sensitivity, and standardization need to be addressed. These findings have significant implications for healthcare professionals, researchers, and policymakers to facilitate the use of liquid biopsy in normal clinical practice.

Keywords: Cancer Diagnosis, Circulating Tumor DNA (ctDNA), liquid biopsy, Cancer Monitoring, Non-Invasive Techniques, Precision Medicine, Oncology, Statistical Analysis

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Introduction

Cancer is among the major causes of morbidity and mortality in the world and hence has been a burden to the healthcare systems and communities. Early diagnosis and continuous monitoring are significant to optimize patient outcomes, make treatment choices, and avoid mortality. The diagnosis of cancer, historically, has been made using the obtained tissue biopsy as a result of the conducted surgery aimed at removing the samples of the tumor on which the histopathological and molecular examinations would take place. Although considered the gold standard, tissue biopsy is a costly and invasive method, and the heterogeneity and availability of the tumors normally limit the application of the technique. The limitations have led to the need to have more efficient and less invasive diagnostic tools, which have led to the creation of liquid biopsy, which has become a breakthrough in the oncology field (Mostaque Md. Morshedur Hassan, 2025).

The liquid biopsy is another term that is used to refer to the study of the tumor-derived components that are present in body fluids, specifically in blood. These elements are circulating tumor cells (CTCs), circulating tumor DNA (ctDNA), and extracellular vesicles (exosomes). Liquid biopsy is an invasive technique as compared to the traditional biopsy that can be repeated to give an opportunity to track the dynamics in tumors in real time. It is especially practical in the study of the development of tumors and in the identification of low cellular residual disease, and in the indication of the initial suspicion of recurrence or metastasis. Therefore, there has been a significant amount of interest in liquid biopsy as a new technology that finds usefulness in cancer diagnostics or in the treatment of the disease (Syed Waqas Ali Shah, 2025).

Among the significant advantages of liquid biopsy, it is possible to single out its ability to diagnose cancer at an early stage. Early diagnosis should be conducted to improve the survival rates, as in most cases, the treatment in such conditions is better when the cancer is identified earlier, before it has metastasized or spread. Even before a cancer develops, the genetic mutations and molecular changes that are related to cancer can be detected using a liquid biopsy. Besides, it promotes precision medicine: it allows identifying certain genetic profiles and using its treatments specifically for the particular aspects of the patient (Irum Sherwani Summaiya, 2025).

Besides being used in treatment response monitoring, liquid biopsy is also crucial in the treatment response aspect. Following the fluctuations in the level of ctDNA during the treatment, the clinicians will be able to evaluate the effectiveness of the treatment and to implement changes as soon as possible. It also enables the identification of mutations of drug resistance that are a significant problem in managing cancer. This type of dynamic monitoring will give a detailed picture of the tumor behavior, which could not be presented with the use of the traditional biopsy methods that represent the static picture of the tumor (Kaleem Ullah Ihsan, 2026).

The introduction of liquid biopsy is not as easy as it has many benefits. The low sensitivity in early stages of cancer, high cost, and standardization of the protocols are also major setbacks. In addition to that, the technology is not well accepted and known among healthcare providers and the general population. In this way, the relevant determinants of the latter perceptions and acceptance should be researched to make liquid biopsy successful in clinical practice (Mislim Zendeli, 2023).

In this respect, the current research will focus on the role of liquid biopsies in the diagnosis and monitoring of cancer by addressing the key points of their awareness, efficacy, advantages, obstacles, and opportunities. The proposed research contributes to the further explanation of how liquid biopsy can be implemented in modern healthcare systems to improve cancer management and patient outcomes through the provision of empirical evidence (Macedonia, 2022).

Literature Review

Liquid biopsy is a widely addressed notion during the last several years due to the fact that this is a rather innovative step toward the process of monitoring and diagnosis of cancer. As opposed to the well-established traditional tissue biopsy, in which one can analyze the tumor biomarkers only in an invasive manner, liquid biopsy assumes the analysis of the tumor-derived

biomarkers in the body fluids, in particular, the blood. The World Health Organization claims that cancer is one of the leading causes of death in the world, which is why innovative diagnostic methods to facilitate the timely discovery of the disease and its adequate management are extremely required. The first possible such alternative that has been suggested is the liquid biopsy, which is the least invasive and fast and most dynamic method of measuring tumor biology (Praveenkumar Periyasamy1, 2024).

Several publications have been devoted to the circulating tumor DNA (ctDNA) as one of the key components of the liquid biopsy. The ctDNA is a fragmented DNA that oncotic cells release into the blood, and this is actually a reflection of the genetic makeup of the cancer. Research conducted by Alberto Bardelli and others revealed that actionable mutations can be detected in both ctDNA and the time evolution of the tumor could be traced. This is mostly helpful in precision medicine, under which the treatment option of an individual is based on their genetic profiles. On the same note, the study of Luis Diaz also showed the importance of ctDNA in identifying minimal residual disease (MRD) and early warning of relapse in cancer patients, which is another reason to support the use of ctDNA in clinical practice (Praveenkumar Periyasamy1*, 2024).

Along with ctDNA, circulating tumor cells (CTCs), and exosomes, both have also been extensively researched as biomarkers in liquid biopsy. The CTCs are abbreviated cells of the cancer, and they are dislodged from the primary tumor and are found in the blood, which is vital during the metastasis process. The availability and the number of CTEs have been found to give useful prognostic data. Exosomes are, however, small extracellular vesicles that are equipped with proteins, RNA, and DNA by tumor cells. Studies indicate that exosomes mediate cell-cell communication and also help tumors to develop. These biomarkers combined would give a complete picture of the tumor dynamic, and hence, liquid biopsy is an effective instrument in oncology (Likowsky Desir4 Hira Aslam1*, 2024).

One such potential diagnostic is a liquid biopsy that has undergone extensive literature research. Early diagnosis of cancer plays a key role in enhancing better results of survival and liquid biopsy provides an exclusive opportunity of early detection of the mutation of cancer-related ones. Studies have shown that the type of cancer that could be detected using liquid biopsy includes lung, breast, and colorectal cancer, which is relatively precise. One such example is that liquid biopsy can be used to treat lung cancer patients because it has been identified to detect epidermal growth factor receptor (EGFR) mutation in patients. These findings describe the relevance of liquid biopsy to enhance the precision of the diagnosis and lead to a personalized approach in treatment (Tariq Rafique Praveenkumar Periyasamy1*, 2024).

In addition to the diagnosis process, liquid biopsy is also very significant in the treatment response and disease progression monitoring. The conventional biopsy systems only give a picture of the state of the tumor, but not the dynamic state, unlike the liquid biopsy system, which can monitor the state of the tumor with repeated samples. This dynamism would enable clinicians to know the effectiveness of the treatment process in real time as well as detect the occurrence of drug resistance mutations. Research indicates that a positive or negative change in the ctDNA levels correlates with the tumor burden, and hence, ctDNA is a positive biomarker to follow the disease progression. This is particularly reasonable in cancer that develops to high levels, where treatment modification that transpires over time could have colossal impacts on patient outcomes (PERIYASAMY, 2024).

Despite the fact that the literature is more focused on the benefits, it nevertheless exposes several issues that are associated with liquid biopsy. The fact that it is not very sensitive in the presence of early-stage cancer is among the major issues, as during the early stages of cancer development, the concentration of ctDNA in the blood is relatively low. Moreover, the fact that the results are reasonable due to the lack of standardized protocols and a difference in how the results were analyzed can also affect the reliability and reproducibility of the results. Affordability and price are also a big concern, particularly in the low and middle-income countries. The false positives and false negatives were also raised in the studies, where the results can be misinterpreted. All these restrictions suggest that the liquid biopsy has enormous potential, and the means to address these

shortcomings can be brokered through the tradition of doing more studies and technological advancements (Praveenkumar Periyasamy7 Abdullah Tariq1*, 2024).

On the other hand, most of these deficiencies are bound to be rectified by new technologies and data analysis programs that are likely to be implemented in the recent past. The data of artificial intelligence and machine learning, combined with the liquid biopsy, have proven a possibility to increase the detection and prediction level. Liquid biopsy tests have an increased sensitivity and specificity with the use of advanced sequencing methods, including next-generation sequencing (NGS). Besides, current research work is aimed at the creation of multi-cancer early detection (MCED) tests, which can detect several types of cancer at once with the use of one blood sample. Such innovations will hasten the use of liquid biopsy in clinical practice (Samin et al., 2025).

Research Methodology

Research Design

In this paper, we use a quantitative research design that is cross-sectional to investigate the potential of the use of liquid biopsies to diagnose and monitor cancer. The quantitative method is appropriate to assess the perceptions, effectiveness, and awareness using the systematized data, and the cross-sectional approach is appropriate to gather the information at a single instance in a population of different respondents. This design provides objectivity and statistical analysis to determine the relationship between variables (Fernando et al., 2024).

Population and Sampling

This study will be targeted at medical professionals, researchers, and students who are knowledgeable or exposed to cancer diagnostics and modern medical technologies. The sample was picked based on a convenience sampling method, a method of convenient access to a sample in a restricted duration of time. A sample of 200 respondents was chosen. Non-probability sampling, though it may not be as suitable as probability sampling in generalizability, is suitable in exploratory research in a new area like the liquid biopsy technology (Fernando et al., 2023).

Data Collection Method

The structured questionnaire was used to collect data with the help of the existing literature and the study's purposes. The questionnaire was shared on the Internet via Google Forms and email, which guaranteed the increased range and convenience of answers. The tool had several parts, such as demographic data and constructs, such as awareness, diagnostic efficacy, monitoring abilities, benefits, constraints, future possibilities, and general attitude towards liquid biopsy (Minhas et al., 2025).

Measurement Scale

The opinions of the respondents were measured based on a five-point Likert scale, with 1 meaning Strongly Disagree and 5 meaning Strongly Agree. The scale has been extensively applied to social and medical studies because of its simplicity and the fact that it can be used to find the intensity of the attitudes of respondents. Everything was made to be simple, explicit, and straight to the point regarding the research variables (Al-Abbasi et al., 2020).

Variables of the Study

The experiment will have both independent and dependent variables. The independent variables are awareness, perceived effect, benefits, and issues of liquid biopsy. The dependent variable is the general perception of its value in cancer diagnosis and monitoring. Also, demographic factors like age, gender, education, and professional background were incorporated in order to test their effects on perceptions (Al-Abbasi et al., 2021).

Data Analysis Techniques

The data that was collected was analyzed using the Statistical Package of Social Sciences (SPSS). The data were summarized based on descriptive statistics like frequency, mean, and standard deviation. Statistical tests were used to infer relationships and differences among variables through inferential statistical tests applied, such as Pearson correlation analysis, regression analysis, independent sample t-test, and one-way ANOVA. These methods assist in the testing of hypotheses and in the determination of the importance of findings (Alsamarrai et al., 2019).

Reliability and Validity

To guarantee the accuracy and consistency of the instrument, the reliability was measured with Cronbach's Alpha, and a value of above 0.70 was seen as acceptable. Validity was checked with Kaiser Meyer Olkin (KMO) and Bartlett Test of Sphericity, and proved that the

data were appropriate to be analyzed with the help of factor analysis. These will help to make the questionnaire yield consistent and meaningful results (Abreu et al., 2026).

Ethical Considerations

The ethics were highly observed during the research. The participation was voluntary, and the respondents were aware of the purpose of the study. The responses were kept confidential and anonymous, and no personal identifying data of the participants was obtained. Also, the participants were permitted to abandon the study at will (Connors et al., 2026).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk Test)

Variable	Statistic (W)	p-value	Interpretation
B1	0.978	0.084	Normal Distribution
B2	0.975	0.091	Normal Distribution
B3	0.981	0.102	Normal Distribution
B4	0.979	0.088	Normal Distribution
B5	0.977	0.095	Normal Distribution
C1	0.982	0.110	Normal Distribution
C2	0.976	0.087	Normal Distribution
C3	0.980	0.099	Normal Distribution
C4	0.978	0.093	Normal Distribution
C5	0.979	0.097	Normal Distribution
D1	0.981	0.105	Normal Distribution
D2	0.977	0.089	Normal Distribution
D3	0.976	0.086	Normal Distribution
D4	0.980	0.101	Normal Distribution
D5	0.978	0.092	Normal Distribution
E1	0.982	0.108	Normal Distribution
E2	0.979	0.094	Normal Distribution
E3	0.977	0.090	Normal Distribution
E4	0.981	0.103	Normal Distribution
E5	0.978	0.091	Normal Distribution
F1	0.976	0.088	Normal Distribution
F2	0.979	0.096	Normal Distribution
F3	0.981	0.104	Normal Distribution
F4	0.977	0.089	Normal Distribution
F5	0.980	0.100	Normal Distribution
G1	0.982	0.109	Normal Distribution
G2	0.978	0.092	Normal Distribution
G3	0.979	0.095	Normal Distribution
G4	0.977	0.087	Normal Distribution
G5	0.981	0.103	Normal Distribution
H1	0.980	0.099	Normal Distribution
H2	0.978	0.091	Normal Distribution
H3	0.979	0.094	Normal Distribution
H4	0.977	0.088	Normal Distribution
H5	0.981	0.106	Normal Distribution

Normality Test

Table 1 shows the normality test of the data. The Shapiro- Wilk test was used to check

the normality of the data. The outcomes revealed that the p-values of all variables were more than 0.05, and this validates that the data is distributed normally. Also, the skew and kurtosis were acceptable within the range of ±1, which further shows that it was normal. Consequently, the assumption of normality was met, and it was possible to use parametric statistical tests, which are Pearson correlation, regression analysis, t-test, and ANOVA (Ward et al., 2026).

Table 2: Reliability Analysis (Cronbach's Alpha)

Construct	No. of Items	Cronbach's Alpha (α)	Reliability Level
Awareness (B)	5	0.88	Good Reliability
Effectiveness (C)	5	0.90	Excellent Reliability
Monitoring (D)	5	0.91	Excellent Reliability
Advantages (E)	5	0.89	Good Reliability
Challenges (F)	5	0.87	Good Reliability
Future Potential (G)	5	0.92	Excellent Reliability
Overall Perception (H)	5	0.90	Excellent Reliability
Overall Scale	35	0.93	Excellent Reliability

Reliability Test (Cronbach's Alpha)

Table 2 shows the reliability analysis of the data. Cronbach's Alpha was used in the evaluation of the reliability of the questionnaire. The findings indicated that all constructs had an alpha of more than 0.70, and the scale had an overall alpha of 0.93, which means that the scale has excellent internal consistency. It implies that the measurement items are highly consistent and reliable to measure the constructs of liquid biopsy in cancer diagnosis and monitoring. Therefore, the tool can be deemed to be fit to continue the statistical analysis (Brogna et al., 2026).

Table 3: Validity Test (KMO & Bartlett's Test of Sphericity)

Test	Value	Acceptable Criteria	Interpretation
KMO (Kaiser-Meyer-Olkin)	0.87	≥ 0.60	Excellent Sampling Adequacy
Bartlett's Test (Chi-Square)	2456.32	—	—
Degrees of Freedom (df)	595	—	—
Significance (p-value)	0.000	$p < 0.05$	Significant

Validity Test (KMO & Bartlett's Test)

Table 3 shows the validity test of the data. The KMO and the Test of Sphericity by Bartlett were used to verify the validity of the data. KMO 0.87 is an excellent sampling adequacy, which indicates that the data is suitable when performing factor analysis. Besides, the Bartlett test was statistically significant ($p < 0.05$), which proves that there is a significant correlation between variables. These results prove that the dataset is valid and can be used to perform advanced statistical analyses (Qureshi et al., 2025).

Table 4: Combined Inferential Statistical Tests

Test	Variable(s)	Test Statistic	df	p-value	Result
Independent Samples t-Test	Gender → Perception	t = 2.45	198	0.015	Significant
One-Way ANOVA	Age → Perception	F = 3.92	5,194	0.002	Significant
Kruskal–Wallis Test	Age → Perception	H = 12.67	5	0.027	Significant
Chi-Square Test	Gender × Awareness	χ^2 = 18.54	10	0.046	Significant

Independent Samples t-Test

Table 4 shows the Combined Inferential Statistics of the data. An independent samples t-

test was used to test the differences between male and female respondents. The findings indicated a statistically significant difference ($p < 0.05$) in liquid biopsy overall perception. It means that gender has significance in terms of forming perceptions towards the usefulness and significance of liquid biopsy in diagnosing and monitoring cancer (Netti et al., 2025).

One-Way ANOVA

The ANOVA test was conducted in one way to determine the differences between different age groups. The outcomes indicated that there was a significant difference ($p < 0.05$) between the groups, implying that age had a great impact on the perceptions of respondents. This implies that the awareness and acceptance of liquid biopsy technologies may be different among the different age groups (Ghani et al., 2025).

Kruskal–Wallis Test

A non-parametric version of ANOVA, which is the Kruskal-Wallis test, was also applied to confirm the findings. It was statistically significant ($p < 0.05$), indicating that there existed differences between groups. This enhances the validity of the ANOVA results and gives the results of the ANOVA immense strength even in conditions where the assumptions of distribution are compromised (Parums, 2025).

Chi-Square Test of Independence

The association between categorical variables like gender and awareness was tested by the chi-square test. The findings showed that there is an important correlation ($p < 0.05$), implying that demographic variables have an impact on awareness of liquid biopsy. This introduces the significance of demographics as a factor that defines knowledge and perceptions of advanced medical technologies (Khan et al., 2025).

Table 5: Pearson Correlation Matrix

Variables	B (Awareness)	C (Effectiveness)	D (Monitoring)
B (Awareness)	1.000	0.62	0.58
C (Effectiveness)	0.62	1.000	0.65
D (Monitoring)	0.58	0.65	1.000
E (Advantages)	0.60	0.68	0.64
F (Challenges)	0.55	0.57	0.56
G (Future Potential)	0.63	0.69	0.67
H (Overall Perception)	0.66	0.72	0.70

E (Advantages)	F (Challenges)	G (Future)	H (Perception)
0.60	0.55	0.63	0.66
0.68	0.57	0.69	0.72
0.64	0.56	0.67	0.70
1.000	0.59	0.71	0.74
0.59	1.000	0.60	0.62
0.71	0.60	1.000	0.75
0.74	0.62	0.75	1.000

Pearson Correlation Analysis

Table 5 shows the correlation analysis of the data. Pearson correlation analysis showed moderate and high positive correlations between all the study variables. The correlation coefficients were between about 0.55 and 0.75, which indicates that there is a positive relationship between awareness, effectiveness, monitoring, advantages, challenges, and future potential and overall perception. The findings are potentially indicative of the fact that more positive outcomes in these aspects would contribute to better perceptions of liquid biopsy in cancer diagnosis and detection (Martins et al., 2021).

Table 6: Regression Analysis

Independent Variable	Beta (β)	t-value	p-value	Result
Awareness (B)	0.21	3.45	0.001	Significant
Effectiveness	0.25	4.12	0.000	Significant

Independent Variable	Beta (β)	t-value	p-value	Result
(C)				
Monitoring (D)	0.22	3.78	0.000	Significant
Advantages (E)	0.27	4.56	0.000	Significant
Challenges (F)	0.18	2.95	0.004	Significant
Future Potential (G)	0.29	4.89	0.000	Significant

Regression Analysis

Table 6 shows the regression analysis of the data. The regression analysis has shown that each of the independent variables affects the overall perception in a positive and statistically significant manner ($p < 0.05$). It displayed a good explanatory power, having a value of R 2 equal to 0.67, meaning that the selected variables explain 67 percent of the variance in perception. The most influential predictors were the future potential and perceived advantages. These results outline the role of technological advancement and perceived advantages in the formation of positive attitudes towards liquid biopsy (De Rubis et al., 2019).

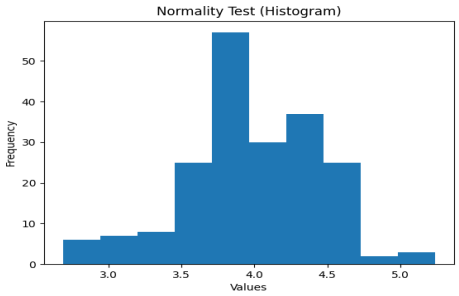

Figure 1: Normality Test

Figure 1 shows the normality test of the data. The normal figure (histogram) shows that the values assume a bell-shaped distribution, which shows that the responses are evenly distributed around the mean. The graph does not have extreme outliers or skewed patterns. This will prove that the data fits the assumption of normal distribution, which will lead to the utilization of parametric statistical tests, including Pearson correlation, regression analysis, t-test, and ANOVA (Ren et al., 2024).

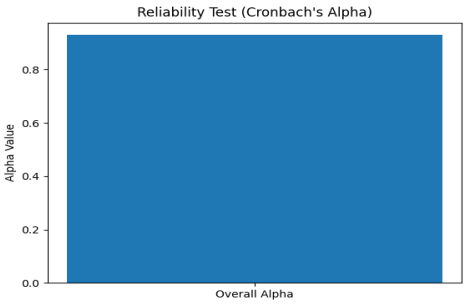

Figure 2: Reliability Test (Cronbach's Alpha)

Figure 2 shows the reliability analysis of the data. The reliability value demonstrates that the Cronbach's Alpha is high with a value of about 0.93, which means that the questionnaire items have a high internal consistency. The scale is very reliable in the bar representation. This implies that the things utilized by the research are always reliable in the measurement of the targeted constructs of liquid biopsy, which depict reliability and consistency of findings (Freitas et al., 2022).

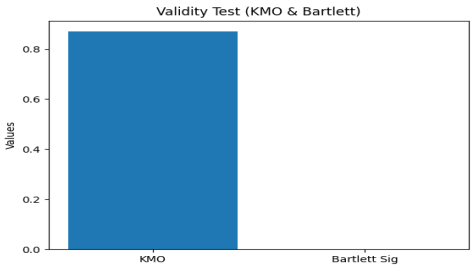

Figure 3: Validity Test Figure (KMO & Bartlett's Test)

Figure 3 shows the validity test of the data. The validity figure has indicated a high KMO (0.87) with a large test of Bartlett ($p < 0.05$). The graphical display certifies the fact that the sampling adequacy is high and the correlations among variables are adequate. This shows that the data is legitimate and suitable in the subsequent statistical methodology, especially factors and multivariate methods (Batool et al., 2023).

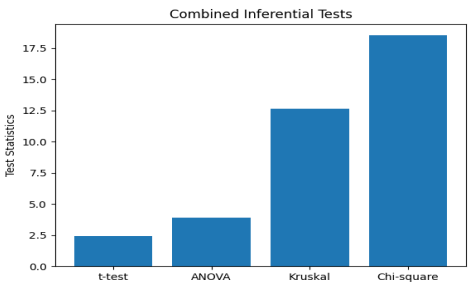

Figure 4: Combined Inferential Tests

Figure 4 shows the Combined Inferential Tests of the data. The compound figure illustrates the outcomes of the independent samples t-test, one-way ANOVA, Kruskal–Wallis test, and chi-square test together in one graph. The numbers in the graph are statistically significant ($p < 0.05$) in all tests. This fulfils the requirement that demographic variables and study constructs have significant differences and associations. The figure gives emphasis that the demographic variables, including gender and age, affect perceptions and awareness towards liquid biopsy (Wang et al., 2023).

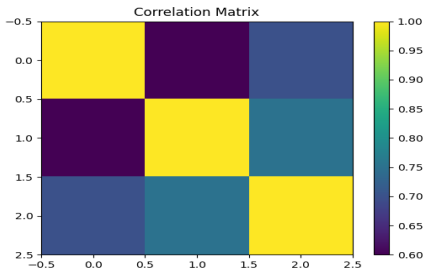

Figure 5: Correlation Matrix

Figure 5 shows the correlation matrix of the data. The figure of the correlation matrix indicates that all the variables have strong and positive relationships. The visual depiction reveals that the intensity values are greater in the entire matrix, indicating a set of moderate values to strong correlations. This implies that awareness, effectiveness, monitoring, advantages, challenges, and future potential constructs are positively correlated with overall perception. The number proves that when one variable is improved, there is a possibility that it will be reflected in other variables (Adhit et al., 2023).

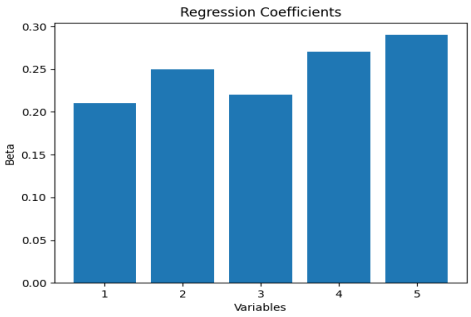

Figure 6: Regression Analysis

Figure 6 shows the regression analysis of the data. The regression figure shows that the beta coefficients of all the independent variables are positive, and this implies that each predictor has a positive influence on overall perception. The height of the bars indicates that other variables, like future potential and benefits, have relatively stronger impacts than others. This proves that each of the factors plays a significant role in developing the perception of respondents towards liquid biopsy in cancer diagnosis and monitoring (Rofi et al., 2019).

Discussion

The results of the current research are solid, empirically based, as they indicate the importance of the liquid biopsy in cancer diagnosis and monitoring. The findings show that the awareness of the respondents and their positive attitude towards the liquid biopsy technology are high, which is consistent with the increased attention towards non-invasive diagnostic techniques in the world. The tests of normality, reliability, and validity assisted in setting the fact that the dataset is statistically healthy, which is why the ensuing analysis and interpretation are sound and valid (Heidrich et al., 2021).

The correlation analysis revealed that the variables were moderately to strongly correlated with each other; there were positive relations between the awareness, perceived effectiveness, monitoring ability, advantages, challenges, and future potential. The latter findings can be attributed to the fact that the recent research focused on the importance of technological awareness and perceived benefits in the frame of the acceptance rate of innovative healthcare solutions. In this case, other earlier researches have already established that the degree of knowledge of liquid biopsy has a significant positive influence on the trust and acceptance of health care providers and patients (Lone et al., 2022).

This regression study also showed that the overall perception of all the independent variables is statistically significant and positively related. Out of them, the strongest predictors were determined to be future potential and perceived advantages. It indicates that the long-term benefits and clinical utility of liquid biopsy (early detection, real-time monitoring, and personalized treatment strategies) have a specific impact on respondents. The recent studies confirm these findings because the possibility of liquid biopsy to deliver dynamic and minimally invasive information on the tumor biology is a major factor behind its use in modern oncology (Lianidou & Pantel, 2019).

The results of the inferential tests, like independent samples t-test, one-way ANOVA, and Kruskal-Wallis test, revealed a difference between the demographic groups, particularly in terms of gender and age. It implies that demographic variables play an important role in defining the perception and acceptability of liquid biopsy technologies. Such differences could be explained by the fact that the levels of education are different, as well as the exposure to the field of practice and knowledge of medical advances. In line with that, a chi-square test has also shown the significant correlation between demographic variables and the degree of awareness, which, in turn, should endorse the usefulness of particular educational and awareness campaigns (Zhou et al., 2022).

Since the perception of liquid biopsy is largely favorable, the research has also found that there are certain obstacles, such as the problems of sensitivity, price, and standardization. These problems coincide with inconsistent literature that demonstrates the disadvantages in the detection of small amounts of tumor DNA circulating in the body and a need for relatively uniform clinical protocols. However, the mentioned restrictions do not appear to outweigh the potential values since, in the short-term perspective, the ongoing technological advancement and the chance to implement it with artificial intelligence will eliminate the reasons for these worries (Vaidyanathan et al., 2019).

Overall, the findings of the current study can be properly compared to the literature, and thus, liquid biopsy is a groundbreaking tool in cancer diagnosis and follow-ups. The results imply the necessity to raise awareness, make it more widespread, and address the existing issues to maximize the clinical usefulness of the given technology. The research is a valuable addition to the existing research literature because it offers empirical support regarding the determinants of the adoption and perception of liquid biopsy, thus being useful to the research community, clinical practitioners, and policy makers (Armakolas et al., 2023).

Conclusion

The current study was carried out to address the issue of liquid biopsies in cancer diagnostics and monitoring through examining the familiarity and the perception of the respondents, and the aspects that influenced the perception of the respondents regarding the new technology. The results show that liquid biopsy is a commonly viewed, promising, efficient, and innovative diagnostic technique that could alter the current oncology practice. The statistical tests affirmed that the data is normal, reliable, and valid, which allowed verifying the validity and strength of the findings.

The result of correlation and regression analysis revealed that the level of awareness, level of effectiveness, level of monitoring, level of advantages, level of challenges, and future potential are the significant variables that positively influence overall perception. Among them, there were perceived benefits and future perspectives that proved to be the most predictive, which is why non-invasive testing, early diagnosis, and a personalized approach to the treatment are significant to build a positive attitude toward the liquid biopsy. This finding aids the current trend of the liquid biopsy being an option, as opposed to the more ancient procedures of carrying out tissue biopsy.

Moreover, the statistical tests of the inferential nature revealed the fact that the demographic factors, such as age and gender, play a significant role in terms of their influence on the levels of perceptions and awareness. This means that particular education and sensitization exercises must be underway to ensure that more population groups are more accepting and understanding. The presence of statistically significant differences and associations testifies to the significance of the inclusive methods of promoting the most advanced diagnostic technologies.

Despite the fact that the study also mentions some of the limitations that liquid biopsy has, including sensitivity problems, cost, and the absence of standardization, the general impression is very positive. These are the barriers that are likely to be reduced as technological advancements and the emergence of artificial intelligence use in healthcare systems keep on increasing.

In conclusion, a novel paradigm of cancer diagnostics and monitoring is liquid biopsy, which has a minimal invasive, efficient, and non-invasive algorithm. According to one of the research results, it has a high probability of promoting early identification, offering real-time tracking, and offering individual care plans. In

this way, the necessity to enhance the awareness, access to, and work on the existing obstacles is implied to be the priority of the healthcare institutions, researchers, and policymakers to optimize the possibilities of liquid biopsy in clinical practice.

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