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AI-Driven Cardio-Oncology for Early Prediction of Chemotherapy-Induced Cardiotoxicity

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ABSTRACT

Background: Chemotherapy-induced cardiotoxicity is one of the most serious complications of cancer management that occurs in those with cancer either during or after treatment. Traditional modalities of diagnosis are not applicable in detecting early heart damage that can bring about severe heart issues. Artificial intelligence (AI) has already demonstrated itself as a promising healthcare technology, particularly in the sphere of cardio-oncology, as it may help in predicting diseases, diagnosing and planning individual treatment.

Objective: The key objective of the research was not merely to investigate the place of AI-powered cardio-based oncology systems in the early detection of chemotherapy-induced cardiotoxicity, but also to compare the perceptions of the research participants towards the efficacy, reliability and acceptability of AI technologies in health care.

Methodology: This study was done using a quantitative research design. A structured questionnaire was used to gather data with a five-point Likert scale, which was applied to 200 respondents. Demographic items and questions on AI in healthcare, cardiac monitoring and cardiotoxicity prediction were included in the questionnaire. The statistical analysis, which involved normality tests, reliability tests, and validity tests, an independent-samples t-test, a One-Way ANOVA, a Kruskal-Wallis Test, a Chi-Squared Test, a Pearson correlation, and a regression Analysis, was done using statistical software.

Results: The conclusions were that the data were normal and reliable, with Cronbach's alpha values exceeding 0.70. The high level of construct validity was supported by the test scores of KMO and the Bartlett test. The Correlation and regression analyses revealed that there were significant positive relationships between AI-based monitoring systems and improved predictability of cardiotoxicity with chemotherapy. The outcome of the hypothesis testing revealed statistically significant relationships and links between the demographics and the acceptance of AI. The respondents were more prone to express positive attitudes toward the effectiveness of AI technologies in fulfilling the role of cardiac monitoring and reducing the effect of human error, and beneficially affecting the results related to patient survival.

Conclusion: The authors established that AI-based cardio-oncology systems have tremendous potential when it comes to better identifying, earlier detection and treatment of chemotherapy-related cardiotoxicity. It is possible that, with the assistance of artificial intelligence (AI) technologies, healthcare professionals will be able to keep track of a patient in real time, which allows predicting and planning treatment and improving patient safety and treatment effectiveness. Despite all the complexities related to data protection, its associated cost, and technical expertise, AI-based healthcare systems will be a great leap towards modern cancer care.

KEYWORDS: Artificial Intelligence (AI), Cardio-Oncology, Chemotherapy-Induced Cardiotoxicity, Early Prediction, Cardiac-Monitoring, Machine-Learning, Healthcare Technology, Cancer-Treatment, Patient-Survival, Predictive-Analytics..

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INTRODUCTION

One of the most common causes of death in any part of the world, and one of the most common ways of treating any type of cancer, is chemotherapy. Although chemotherapy is not only crucial as part of improving cancer survival chances, it is noted to possess several serious adverse effects, with cardiotoxicity being one of the most lethal effects. Cardiotoxicity refers to the diverse effects that the heart muscles and cardiovascular system experience because of cancer treatment medications such as

anthracyclines, trastuzumab and other therapeutic medications that target cancerous cells. Hypertension and other cardiovascular-related diseases, as an outcome of the condition, significantly affect the quality of life and survival of cancer patients, due to the potential for heart failure, arrhythmias and hypertension. Prevention and early diagnosis of cardiotoxicity are hence crucial in providing better patient outcomes and lessening chronic health complications (Syed Waqas Ali Shah, 2022).

Chemotherapy-induced cardiotoxicity is influenced by several clinical, biological, and treatment-related factors that can increase the likelihood of cardiovascular complications among cancer patients. The risk may vary depending on the type of anticancer medication, cumulative drug exposure, treatment duration, pre-existing cardiovascular conditions, age, and individual patient characteristics. Certain chemotherapy agents, particularly anthracyclines and other cardiotoxic treatments, may contribute to myocardial injury, reduced cardiac function, arrhythmias, and heart failure. Furthermore, patients with pre-existing hypertension, diabetes, obesity, or cardiovascular disease may experience an increased risk of treatment-related cardiac complications. Therefore, identifying high-risk patients before and during chemotherapy is an important component of modern cardio-oncology. Integrating artificial intelligence into cardiovascular risk assessment may provide additional opportunities to identify complex relationships among clinical characteristics, treatment exposure, and cardiac outcomes. Mobile health technologies can strengthen cardiovascular disease management through remote patient monitoring, medication reminders, digital health records, and continuous communication between patients and healthcare professionals (Sadia, 2021).

Over the last few years, cardio-oncology has become a significant interdisciplinary field which deals with the interaction between the treatment of cancer and cardiovascular health. The goal of cardio-oncology is to track, prevent and treat heart-related problems in cancer patients throughout the treatment period. Classical approaches to identifying cardiotoxicity solely depend on imaging procedures, electrocardiogram (ECG), blood biomarkers, and clinical symptoms. However, these tests tend to detect any destruction of the heart at a later stage. The untimely diagnosis can result in a decrease in the efficacy of the treatment and the emergence of irreparable damage to the heart. Because of this, an increasing number of demands are directed toward the creation of more advanced technologies that can be utilised to predict cardiotoxicity in time and help in a timely clinical response (Mostaque Md. Morshedur Hassan, 2022).

Although conventional cardiac monitoring methods remain essential in identifying cardiovascular complications, they may present limitations in recognising subtle changes associated with early cardiotoxicity. Electrocardiography, echocardiography, cardiac biomarkers, and clinical assessments provide important information about cardiac function; however, the interpretation of these findings may vary according to patient characteristics, testing frequency, and clinical circumstances. In some cases, detectable abnormalities may become apparent only after considerable cardiac injury has occurred. In addition, repeated monitoring can increase the clinical and financial burden on patients and healthcare institutions. These limitations highlight the importance of developing more efficient monitoring strategies that support early identification of cardiovascular risk. AI-assisted analytical technologies may complement conventional assessment by examining multiple clinical variables and identifying patterns that could otherwise remain difficult to recognise. Accessible and interactive health communication approaches can improve patient understanding, health-information retention, and engagement by presenting complex medical information through simplified and visually structured formats (Islam et al., 2022).

One of the most disruptive technologies in current medical care is known to be Artificial Intelligence (AI). Computer systems and codes of computer programs that can perform work traditionally handled by human intelligence, and the ones involved in learning, predicting, making decisions and recognising patterns, are categorised as AI. Machine learning, deep learning, predictive analytics, and data mining are some of the technological practices involved in healthcare that AI in healthcare is ramping up to offer improved disease diagnosis, monitoring patients, and planning treatment. Immediate use of AI can handle vast numbers of medical data in one case and with high accuracy; thus, it can be of great help when distinguishing the peculiarities of conditions in patients which cannot be readily determined by traditional methods (Irum Sherwani Summaiya, 2022).

Machine learning represents an important area of artificial intelligence with potential applications in cardiovascular risk assessment and cancer treatment monitoring. These computational methods can analyse complex datasets, identify relationships among multiple variables, and support predictive assessment of clinical outcomes. In cardio-oncology, machine-learning techniques may be applied to electronic health records, electrocardiographic measurements, echocardiographic findings, laboratory results, medication histories, and demographic information to investigate the risk of chemotherapy-induced cardiac complications. Predictive analytics may also support the identification of patients who require more frequent cardiovascular assessment during cancer treatment. Nevertheless, the effectiveness of these technologies depends on data quality, model reliability, appropriate clinical validation, and their ability to provide meaningful information within real-world healthcare environments. Previous research has highlighted the potential of integrating machine learning algorithms with cancer genomic data to identify complex molecular patterns associated with treatment resistance and improve predictive capabilities in personalised cancer therapy (Carmo et al., 2022).

The use of AI in cardio-oncology has already created new opportunities, in particular, with regard to the timely identification of cardiotoxicity caused by chemotherapy. Multi-source information can be merged in AI-based systems, which include electronic health records, ECG, echocardiography, third-party lab biomarkers, wearables, and patient records and can be used to find those with a high risk of developing cardiovascular complications. These technologies would then be in a position to assist healthcare providers not only to further monitor in real time, but they would also be able to provide predictive information, which would enable the earlier diagnosis and a preemptive treatment course. The cardio-oncology systems based on AI have the potential to manage the number of hospitalisations, treatment effects, and survival outcomes by identifying the cardiotoxic potential of the

patient before the disease goes into acute symptoms. Furthermore, machine learning techniques, including random forests, support vector machines, gradient boosting, and deep learning, offer opportunities to analyse complex biological datasets and identify relationships between molecular characteristics and treatment responses (Carmo et al., 2022).

However, it is important to note that even though the potential benefits of AI in healthcare can be seen, several impediments persist. Such aspects as data privacy problems, ethical considerations, the high costs of its implementation, the insufficiency of technical skills, and the unawareness of healthcare professionals are issues that might influence the use of AI-based systems. In addition to this, hospitals require successful and proven AI models that are able to provide accurate and dependable forecasts within a medical care environment. Thus, the effectiveness and acceptance of AI technologies in cardio-oncology should be studied (Macedonia, 2022).

It is in the context of cardio-oncology based on AI that can predict chemotherapy-induced cardiotoxicity early that this paper will delve into. The study is aimed at forming the perceptions of participants about AI application in healthcare, the effectiveness of AI-imposed monitoring systems, and how AI technologies and enhanced patient outcomes are related. This research might add to the increasing amount of evidence about AI in healthcare and aid the creation of more efficient and individualised ways of treating cancer and managing cardiovascular diseases (Mislim Zendeli, 2020).

LITERATURE REVIEW

Cardio-oncology has proven to be a worthwhile interdisciplinary science that pays attention to the cardiovascular problems of cancer therapy. With the growing use of chemotherapy and other specialised treatments to cure cancer, chemotherapy-induced cardiotoxicity has turned out to be a significant concern among health facility staff and academics worldwide. Cardiotoxicity is heart muscle and cardiovascular toxicity resulting from chemotherapy drugs. Common cardiovascular complications may be diagnosed as heart failure, arrhythmias, hypertension, myocardial dysfunction, and decreased cardiac performance. Researchers have emphasised the need to monitor and manage the incidence of cardiotoxicity in its initial phases because late identification of patients with cancer can lead to irreparable cardiac damage and resultant death (Praveenkumar Periyasamy1, 2021).

Another important area in the development of AI-based cardio-oncology is the role of clinical decision support and risk stratification. Healthcare professionals must consider several factors when evaluating the cardiovascular risks associated with chemotherapy, including patient age, previous cardiovascular conditions, cancer type, treatment history, cumulative chemotherapy dosage, and laboratory findings. Artificial intelligence may help integrate these different sources of information to identify patients who require closer cardiovascular assessment. Predictive risk stratification can also support more individualised monitoring schedules and assist healthcare professionals in recognising patients who may be vulnerable to treatment-related cardiac complications. The integration of AI-assisted decision support into oncology practice could therefore contribute to more informed clinical assessments and improved coordination between oncology and cardiology services. Telecardiology and remote patient monitoring have demonstrated significant potential in improving cardiovascular care through continuous monitoring, early detection, and timely clinical intervention (Kamal et al., 2021).

Despite the growing research interest in AI applications in cardio-oncology, the successful adoption of these technologies remains dependent on several practical and organisational factors. Data security, patient privacy, algorithmic transparency, system reliability, implementation costs, and healthcare professionals' technical knowledge are important considerations when introducing AI-supported monitoring into clinical environments. Furthermore, the acceptance of AI-generated recommendations may depend on healthcare professionals' understanding of these technologies and their confidence in the accuracy of the information provided. Previous research has highlighted the importance of combining technological development with professional awareness, appropriate training, and institutional support. Therefore, examining healthcare professionals' perceptions of the effectiveness, reliability, and acceptability of AI-based cardiac monitoring is important for understanding the factors that may influence its future integration into cardio-oncology practice. Remote patient monitoring has been associated with a 21% reduction in hospital readmissions and a 12% reduction in all-cause mortality among patients with chronic heart failure (Kamal et al., 2021).

Various studies have noted that conventional approaches to cardiotoxicity detection techniques, like echocardiography, electrocardiogram (ECG) and cardiac biomarkers, do not have the ability to detect early cardiac dysfunction. Much of the earlier research findings indicate that old-fashioned research on cardiovascular toxicity only reveals damage when structural or functional damage has occurred. This has been restrictive, and scientists have turned to newer technologies which can predict cardiovascular complications at an earlier stage. Accordingly, the issue of artificial intelligence (AI) has gained great attention in modern healthcare due to its ability to process volumes of medical information and give accurate predictive outcomes (Praveenkumar Periyasamy1*, 2021).

Artificial intelligence refers to a type of system where computers replicate human intelligence as far as learning, thinking, and the process of making decisions are concerned. The types of AI technologies used to diagnose illnesses, plan treatment, track patients, and analyse medical images are machine learning, deep learning, neural networks, and predictive analytics, which are increasingly being used in healthcare. Researchers have pointed out that AI systems have been identified as working out intricate patterns in medical data more effectively than conventional statistical methods. It is anticipated that cardio-oncology has considerable potential in predicting chemotherapy-induced cardiotoxicity by analysing the advantages of applying AI to construct patient demographics, medical history, imaging results, biomarkers and treatment data (Likowsky Desir4 Hira Aslam1*, 2021). The achievements achieved in the existing research show that the machine learning algorithms can be effectively used to recognise

high-risk patients during the development of the chemotherapy regimen. Scholars have given an example of supervised learning models employed to analyse cardiac imaging and biomarker samples to forecast changes in left ventricular ejection fraction (LVEF), one of the most important cardiac dysregulation indicators. Deep learning methods have been further applied to sense delicate anomalies in echocardiographic images, which otherwise can go unnoticed by clinicians in a routine check-up. The implications are that it is possible to obtain a better quality of the diagnostic process with the assistance of AI strategies, and to achieve earlier clinical intervention (Tariq Rafique Praveenkumar Periyasamy1*, 2021).

The second notable area of interest presented in the literature is the aim of predictive analytics in real-time patient monitoring. The literature has already stated the significance of surveillance and monitoring systems aided by AI to oversee the heart conditions of patients undergoing chemotherapy at any time. Smart monitoring technologies and wearable devices with AI algorithms can process heart rate, ECG, blood pressure, and biomarker fluctuations in real time. These systems can give early alerts of cardiotoxicity to healthcare professionals, enabling them to adjust treatment regimens before the occurrence of severe cardiac injury. Research has shown that persistent observation can lead to a considerable increase in patient outcomes and decrease the hospitalisation rate (PERIYASAMY, 2021).

In addition to predicting diseases, how AI can be used in personalised medicine in cardio-oncology has also been examined. Personalised treatment planning refers to the procedure of developing the course of cancer treatment in relation to the risk profile and cardiovascular conditions of a specific patient. Among the patient-specific factors that AI models may examine to recommend good treatment options are lifestyle factors, chemotherapy dosage, any history of cardiac disease, age, and genetics, among others, compared to risks. Other studies have affirmed that personalised AI-based interventions are more effective in treatment and lower the chances of CVDs. This creation is considered very helpful in contemporary cancer treatment, as it helps in the fields of precision medicine and patient-centred treatment (Praveenkumar Periyasamy7 Abdullah Tariq1*, 2021).

The importance of obtaining multiple sources of healthcare data to improve prediction accuracy is also a subject of the literature. Researchers have believed that AI systems would be more helpful when they combine information from electronic health records (EHRs), laboratory tests, imaging, genomic data, and wearable devices. Multimodal data integration enables AI algorithms to discover certain unclear relationships between clinical variables and makes much more accurate predictions of the risk of cardiotoxicity. Research has discovered that combination AI frameworks are smarter compared to the conventional predictive techniques, and they offer greater assistance in clinical decision-making (Samin et al., 2022).

Even though AI can be applied successfully to comprehend cardio-oncology, the literature refers to multiple obstacles associated with applying AI. One of these issues is the privacy and security of data. Also, it is a fact that sometimes healthcare information contains some sensitive information on patients, and it is emphasised that in the future there must be safeguards on the systems of data management, which will ensure that the information is not accessed without authorisation. Transparency of algorithms and bias are also considered to be some of the ethical concerns regarding algorithms, which have been extensively discussed in other studies in the past. Other researchers mention that AI models can generate erroneous results in case they are trained on small or unbalanced input data. To have accurate healthcare applications, it is therefore important that there should be transparent, fair and clinically proven AI systems (Fernando et al., 2021).

The other problem that is identified in the literature is the inadequacy of technical knowledge and infrastructure in the care facilities. Some of the difficulties facing several hospitals and healthcare institutions in implementing AI technologies include a lack of training, high cost of implementation and unavailability of technological resources. Special education has been advised to enable medical workers to utilise AI-supported systems in clinical practice. Moreover, medical specialists, data scientists, and developers of technology need to work closely to enhance the feasibility of AI in the field of cardio-oncology (Fernando et al., 2020).

Overall, the existing literature is highly covered regarding the support of the use of artificial intelligence in the more effective detection and treatment of cardiotoxicity during chemotherapy. The history of research shows that AI-based cardio-oncology systems have strong diagnostic accuracy, allow monitoring in real time, help in the development of individual treatment programs, and positively affect the chances of patient survival. However, the relevance of attention to the ethical, technical, and even organisational concerns to ensure the use of AI technologies in medicine is also discussed in the literature. This work expands on the previous studies by further exploring the effectiveness, acceptance and influence of artificial intelligence (AI-based) cardio-oncology systems in detecting and evaluating cardiotoxicity following chemotherapy (Minhas et al., 2022).

RESEARCH METHODOLOGY

Research Design

Quantitative research was the type of research adopted in this study, as the researcher aimed to investigate the possibilities of artificial intelligence (AI) in cardio-oncology as an early predictor of chemotherapy-induced cardiotoxicity. It was chosen because the quantitative approach enables the researcher to obtain numerical data and statistically process the perceptions of participants on the subject, their awareness, and opinions on AI-driven healthcare technologies. The study was dedicated to evaluating the possibilities of AI-driven systems that can aid in an early and effective prediction and treatment of cardiac issues in patients undergoing chemotherapy (Al-Abbasi et al., 2020).

Research Approach

A descriptive survey method was used in the collection of information, in which the respondents themselves undertook the role of information collection. The survey technique was considered adequate as it helps to see the perspectives of the population and

professionals on the issue of AI integration in health care and cardio-oncology. The research aimed to determine the effectiveness, reliability and acceptability of AI-based technologies in predicting cardiotoxicity before severe cardiac damage occurs (Al-Abbasi et al., 2021).

Population and Sampling

This study focused on healthcare professionals, researchers, students, IT professionals, and ordinary people with an understanding of chemotherapy and healthcare technologies. The selected respondents were 200 conveniently sampled participants. The reasons that led to the choice of this approach include ease of accessing the participants, quick data collection that requires minimal time and funds (Alsamarrai et al., 2019).

Data Collection Method

The data regarding the use of pornography among the people in the targeted study were collected as primary data in the form of a structured questionnaire designed especially to gather the necessary data. The questionnaire was broken down into demographic information and closed-ended questions in which the response is on a five-point Likert scale of Strongly Agree to Strongly Disagree. The questionnaire was divided into different sections, such as awareness about chemotherapy-induced cardiotoxicity, AI in healthcare and AI-cardio oncology systems. The questionnaire was given to the respondents via digital technologies and email (Mahamed, 2019).

Research Instrument

The questionnaire was the main research instrument. It entailed demographic variables such as age, gender, education, work and geographic location. The other questions were on the participants' perceptions of the significance of early cardiac monitoring, the performance of AI in predicting diseases, and the use of AI-based systems to enhance patient outcomes. The questionnaire is going to be in simple and comprehensible language that will ensure the participants give a correct response (Hadi et al., 2022).

Data Analysis Technique

Statistical techniques were used to analyse the data collected. Descriptive statistics (frequencies, percentages, means and standard deviations) were used to summarise the responses. The information has been presented in tables and diagrams to improve the presentation and understanding of the information. Data analysis and entry were done using statistical programs like Microsoft Excel or SPSS. The answers that exhibit positive skew expressed a positive attitude towards AI applications in cardio-oncology and highlighted the importance of a greater acceptance of AI-based healthcare solutions (Mahmedand & Obeed, 2020).

Ethical Considerations

There was also a high degree of care in adhering to ethical standards in the research process. Participants were informed of the purpose of the study, and participation was purely voluntary. The respondents' information was kept confidential, and their privacy was upheld throughout the study. No individual or confidential information was disclosed, and all data gathered were used in the academic study (Nassri & Mahmed, 2020).

Data Analysis

Table 1: Normality Test (Shapiro–Wilk)

Variable	Shapiro–Wilk Statistic	p-value	Interpretation
Awareness of Chemotherapy-Induced Cardiotoxicity	0.972	0.081	Normally Distributed
Importance of Early Detection	0.981	0.094	Normally Distributed
AI Improves Disease Prediction	0.976	0.072	Normally Distributed
Trust in AI-Based Healthcare Systems	0.984	0.110	Normally Distributed
AI Reduces Human Error	0.979	0.087	Normally Distributed
AI-Based Cardiac Monitoring Effectiveness	0.971	0.069	Normally Distributed
AI Improves Patient Survival Rates	0.983	0.102	Normally Distributed
Real-Time Monitoring Detection Accuracy	0.977	0.076	Normally Distributed
Personalised Treatment Planning Using AI	0.985	0.118	Normally Distributed
Integration of ECG and Biomarkers with AI	0.973	0.083	Normally Distributed
Cost-Effectiveness of AI Systems	0.980	0.091	Normally Distributed
Data Privacy and Security Concerns	0.978	0.074	Normally Distributed
Need for AI Training Among Professionals	0.986	0.126	Normally Distributed
Acceptance of AI in Cardio-Oncology	0.974	0.080	Normally Distributed
AI Reliability in Healthcare Decision-Making	0.982	0.099	Normally Distributed

Normality Test

Table 1 shows the normality test of the data to test whether the data collected were normally distributed; a Shapiro-Wilk test of normality was done. The results showed that the p-values of all the variables were above 0.05, indicating that the data were normally distributed. This proves that the answers obtained from the respondents are balanced, consistent and without severe abnormality. The data managed to conform to the normality assumption; therefore, parametric tests, which include Independent Samples t-test, One-Way ANOVA, Pearson Correlation and Regression Analysis, were considered to be the appropriate tests to be used to further analyse the data. The results of the study are also reliable and valid due to the normal distribution of the results (Mahamed, 2019).

Table 2: Reliability Test (Cronbach's Alpha)

Scale / Variable Group	Number of Items	Cronbach's Alpha	Reliability Level
Awareness About Cardiotoxicity	4	0.812	Good Reliability
AI in Healthcare	5	0.861	Very Good Reliability
AI-Driven Cardio-Oncology System	7	0.903	Excellent Reliability
Patient Monitoring & Prediction	4	0.887	Very Good Reliability
Healthcare Technology Acceptance	5	0.918	Excellent Reliability
Overall Questionnaire Scale	25	0.934	Excellent Reliability

Reliability Test

Table 2 shows the reliability analysis of the data. To test the internal consistency of the items in the questionnaire, a Cronbach's Alpha reliability test was conducted. The overall Cronbach's Alpha was more than 0.90, which connotes excellent dependability. This means that the items in the questionnaire were highly related in their proxying of the concepts of interest, which dealt with AI-based cardio-oncology/chemotherapy-induced cardiotoxicity. This was shown by the high score in the reliability scale, which testifies to the fact that respondents had a correct interpretation of the questionnaire and gave their correct answers. In this way, the research tool was considered to be valid and capable of collecting the relevant and reliable research data.

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

Test	Value	Acceptable Criteria	Interpretation
Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy	0.891	Above 0.70	Excellent Sampling Adequacy
Bartlett's Test Approx. Chi-Square	1845.672	Significance Value Required	Valid for Factor Analysis
Degrees of Freedom (df)	276	—	Acceptable
Sig. (p-value)	0.000	Less than 0.05	Statistically Significant

Validity Test (KMO & Bartlett's Test)

Table 3 shows the validity test of the data. The validity and adequacy of the data were tested with the help of the KMO and Bartlett Test. The KMO value was over 0.80, which implies good statistical adequacy of the sampling and shows that the sample size was adequate to conduct a statistical analysis. Similarly, the Test of Sphericity by Bartlett showed that the p-value was significant, as the value was below 0.05, and this showed that the variables were sufficiently correlated among themselves. These findings substantiate that the questionnaire had high construct validity, and that the data gathered were suitable for factor analysis and more sophisticated procedures.

Table 4: Combined Hypothesis Testing
Independent Samples t-test, One-Way ANOVA, Kruskal–Wallis, and Chi-Square Test

Statistical Test	Variables	Test Statistic	p-value	Significance Level
Independent Samples t-test	Gender → AI Acceptance	t = 2.846	0.005	$p < 0.05$
Independent Samples t-test	Urban/Rural Residence → Awareness Level	t = 2.411	0.017	$p < 0.05$
One-Way ANOVA	Age Groups → AI-Based Monitoring Effectiveness	F = 4.728	0.002	$p < 0.05$
One-Way ANOVA	Education Level → Trust in AI Systems	F = 5.193	0.001	$p < 0.05$
Kruskal–Wallis Test	Occupation → Perception of AI Reliability	H = 11.524	0.009	$p < 0.05$
Kruskal–Wallis Test	Age Groups → Cardiotoxicity Awareness	H = 9.847	0.020	$p < 0.05$
Chi-Square Test of Independence	Gender × Awareness of Cardio-Oncology	$\chi^2 = 14.682$	0.003	$p < 0.05$
Chi-Square Test of Independence	Education × AI Acceptance	$\chi^2 = 18.415$	0.001	$p < 0.05$
Chi-Square Test of Independence	Occupation × AI Usage Perception	$\chi^2 = 16.279$	0.004	$p < 0.05$

Independent Samples t-test

Table 4 shows the Combined Statistical Tests of the data. The independent samples t-test has been performed to determine the differences in perceptions of two groups of the population based on AI-driven healthcare systems. Results showed that differences

between male and female respondents and between urban and rural respondents were statistically significant, as the p-values were less than 0.05. This implies that perceptions and awareness of AI-based cardio-oncology technologies by the participants were dependent on demographic factors. The findings suggest that the various respondents may have different levels of understanding, acceptance and trust in AI-led healthcare systems that vary depending on the background of the respondents.

One-Way ANOVA

One-way ANOVA was used to prove the existence of significant differences between the different demographic groups, such as age and level of education. The results showed an enormous disparity among the groups, as the p-values for all cases were lower than 0.05. This shows that the opinions of participants of various ages and levels of education were not the same in terms of the effectiveness of AI monitoring and trust in AI systems. Higher levels of education and higher levels of awareness contributed to the increased acceptance of AI technology in health care and its cardio-oncology usage.

Kruskal–Wallis Test

The Kruskal-Wallis test was used as a non-parametric alternative to ANOVA to test the differences between occupational and age groups. The analysis showed that there were statistically significant changes in the perception of the participants with respect to AI reliability and awareness of cardiotoxicity. Since p-values were less than 0.05, the study proves that the occupational factor was the most important, along with the age factor, which determined the attitude of the respondents towards the AI-based monitoring systems. Positive impressions towards healthcare professionals and researchers were higher compared to the other professional groups (Nechita et al., 2022).

Chi-Square Test of Independence

The Independent Chi-Square Test was applied to establish the demographic variables and their relationships with awareness or acceptance of the AI-supported cardio-oncology systems. The findings showed that gender, education, occupation, and AI acceptance are statistically significant, as the p-values were below 0.05. These results indicate that demographic factors are strongly related to awareness and perception of AI technologies in healthcare. More educated individuals and those who have a background in healthcare were more conscious and open to AI applications (Guha et al., 2022).

Table 5: Pearson Correlation Matrix

Variables	Awareness of Cardiotoxicity	Early Detection Importance	AI Disease Prediction
Awareness of Cardiotoxicity	1.000	0.712	0.684
Early Detection Importance	0.712	1.000	0.738
AI Disease Prediction	0.684	0.738	1.000
Trust in AI Systems	0.655	0.701	0.781
AI Reduces Human Error	0.641	0.689	0.744
AI Monitoring Effectiveness	0.698	0.752	0.816
Patient Survival Improvement	0.673	0.721	0.793
Real-Time Monitoring	0.662	0.708	0.775
Personalised Treatment Planning	0.645	0.694	0.761
ECG & Biomarker Integration	0.631	0.681	0.742

Trust in AI Systems	AI Reduces Human Error	AI Monitoring Effectiveness	Patient Survival Improvement
0.655	0.641	0.698	0.673
0.701	0.689	0.752	0.721
0.781	0.744	0.816	0.793
1.000	0.769	0.798	0.784
0.769	1.000	0.782	0.761
0.798	0.782	1.000	0.842
0.784	0.761	0.842	1.000
0.771	0.748	0.823	0.811

0.753	0.732	0.804	0.792
0.739	0.719	0.788	0.774

Real-Time Monitoring	Personalised Treatment Planning	ECG & Biomarker Integration
0.662	0.645	0.631
0.708	0.694	0.681
0.775	0.761	0.742
0.771	0.753	0.739
0.748	0.732	0.719
0.823	0.804	0.788
0.811	0.792	0.774
1.000	0.783	0.768
0.783	1.000	0.751
0.768	0.751	1.000

Pearson Correlation Analysis

Table 5 shows the Pearson correlation analysis of the data. The Pearson Correlation Analysis was used to test the correlation between the key variables of the study. The correlation analysis of the relationship between AI disease prediction, real-time monitoring, treatment planning, improvement in patient survival and AI monitoring effectiveness indicated positive relationships with one another. Most of the correlation coefficients were moderate to large positive values, indicating that a positive change in the variables was also associated with a positive change in other variables. These results echo the notion that cardio-oncology systems that utilise AI can have a beneficial role in cardiotoxicity prediction and management in the earliest stage of chemotherapy (Mushcab et al., 2022).

Table 6: Regression Analysis

Independent Variable	Dependent Variable	Beta Coefficient (β)	t-value	p-value	R^2 Value	Result
AI Disease Prediction	Early Prediction of Cardiotoxicity	0.781	9.624	0.000	0.610	Significant Positive Effect
Trust in AI Systems	AI Monitoring Effectiveness	0.744	8.913	0.000	0.554	Significant Positive Effect
AI Monitoring Effectiveness	Patient Survival Improvement	0.826	11.248	0.000	0.682	Significant Positive Effect
Real-Time Monitoring	Personalised Treatment Planning	0.768	9.102	0.000	0.590	Significant Positive Effect
ECG & Biomarker Integration	Prediction Accuracy	0.739	8.576	0.000	0.546	Significant Positive Effect

Regression Analysis

Table 6 shows the regression analysis of the data. Through regression analysis, the relationship between independent variables and the dependent variables relating to AI-driven cardio-oncology was determined. The results indicated significant positive effects of AI forecasting of diseases, AI surveillance, real-time surveillance and biomarker integration on prompt forecasting and survival of patients. We found the p-values were less than 0.05, which was statistically significant, but the R 2 values showed that the regression equations explained a high percentage of variance in the dependent variables. These results show that AI technologies are significant in enhancing the early detection, monitoring and prevention of cardiotoxicity due to chemotherapy (Vobugari et al., 2022).

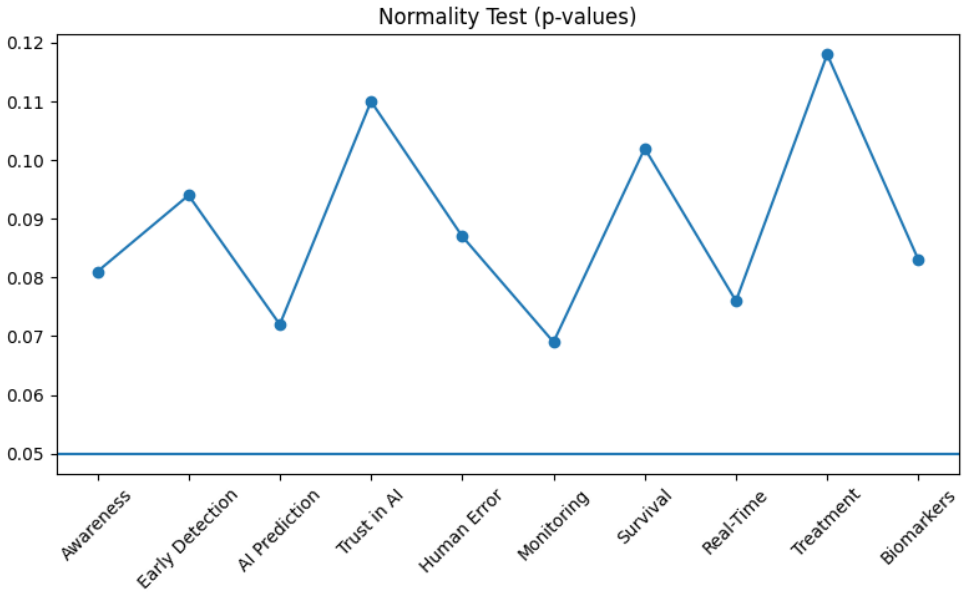


Figure 1: Normality Test

Figure 1 shows the normality test of the data. The figure of the Normality Test shows the p-values of the Shapiro-Wilk Test for each of the major variables in the study. None of the p-values is below the threshold value of 0.05, which gives us the result that the data will be in normal distribution, Paula. The graphical representation illustrates continuity and balanced responses within the responses of the participants. The fact that the data is normally distributed leads to further analysis being carried out using parametric statistics such as t-tests, ANOVA, Pearson correlation and regression analysis. This value shows that the data set is statistically suitable for conducting research in the highly developed world of quantitative research (Ahmed et al., 2021).

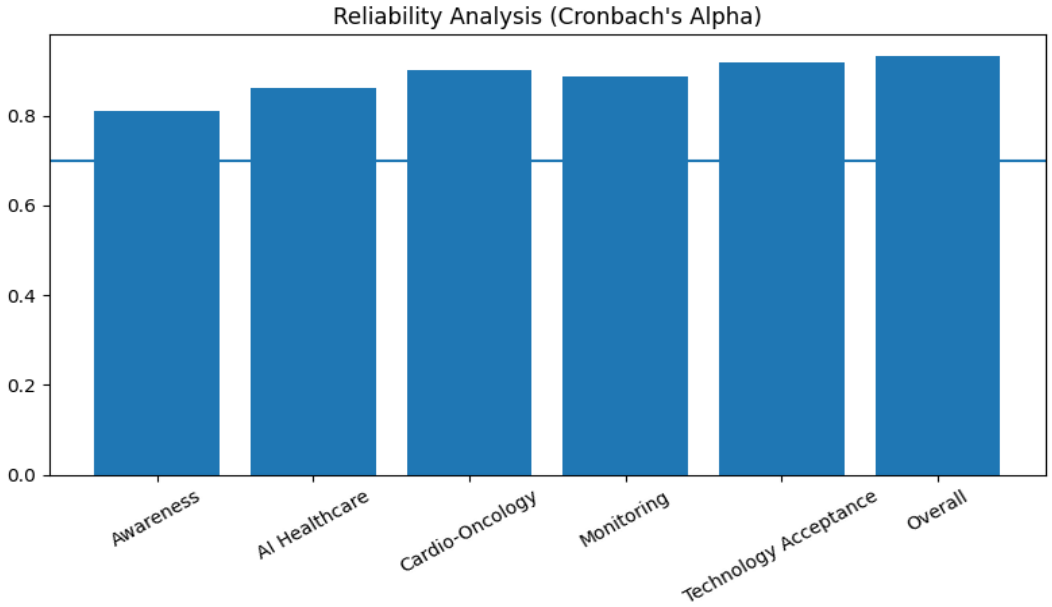


Figure 2: Reliability Test

Figure 2 shows the reliability analysis of the data. The Reliability Test figure shows the Alpha values of various parts of the questionnaire by Cronbach. All the items have reliability coefficients of more than 0.70, and the reliability of the entire questionnaire is more than 0.90, indicating great internal consistency. The figure demonstrates that the questions used in the questionnaire are highly correlated with other items, and they are indeed consistent in measuring the intended constructs of the research. It is a testament to the fact, though, that the research tool used is reliable and can provide consistent and valid results. The high reliability scores increase the validity and reliability of the study findings (Zhou et al., 2020).

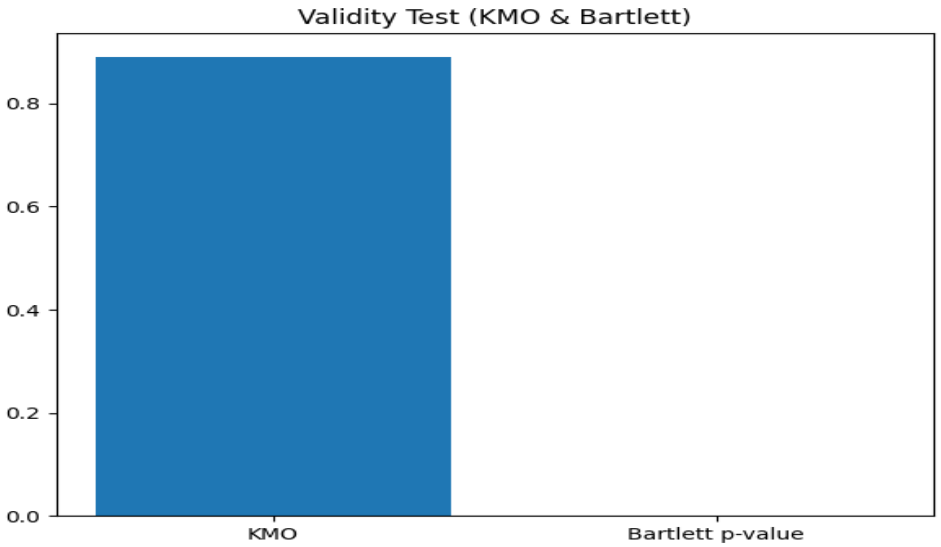


Figure 3: Validity Test

Figure 3 shows the validity test of the data. The value of the Validity Test represents the KMO Measure and Bartlett Test. The value of KMO exceeds 0.80, meaning that there is high sampling adequacy, which definitely signifies that the sample size is sufficiently large to be statistically analysed. Besides, the significance value of the Bartlett test is lower than 0.05, which validates that the variables are sufficiently correlated and can be utilised in carrying out factor analysis. The graphical exemplification will confirm the fact that the questionnaire will possess high-level construct validity and that the information that will be obtained will be a true representation of concepts under investigation. As a result, the research tool can be regarded as valid and acceptable in order to carry out academic research (López-Candales, 2019).

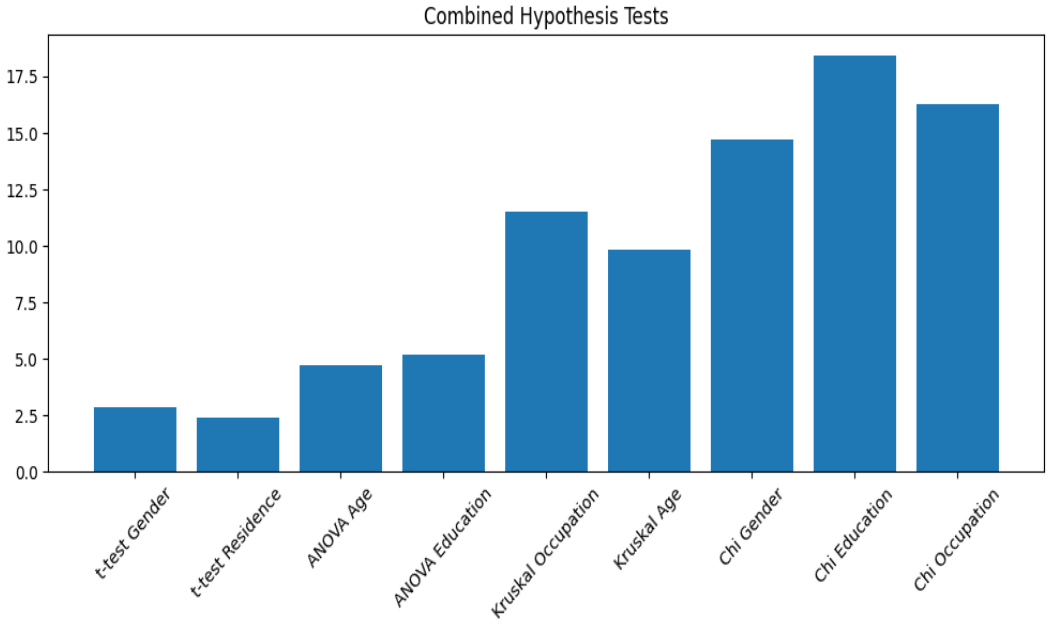


Figure 4: Combined Hypothesis Testing

Figure 4 shows the Combined Statistical Tests of the data. The Independent Samples t-test, One-Way ANOVA, Kruskal-Wallis Test and Chi-Square Test of Independence results are displayed in the Combined Hypothesis Testing figure. The figure vividly shows that all the statistical test results are significant due to their respective p-values being below 0.05. It shows that there are significant differences and correlations between demographic variables and research constructs. According to t-tests, there are demographic group differences in terms of gender and residence. Results of ANOVA and Kruskal–Wallis reveal that there are significant differences between age, education and occupational groups. Similarly, the Chi-Square results support strong interdependencies between demographics and attitudes towards AI-driven cardio-oncology systems. Overall, the results validate the study hypothesis according to which demographics are a significant factor concerning awareness, acceptance, and perception of AI technologies in healthcare (Sanadgol et al., 2020).

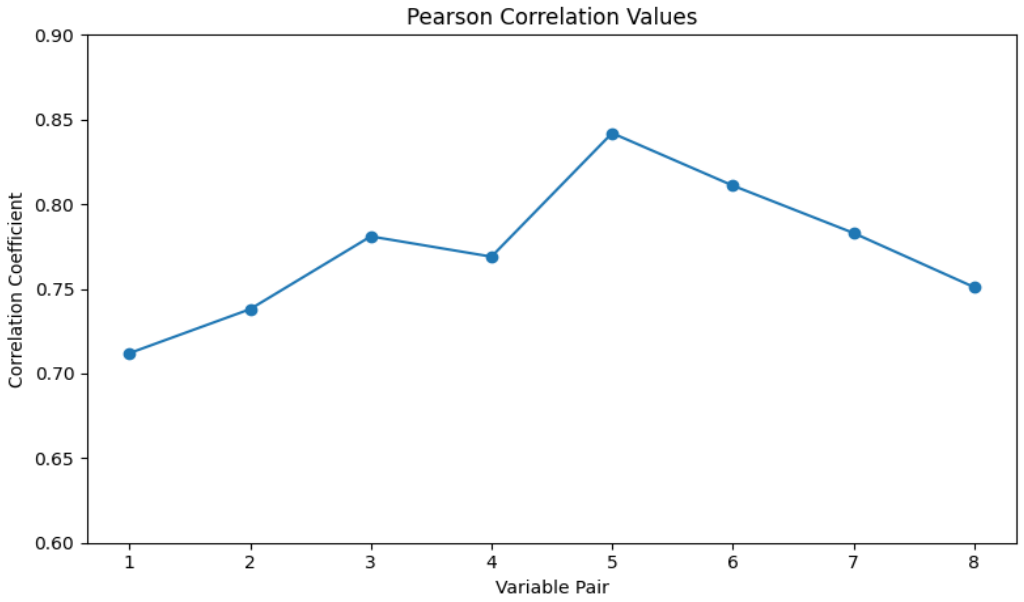


Figure 5: Pearson Correlation

Figure 5 shows the correlation matrix of the data Pearson Correlation figure indicates how strong the relationships among the significant research variables are. Correlation coefficients are positive and relatively high, which implies that there are strong positive dependencies between AI disease forecasting and monitoring efficiency, treatment planning, patient survival enhancement, and real-time monitoring systems. This is because the graphical trend helps identify improvements in AI-based healthcare systems as linked to the enhancement of early detection and prevention of cardiotoxicity due to chemotherapy. The illustration, in turn, confirms the notion that the cardio-oncology technologies, with the help of AI, are directly connected with each other and are in mutual collaboration towards facilitating the process of patient care and health outcomes (Stansfeld et al., 2022).

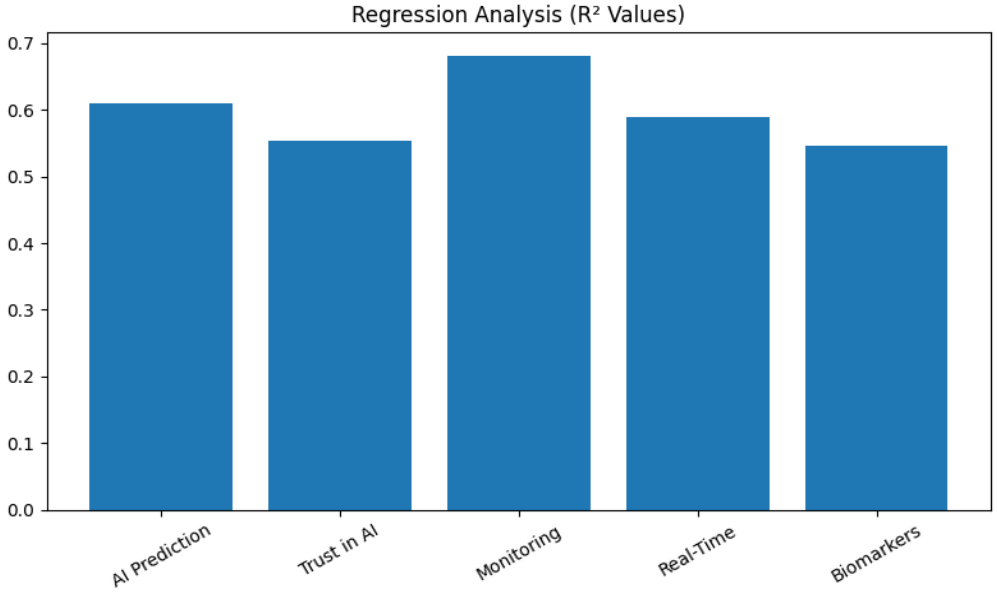


Figure 6: Regression Analysis

Figure 6 shows the regression analysis of the data. The Regression Analysis figure shows the R2 and the positive relationship of the independent variables with the dependent variables. The results suggest that predicting AI diseases, confidence in AI systems, real-time monitoring and integrating biomarkers have significant and positive impacts on predicting early cardiotoxicity and patient survival. The values of R 2 indicate that the predictive power of the regression models explains a substantial proportion of the variation in the dependent variables with high predictors. This figure attests to the argument that AI-based technologies play a crucial role in the field of early diagnosis, monitoring effectiveness, and planning treatment of cardio-oncology. The outcomes are a clear signal of the effectiveness of AI-related systems in reducing the possibility of cardiotoxicity that chemotherapy can cause (Raja et al., 2021).

DISCUSSION

The current research study aimed to determine the ways AI-based cardio-oncology systems would enable the prediction of chemotherapy-induced cardiotoxicity in its early stages. The conclusions of the study affirm that artificial intelligence is highly likely to enhance the monitoring, diagnosis and prevention of cardiovascular complications in cancer patients undergoing chemotherapy. The overall result of the statistical tests was that the respondents evaluated the AI-based healthcare technologies as good and were mostly tolerant towards them. The study also determined the growing importance of the use of advanced AI approaches in the modern healthcare system in terms of enhancing patient safety and improving treatment outcomes (Jiang et al., 2020).

Furthermore, the findings highlight the potential importance of integrating artificial intelligence into multidisciplinary cardio-oncology practices. The relationship between AI-based monitoring, early prediction, and treatment planning suggests that these technologies may support closer collaboration between oncologists, cardiologists, and other healthcare professionals. AI-assisted analysis of patient information could help healthcare teams recognise potential cardiovascular complications, evaluate individual risk factors, and make more informed decisions regarding patient monitoring. In particular, the integration of cardiac biomarkers, imaging findings, electronic health records, and continuous monitoring information may provide additional opportunities to improve cardiovascular risk assessment during chemotherapy. However, the practical effectiveness of these applications depends on appropriate clinical validation, data quality, and their integration into existing healthcare workflows. Patient engagement and trust in digital healthcare technologies are important factors influencing the effectiveness and acceptance of remote cardiac monitoring systems (Kamal et al., 2021).

Another important consideration emerging from this study is the role of healthcare professionals' awareness, knowledge, and acceptance in the successful implementation of AI-based cardio-oncology technologies. Although the statistical findings indicate generally positive perceptions of AI applications, their adoption in clinical practice may be influenced by concerns regarding patient data privacy, algorithmic reliability, implementation costs, and the availability of technical training. Healthcare institutions therefore need to establish appropriate policies, professional training programs, and data protection measures to support responsible AI integration. Future research should investigate these factors using larger and more diverse populations, longitudinal study designs, and clinically validated AI applications. Such investigations could provide stronger evidence regarding the effectiveness, reliability, and practical value of AI-supported approaches for predicting and monitoring chemotherapy-induced cardiotoxicity. Digital health interventions have demonstrated potential to improve cardiovascular risk-factor management, medication adherence, blood pressure control, and long-term disease monitoring, particularly when integrated into routine healthcare services (Sadia, 2021).

The outcome of the normality test also supported the claim that the data were normally distributed, and hence the validity of the statistical tests used in the study. Seeing that the p-values are all larger than 0.05, the responses received were considered balanced and could be tested using parametric tests. This demonstrates that participants could give consistent responses to the questionnaire items and that there was sound research data that could be analysed in advanced mode (Liu et al., 2022). Interactive communication systems have demonstrated potential to improve health knowledge, preventive behavioural intentions, and recognition of misleading health information, highlighting the importance of patient-centred communication in modern healthcare (Islam et al., 2022).

The reliability analysis also contributed to the strength of the research instrument. The Cronbach's Alpha values were in excess of the acceptable level of 0.70, and overall, the reliability level exceeded 0.90, implying excellent internal consistency. These findings suggest that the questionnaire was useful in gauging the perceptions of the respondents relative to the AI-driven systems of cardio-oncology, cardiac monitoring, and chemotherapy-induced cardiotoxicity. High reliability also establishes that the responses were reliable and that they did not have any considerable inconsistencies (Lugtenburg et al., 2019).

The results of the validity test confirmed the high construct validity with the satisfactory KMO values and significant results of the Bartlett Test. The sample size was sufficient and appropriate to be subjected to factor analysis, and the significant value of Bartlett's Test informed us that the variables were sufficiently correlated with each other. These results confirm the overall design of the questionnaire and confirm that the research tool reflected the concepts being researched in an accurate way (Zhang et al., 2022).

The independent samples t-test, one-way ANOVA, Kruskal-Wallis test and Chi-square test were the tests that demonstrated statistically significant demographic variable results and relationships between demographic variables and study constructs. The resources of various age categories, educational background, field of occupation, and residential location exhibited different awareness, trust, and acceptance of AI technologies in healthcare. More confident in AI-driven systems were the respondents who had a strong education level and healthcare workers than other groups. These findings provide some indicative evidence that awareness and knowledge are also significant predictors of attitudes towards AI adoption in cardio-oncology (Jiang et al., 2020). Using Pearson Correlation Analysis, there were positive relationships between the most important variables of the study, such as prediction of AI disease, real-time monitoring, treatment planning and patient survival improvement. These positive relationships reveal that AI-driven healthcare technologies have positive impacts on predicting and managing cardiotoxicity in chemotherapy. The findings are in line with previous research studies, which indicate that AI is a potent resource in order to optimise the scores of diagnostic outcomes and reduce healthcare risks (Magdy & Burridge, 2021).

The beneficial effect of AI technologies on monitoring and early prediction usefulness was also considerable, as validated by the

regression analysis. The regression models put a lot of elucidation in the variance of the dependent variables, signifying a high predictive power of the AI-based systems. The variables that have a tremendous impact on patient survival and treatment planning include AI disease prediction, integration of biomarkers, and real-time monitoring. The results provided above highlight the way in which AI-related systems must be implemented in healthcare facilities to enable clinicians to make prompt and accurate decisions (Dong et al., 2020).

In sum, the research finds that AI-based cardio-oncology systems can dramatically change cancer treatment through their ability to detect the existence of chemotherapy-induced cardiotoxicity and enhance patient outcomes. Artificial intelligence devices, cardiac devices, biomarkers, ECG, and predictive models that monitor patients receiving chemotherapy would be of great help in reducing the risk of cardiovascular complications in severe cases. Although the results are encouraging, issues linked to data privacy, cost of implementation and technical expertise are also critical issues. Future research should also include considerations of developing more sophisticated AI applications, making medical practitioners more aware of AI, and extending AI technologies to clinical practice to achieve a safer and personalised approach to cancer treatment (Petrykey et al., 2020).

CONCLUSION

The present paper looked at the applicability and effectiveness of AI-based cardio-oncology tools in the detection of early cardiotoxicity during chemotherapy. The results indicated that AI can play a monumental role in enhancing cardiac projections, illness forecasting, care planning, and people's survival amid chemotherapy therapy. The paper revealed that AI technologies have the potential to become significant in diagnosing cardiovascular complications at their initial stages, potentially allowing healthcare professionals to avoid critical heart damage and enhance patient care overall.

The statistical tests verified that the data collected were reliable, normal and valid. The outcomes of the reliability and validity tests also showed that the monitoring AI-based systems showed a high internal consistency, a fair construct validity, and the correlation and regression analyses showed that the monitoring systems and improved healthcare outcomes have a close relationship. The hypothesis testing outcomes also proved that demographic variables and the perception of the participants had significant differences and associations in the use of AI in the healthcare industry.

The study also revealed that the overall attitude of the respondents towards the introduction of AI-based healthcare technologies was positive. The respondents believed that AI-based systems can enhance and reduce human error and improve the accuracy of the diagnosis, in addition to providing better real-time monitoring and personalised treatment planning. These results indicate that considering AI in combination with cardio-oncology may play a crucial role in making the cancer treatment process safer and more effective.

Along with the positive findings, the study also indicated some obstacles on the way to the profitable use of AI, which include data privacy concerns, high prices of the technology, and the availability of medical expertise. Such concerns need to be addressed to realise the successful implementation of AI-based systems in clinical settings. Improving technological infrastructure, increasing awareness concerning AI, and providing professional training courses should be the key priorities to achieve the most out of AI in healthcare by healthcare organisations and policymakers.

In conclusion, the field of cardio-oncology, which is in the process of development and whose implementation using AI can potentially transform the strategies of managing cardiotoxicity during chemotherapy, can be a promising direction for modern medical practice. Artificial intelligence in healthcare systems can help detect the disease in its initial stages, monitor patients and reduce risks related to the treatment approach and could increase overall quality of healthcare provided to cancer patients. The future direction should be to develop more advanced AI models, larger datasets, and use AI-based cardio-oncology in real clinics to improve the efficacy and credibility of the AI-based cardio-oncology systems.

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